
CMOS × CGU
2025
Resilient Futures
Un avenir résilient
May 25-29
TCU Place • Saskatoon, SK
cmos.ca | scmo.ca | cgu-ugc.ca

CMOS 59th Congress with CGU

May 25-29, 2025 – Saskatoon SK (hybrid)

* * *

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OFFICE OF THE MAYOR

— City of —
Saskatoon

On behalf of the City of Saskatoon, I am delighted to welcome all delegates to the Joint Scientific Congress of the Canadian Meteorological and Oceanographic Society and the Canadian Geophysical Union.

We are honoured to host this prestigious gathering of scientists, researchers, and experts whose work is vital to understanding and protecting our planet. Saskatoon is a city rooted in innovation and collaboration, and we are proud to provide a space where ideas can flourish, and knowledge can be shared.

Thank you for choosing Saskatoon. I hope you find inspiration in your discussions and enjoy all that our vibrant community has to offer.

Warm regards,

Cynthia Block
Mayor

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Government
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Minister of Environment

Legislative Building
Regina, Canada S4S 0B3

A Message from the Minister of Environment

On behalf of the Government of Saskatchewan, we are pleased to welcome you all to Saskatchewan for the 59th Joint Scientific Congress of the Canadian Meteorological (CMOS)and Oceanographic Society, and the Canadian Geophysical Union (CGU).

It's not every day that our province hosts the largest annual gathering of earth and environmental scientists in the country. Saskatchewan has been and will continue to be a leader in emissions reduction initiatives and technologies, while continuing to be the home of the most environmentally responsible resource sector in the world. I encourage you to see first-hand how as a province, we are reducing our emissions through sustainable land use practices, progressive environmental regulations, and innovative technology, while also maintaining the competitiveness of our businesses and industry.

This year's theme, "Resilient Futures," really resonates with some big questions—how do we build communities and systems that are strong enough to handle the unexpected, but flexible enough to keep evolving? How do we adapt to a changing climate without leaving communities behind? How do we protect critical ecosystems while supporting growing populations and industries? These aren't just theoretical questions – they're challenges you tackle every day.

Your research and insights play a key role in our decisions, not just today but for future generations. I hope you have a fantastic week of learning, connecting and sharing ideas. And while you're here, I encourage you to enjoy what Saskatoon has to offer—great food, beautiful river views and some of the friendliest people you'll ever meet.

Thank you to the organizers for putting this together, and to all of you for the work you do. Your dedication and insights are helping to shape a more resilient, sustainable future. Welcome to Saskatchewan and have a wonderful time at the Congress!

Sincerely,

Travis Keisig
Minister of Environment

2025 Partners

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[(780) 454-2505](tel:7804542505)

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Company representatives

Zach Boudreau

(He/Him)Technical Sales ConsultantCampbell Scientific

Adam Green

Technical Sales ConsultantCampbell Scientifix

City of Saskatoon

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Canadian National Committee for SCOR
Comité national canadien pour SCOR
Scientific Committee on Oceanic Research

CNC-SCOR - Canadian National Committee (CNC) - SCOR (Scientific Committee on Oceanographic Research)

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About

SCOR is the leading international non governmental organization for the promotion and coordination of international oceanographic activities (see https://scor-int.org/scor/about/). It does not have the resources to fund research directly; therefore, SCOR science activities focus on promoting international cooperation in planning and conducting oceanographic research, and solving methodological and conceptual problems that hinder research. Scientists from thirty six nations participate in SCOR working groups and scientific steering committees for large scale ocean research projects.
The working groups are the heart of SCOR's program, each proposed by scientists from the community with specific terms of reference and a finite period of operation.

The Canadian National Committee (CNC) - SCOR is the senior non-governmental oceanographic coordinating committee in Canada. Canada has been a member since shortly after the founding of SCOR in 1957. CNC-SCOR is supported by the Department of Fisheries and Oceans (DFO) and the National

Research Council of Canada (NRC). Organizational support is provided by the Canadian Meteorological and Oceanographic Society (CMOS). For more information on CNC-SCOR, see https://www.cncscor.ca/site/background/CNC.

Contact

Visit Website

https://www.cncscor.ca/site/background/CNC

Company representatives

Paul Myers

Global Institute for Water Security

USASK

Global Institute for Water Security (GIWS)

About

The Global Institute for Water Security at the University of Saskatchewan is a leading water resources research institute in Canada and one of the most advanced hydrology research centres in the world. GIWS is dedicated to:

Protecting water resources
Helping protect our precious freshwater resources needed for the world's growing demand for sustainable food production

Mitigating water-related disasters
Mitigating the risk of water-related disasters such as floods, droughts, and fires

Anticipating global change
Predicting and forecasting extremes of global change through the use of advanced remote sensing and modelling techniques

Co-creating research with Indigenous Peoples
Co-creating research and braiding Traditional Knowledge with modern science to empower Indigenous communities in protecting healthy waters, people, and ecosystems

Contact

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3069668014

Visit Website

https://water.usask.ca/index.php

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Follow on LinkedIn

https://www.linkedin.com/company/global-institute-for-water-security/

Company representatives

Viviana Barrera Niño

Research coordinatorGIWS

Documents

Everyone Together Mistawasis Nehiyawak Water Gathering Statement.pdf

2 MB

GIWS Pamphlet (8.75 x 11.25 in).pdf

4 MB

Link

GIWS Youtube

https://www.youtube.com/usaskgiws

Instagram

https://www.instagram.com/usask_water/#

GLOBAL WATER FUTURES OBSERVATORIES

Global Water Futures Observatories (GWFO)

About

Global Water Futures Observatories (GWFO) is Canada's premier national freshwater research facility, funded in part through the Canada Foundation for Innovation (CFI) and its Major Science Initiatives (MSI) from 2023–2029. GWFO supports critical water research to safeguard Canadian water resources in an era of rapid change. It operates 64 instrumented water observation sites in lakes, rivers, wetlands, glaciers, and drainage basins across Canada; 15 deployable measurement systems for specialized field data acquisition; and 18 state-of-the-art water laboratories at the partner universities for detailed water quality, biological, and other analyses. The geographical scope of GWFO covers four major transboundary (interprovincial and territorial, international) river basins, including the Yukon, Mackenzie, Saskatchewan–Nelson, and Great Lakes–St. Lawrence. GWFO is led by the University of Saskatchewan (USask) and is a partnership amongst USask, the University of Waterloo, McMaster University, Wilfrid Laurier University, the University of Windsor, Trent University, Carleton University, the University of Western Ontario, and the University of Toronto.

Contact

Give a Call

[306-966-1427](tel:306-966-1427)

Visit Website

https://gwfo.ca/

Follow on LinkedIn

https://www.linkedin.com/company/global-water-futures

Company representatives

Stacey Dumanski

Documents

GWFO Brochure (8.5 x 11 in).pdf

6 MB

Link

GWFO Mailing List - Sign Up

https://gwfo.ca/outreach/enewsletter.php

BlueSky

https://bsky.app/profile/gwfobservatories.bsky.social

Instagram

https://www.instagram.com/gwf_water/

Hoskin Scientific

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Company representatives

Julie Robinson

Hoskin Scientific

Documents

Edmonton-Systems.pdf

33 MB

METER-ENV.pdf

3 MB

Onset-Product-Catalog-2023.pdf

6 MB

SoilScience.pdf

6 MB

Water-Level-Flow.pdf

3 MB

WaterQuality.pdf

8 MB

Ocean Networks Canada

Contact

Visit Website

https://www.oceannetworks.ca/

Company representatives

Kohen Bauer

Director, ScienceOcean Networks Canada

Ocean Frontier Institute

About

The Ocean Frontier Institute (OFI), led by Dalhousie University, is a global leader in interdisciplinary ocean research.

Established in September 2015, OFI unites researchers, industry, and government to solve complex ocean problems.

Contact

Visit Website

https://www.ofi.ca

Company representatives

Andrea Anderson

Khrista Jeffrey

Pelmorex - The Weather Network

Contact

Visit Website

https://www.pelmorex.com/en/

University of Saskatchewan

Contact

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2025 CMOS-CGU Congress - Week at a Glance

This schedule is subject to change, All times listed are in Local Saskatchewan time (Central Standard Time (CST)

Week at a Glance / La semaine en coup d'oeil

Time (SK) Heures	Sunday May 25 Dimanch 25 mai	Monday May 26 Lundi 26 mai	Tuesday May 27 Mardi 27 mai	Wednesday May 28 Mecredi 28 mai	Thursday May 29 Jeudi 29 mai	Time (SK) Heures (SK)
8:30 - 9:00		Opening ceremony Cérémonie d'ouverture				8:30 - 9:00
9:00 - 10:00		Plenary 1 / Plénière 1 Dr. Joseph Shea (UNBC) Maria Chadid Hernandez (UNBC) The importance of EDI in 2025	Plenary 2 / Plénière 2 Dr. Catherine Robin (Canadian Geodetic Survey) Modernization of Heights Above Sea Level and other spatial references: Implications for geospatial and hydrospatial data	Plenary 3A&B / Plénière 3A&B Dr. Genevieve Ali (McGill), From hydrological process studies to watershed management: can we bridge the scale gap? (Woo Lecture) Dr. Rachel Chang (Dalhousie), How marine emissions contribute to atmospheric particles, with implications for climate	Plenary 4A&B / Plénière 4A&B Dr. Helen Baulch (U. Sask), Eutrophication, harmful algal blooms, and a conversation on the place of water science in environmental problem solving. Dr. Doug Degenstein (U. Sask), Thirty Five Years of Atmospheric Remote Sensing from Satellite Platforms – A University of Saskatchewan Perspective	9:00 - 10:00
10:00 - 10:30		Break / Pause				10:00 - 10:30
10:30 - 12:00		Parallel Sessions / Sessions parallèles (2010,3030,7040,8010,8040,10020,12010)	Parallel Sessions / Sessions parallèles (2030,4060,5020,6010,6020,8020)	Parallel Sessions / Sessions parallèles (2020,3050,4050,6010,7050,8020,10040)	Parallel Sessions / Sessions parallèles (3010,5030,8030,8050,9020,NEMO)	10:30 - 12:00
12:00 - 13:30 Lunch (provided) / Déjeuner (fourni)		Lunch (provided) / Déjeuner (fourni)				12:00 - 13:30
		AGMs: Biogeosciences, Hydrology, Geodesy	Student Career Fair Salon de l'emploi pour les étudiant(e)s			
13:30 - 15:00		Parallel Sessions / Sessions parallèles (2010,3020,5080,7040,8040,10020,7010)	Parallel Sessions / Sessions parallèles (3040,4060,6010,8020,10040,13020)	Parallel Sessions / Sessions parallèles (3050,4050,6010,7050,8030,9010,10030)	Parallel Sessions / Sessions parallèles (3060,5050,8030,9020,NEMO)	13:30 - 15:00
15:00 - 15:30	Registration Inscription	Break / Pause				15:00 - 15:30
15:30 - 17:00		Parallel Sessions / Sessions parallèles (2030,3020,5020,7020,7040,8040,12030)	Poster Session Session d'affiches	Parallel Sessions / Sessions parallèles (4050,5010,8030,10030)	(NEMO)	15:30 - 17:00
17:00 - 18:00		PICO-F CGU AGM	NSERC Session CYHS Workshop			17:00 - 18:00
18:00 - 22:00	19:00 – 20:00 Public Lecture / Conférence publique Dr. Corrine Schuster-Wallace (U. Sask), Changing Waterscapes; Resilient Futures			18:00 – 21:00 Banquets		18:00 - 22:00
	20:00 – 22:00 Icebreaker Reception / Réception brise-glace					

Local Saskatchewan time is UTC-6 or EDT-2 / l'heure locale de la Saskatchewan est UTC-6 ou HAE-2

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12:00 - 13:30 Lunch (provided) / Déjeuner (fourni)		Lunch (provided) / Déjeuner (fourni)				12:00 - 13:30
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Session Schedule / Horaire du sessions

Time (SK) Heures (SK)	Salon B	Salon C	Salon D	Gallery A	Gallery B	Gallery C	Gallery D	Time (SK) Heures (SK)
	Monday May 26 / lundi 26 mai							
8:30 - 9:00	Opening Ceremony			No Sessions / non sessions				8:30 - 9:00
9:00 - 10:00	Plenary/ Plénière Maria Chadid Hernandez (University of Northern British Columbia) Dr. Joseph Shea (University of Northern British Columbia) Title: The importance of EDI in 2025							9:00 - 10:00
10:00 - 10:30	Break / Pause							10:00 - 10:30
10:30 - 12:00	7040 - Satellite Earth Observation: A unique view of our planet and a critical need for Canada's resilient future - Part 1	8040 - Global Water Futures: Solutions to water threats in an era of global change - Part 1	3030 - General Biogeoscience	2010 - Atmosphere, Ocean, and Climate Dynamics - Part 1	8010 - Advances in forest ecohydrology	10020 - Biological, physical, and chemical oceanographic research - Part 1	12010 - General Geodesy and Geodynamics	10:30 - 12:00
12:00 - 13:30 Lunch (provided) / Déjeuner (fourni)	Lunch (provided) / Déjeuner (fourni)		Biogeosciences AGM	Lunch (provided) / Déjeuner (fourni)	Hydrology AGM	Lunch (provided) / Déjeuner (fourni)	Geodesy AGM	12:00 - 13:30
13:30 - 15:00	7040 - Satellite Earth Observation: A unique view of our planet and a critical need for Canada's resilient future - Part 2	8040 - Global Water Futures: Solutions to water threats in an era of global change - Part 2	3020 - Biogeosciences perspectives Part 1	2010 - Atmosphere, Ocean, and Climate Dynamics - Part 2	5080 - Climate Community, Services & Education	10020 - Biological, physical, and chemical oceanographic Part 2	7010 - Enhancing Weather and Climate Monitoring Capacity through Collaboration	13:30 - 15:00
15:00 - 15:30	Break / Pause							15:00 - 15:30
15:30 - 17:00	7040 - Satellite Earth Observation: A unique view of our planet and a critical need for Canada's resilient future - Part 3	8040 - Global Water Futures: Solutions to water threats in an era of global change - Part 3	3020 - Biogeosciences perspectives Part 2	7020 - Greening and resilience of monitoring networks and programs	2030 - Atmosphere - Theoretical to applied science - Part 1	5020 - Climate Variability and Predictability - Part 1	12030 - Quantum Geophysics	15:30 - 17:00
17:00 - 18:30	CGU AGM	No Sessions / non sessions	PICO-F	No Sessions / non sessions				17:00 - 18:30

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Session Schedule / Horaire du sessions

Time (SK) Heures (SK)	Salon B	Salon C	Salon D	Gallery A	Gallery B	Gallery C	Gallery D	Time (SK) Heures (SK)
	Tuesday May 27 / mardi 27 mai							
8:30 - 9:00								8:30 - 9:00
9:00 - 10:00	Plenary/ Plénière Dr. Catherine Robin (Canadian Geodetic Survey) Title: Modernization of Heights Above Sea Level and other spatial references: Implications for geospatial and hydrospatial data			No Sessions / non sessions				9:00 - 10:00
10:00 - 10:30	Break / Pause							10:00 - 10:30
10:30 - 12:00	4060 - Canadian Climate Services, Impact Assessment, and Actionable Climate Informatio n Part 1	6010 - Observation and modelling of snow and glacier processes Part 1	8020 - Changing Chemical Loads in Evolving Watersheds - Part 1	6020 - Permafrost Hydrology and Hydrogeology Interactions	2030 - Atmosphere - Theoretical to applied science - Part 2	5020 - Climate Variability and Predictability - Part 2		10:30 - 12:00
12:00 - 13:30 Lunch (provided) / Déjeuner (fourni)	Lunch (provided) / Déjeuner (fourni)			Student Career Fair Salon de l'emploi pour les étudiant(e)s	Lunch (provided) / Déjeuner (fourni)			12:00 - 13:30
13:30 - 15:00	4060 - Canadian Climate Services, Impact Assessment, and Actionable Climate Information Part 2	6010 - Observation and modelling of snow and glacier processes Part 2	8020 - Changing Chemical Loads in Evolving Watersheds - Part 2	3040 - Methane Emissions and Measurement Techniques Across Canada	13020 - Multidisciplinary Community, Services & Education	10040 - Ocean Theoretical to applied science - Part 1		13:30 - 15:00
15:00 - 15:30	Break / Pause							15:00 - 15:30
15:30 - 17:00	**Poster Session** **Session d'affiches**							15:30 - 17:00
17:00 - 18:30	**No Sessions / non sessions**			NSERC Session	CYHS Workshop	**No Sessions / non sessions**		17:00 - 18:30

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Session Schedule / Horaire du sessions

Time (SK) Heures (SK)	Wednesday May 28 / mercredi 28 mai							Time (SK) Heures (SK)
	Salon B	Salon C	Salon D	Gallery A	Gallery B	Gallery C	Gallery D	
8:30 - 9:00								8:30 - 9:00
9:00 - 10:00	Plenary A/ Plénière A Dr. Rachel Chang (Dalhousie) Title: How marine emissions contribute to atmospheric particles, with implications for climate		Plenary B/ Plénière B Dr. Genevieve Ali (McGill) Title: From hydrological process studies to watershed management: can we bridge the scale gap? (Woo Lecture)	**No Sessions / non sessions**				9:00 - 10:00
10:00 - 10:30	Break / Pause							10:00 - 10:30
10:30 - 12:00	4050 - Transforming Canada's Weather Services for a Resilient Future - Part 1	6010 - Observation and modelling of snow and glacier processes Part 3	8020 - Changing Chemical Loads in Evolving Watersheds - Part 3	7050 - The Polar Night Experiment (PONEX) Aircraft Campaign in Inuvik - Part 1	2020 - Collaborative Earth System Modelling in Canada	10040 - Ocean Theoretical to applied science - Part 2	3050 - Peatland Disturbance and Policy in Canada - Part 1	10:30 - 12:00
12:00 - 13:30 Lunch (provided) / Déjeuner (fourni)	Lunch (provided) / Déjeuner (fourni)							12:00 - 13:30
13:30 - 15:00	4050 - Transforming Canada's Weather Services for a Resilient Future - Part 2	6010 - Observation and modelling of snow and glacier processes - Part 4	9010 - Advances and applications of artificial intelligence in meteorology	7050 - The Polar Night Experiment (PONEX) Aircraft Campaign in Inuvik - Part 2 + Part 3 Campaign discussion	10030 - Discussions on development, evaluation and analysis of ocean circulation...Modeling Capacity in Canada - Part 1	8030 - General Hydrology - Part 1	3050 - Peatland Disturbance and Policy in Canada - Part 2	13:30 - 15:00
15:00 - 15:30	Break / Pause							15:00 - 15:30
15:30 - 17:00	**No Sessions / non sessions**			4050 - Transforming Canada's Weather Services for a Resilient Future - Part 3	10030 - Discussions on development, evaluation and analysis of ocean circulation...Modeling Capacity in Canada - Part 2	8030 - General Hydrology - Part 2	5010 - Deep understanding of Wx and climate extreme through regional climate modeling	15:30 - 17:00
18:00 - 21:00	**CGU Banquet***	**CMOS Banquet***		*** Common Reception from / réception commune de 18:00-19:00**				18:00 - 21:00

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Session Schedule / Horaire du sessions

Time (SK) Heures (SK)	Salon B	Salon C	Salon D	Gallery A	Gallery B	Gallery C	Gallery D	Time (SK) Heures (SK)
	Thursday May 29 / jeudi 29 mai							
8:30 - 9:00								8:30 - 9:00
9:00 - 10:00	Plenary A / Plénière A Dr. Doug Degenstein (U. Saskatchewan), Thirty Five Years of Atmospheric Remote Sensing from Satellite Platforms - A University of Saskatchewan Perspective		Plenary B / Plénière B Dr. Helen Baulch (U. Saskatchewan), Title: Maybe we can't solve this one: Eutrophication, harmful algal blooms, and a conversation on the place of water science in	No Sessions / non sessions				9:00 - 10:00
10:00 - 10:30	Break / Pause							10:00 - 10:30
10:30 - 12:00	9020 - Applications of AI and machine learning to the atmosphere/ocean/climate system - Part 1	8030 - General Hydrology - Part 3	3010 - Biogeochemistry of Boreal Ecosystems	5030 - ClimatEx: Downscaling for Weather and Climate Extremes	8050 - Hydrometeorology of Lakes and Reservoirs	**No Sessions / non sessions**	NEMO Workshop	10:30 - 12:00
12:00 - 13:30 Lunch (provided) / Déjeuner (fourni)	Lunch (provided) / Déjeuner (fourni)							12:00 - 13:30
13:30 - 15:00	9020 - Applications of AI and machine learning to the atmosphere/ocean/climate system - Part 2	8030 - General Hydrology - Part 4	3060 - Potential of Canadian Peatlands as Nature-Based Climate Solutions	5050 - Weather, Climate, and Environmental Extremes	**No Sessions / non sessions**		NEMO Workshop	13:30 - 15:00
15:00 - 15:30	Break / Pause							15:00 - 15:30
15:30 - 17:00	**No Sessions / non sessions**						NEMO Workshop	15:30 - 17:00
17:00 - 18:30								17:00 - 18:30

Local Saskatchewan time is UTC-6 or EDT-2 / l'heure locale de la Saskatchewan est UTC-6 ou HAE-2

Schedule / Agenda

May 25, 2025	**Sunday - Day 0**		
19:00 - 20:00 CST	Salon B/C/D	Public Lecture - Changing Waterscapes; Resilient Futures	Christopher Marsh Craig Smith Andrew Ireson
20:00 - 22:00 CST		ICEBREAKER	
May 26, 2025	**Monday - Day 1**		
08:30 - 09:00 CST	Salon B/C/D	OPENING SESSION	Craig Smith Andrew Ireson Christopher Marsh
09:00 - 10:00 CST	Salon B/C/D	1001 Plenary - The importance of EDI in 2025	Christopher Marsh
10:00 - 10:30 CST		COFFEE BREAK	
10:30 - 12:00 CST	Gallery A	2010 Atmosphere, Ocean, and Climate Dynamics - Part 1	Adam Monahan
10:30 - 12:00 CST	Gallery B	8010 Advances in forest ecohydrology	Jason Leach
10:30 - 12:00 CST	Gallery C	10020 Biological, physical, and chemical oceanographic research to enhance and support resilient and healthy marine ecosystems - Part 1	Heather Andres
10:30 -	Gallery D	12010 General Geodesy and Geodynamics	Ismael

12:00 CST			Foroughi
10:30 - 12:00 CST	Salon B	7040 Satellite Earth Observation: A unique view of our planet and a critical need for Canada's resilient future - Part 1	Kaley Walker Adam Bourassa
10:30 - 12:00 CST	Salon C	8040 Global Water Futures: Solutions to water threats in an era of global change - Part 1	Chris DeBeer
10:30 - 12:00 CST	Salon D	3030 General Biogeoscience	Britt Hall
12:00 - 13:30 CST		LUNCH (provided)	
12:00 - 13:30 CST	Gallery B	Hydrology AGM	
12:00 - 13:30 CST	Gallery D	Geodesy AGM	
12:00 - 13:30 CST	Salon D	Biogeosciences AGM	
13:30 - 15:00 CST	Gallery A	2011 Atmosphere, Ocean, and Climate Dynamics - Part 2	Adam Monahan
13:30 - 15:00 CST	Gallery B	5080 Climate - Community, Service and Education	
13:30 - 15:00 CST	Gallery C	10021 Biological, physical, and chemical oceanographic research to enhance and support resilient and healthy marine ecosystems - Part 2	Heather Andres
13:30 - 15:00 CST	Gallery D	7010 Enhancing Weather and Climate Monitoring Capacity through Collaboration	Kristine Confalone
13:30 -	Salon B	7041 Satellite Earth Observation: A unique	Kaley Walker

15:00 CST		view of our planet and a critical need for Canada's resilient future - Part 2	Adam Bourassa
13:30 - 15:00 CST	Salon C	8041 Global Water Futures: Solutions to water threats in an era of global change - Part 2	Chris DeBeer
13:30 - 15:00 CST	Salon D	3020 biogEosCiences peRspectives - Part 1	Sophie Wilkinson
15:00 - 15:30 CST		COFFEE BREAK	
15:30 - 17:00 CST	Gallery A	7020 Greening and resilience of monitoring networks and programs	Paige Aldridge
15:30 - 17:00 CST	Gallery B	2030 Atmosphere - Theoretical to applied science - Part 1	Serge Desjardins Julie Theriault
15:30 - 17:00 CST	Gallery C	5020 Climate Variability and Predictability - Part 1	Hai Lin
15:30 - 17:00 CST	Gallery D	12030 Quantum Geodesy: A New Frontier	Catherine Robin
15:30 - 17:00 CST	Salon B	7042 Satellite Earth Observation: A unique view of our planet and a critical need for Canada's resilient future - Part 3	Kaley Walker Adam Bourassa
15:30 - 17:00 CST	Salon C	8042 Global Water Futures: Solutions to water threats in an era of global change - Part 3	Chris DeBeer
15:30 - 17:00 CST	Salon D	3021 biogEosCiences peRspectives - Part 2	Sophie Wilkinson
17:00 - 18:30 CST	Salon B	CGU AGM	
17:00 - 18:30	Salon D	La Présentation Intensive et Courte pour Orateurs Francophone (PICO-F)	

CST			
May 27, 2025	**Tuesday - Day 2**		
09:00 - 10:00 CST	Salon B/C/D	1002 Plenary - Modernization of Heights Above Sea Level and other spatial references: Implications for geospatial and hydrospatial data	Christopher Marsh
10:00 - 10:30 CST		COFFEE BREAK	
10:30 - 12:00 CST	Gallery A	6020 Permafrost Hydrology and Hydrogeology Interactions	Christopher Spence
10:30 - 12:00 CST	Gallery B	2031 Atmosphere - Theoretical to applied science - Part 2	Julie Theriault Serge Desjardins
10:30 - 12:00 CST	Gallery C	5021 Climate Variability and Predictability - Part 2	Hai Lin
10:30 - 12:00 CST	Salon B	4060 Canadian Climate Services, Impact Assessment, and Actionable Climate Information - Part 1	Michael Morris
10:30 - 12:00 CST	Salon C	6010 Observation and modelling of snow and glacier processes - Part 1	Christopher Marsh Craig Smith
10:30 - 12:00 CST	Salon D	8020 Changing Chemical Loads in Evolving Watershed - Part 1	Serghei Bocaniov
12:00 - 13:30 CST		LUNCH (provided)	
12:00 - 13:00 CST	Gallery A	Student Career Fair	Jim Abraham
13:30 - 15:00 CST	Gallery A	3040 Methane Emissions and Measurement Techniques Across Canada	Rayden Laliberte

13:30 - 15:00 CST	Gallery B	13020 Multidisciplinary- Community, Service and Education	Serge Desjardins
13:30 - 15:00 CST	Gallery C	10040 Ocean - Theoretical to applied science - Part 1	Nancy Soontiens
13:30 - 15:00 CST	Salon B	4061 Canadian Climate Services, Impact Assessment, and Actionable Climate Information - Part 2	Michael Morris
13:30 - 15:00 CST	Salon C	6011 Observation and modelling of snow and glacier processes - Part 2	Christopher Marsh
13:30 - 15:00 CST	Salon D	8021 Changing Chemical Loads in Evolving Watershed - Part 2	Serghei Bocaniov
15:00 - 15:30 CST		COFFEE BREAK	
15:30 - 17:00 CST		14010 POSTER SESSION	Christopher Marsh Claire Oswald
17:00 - 18:30 CST	Gallery A	NSERC Session	
17:00 - 18:30 CST	Gallery B	The Canadian Young Hydrologic Society (CYHS) Workshop	
May 28, 2025	**Wednesday - Day 3**		
09:00 - 10:00 CST	Salon B/C	1003 Plenary - How marine emissions contribute to atmospheric particles, with implications for climate	Christopher Marsh
09:00 - 10:00 CST	Salon D	1004 Plenary (Woo Lecture) - From hydrological process studies to watershed management: can we bridge the scale gap?	Christopher Marsh
10:00 - 10:30		COFFEE BREAK	

CST			
10:30 - 12:00 CST	Gallery A	7050 The Polar Night Experiment (PONEX) Aircraft Campaign in Inuvik - Part 1	Zen Mariani
10:30 - 12:00 CST	Gallery B	2020 Collaborative Earth System Modelling in Canada	Matthew Toohey
10:30 - 12:00 CST	Gallery C	10041 Ocean - Theoretical to applied science - Part 2	Nancy Soontiens Susan Allen
10:30 - 12:00 CST	Gallery D	3050 Peatland disturbance and policy in Canada - Part 1	Adam Kirkwood
10:30 - 12:00 CST	Salon B	4050 Transforming Canada's Weather Services for a Resilient Future - Part 1	Erik de Groot
10:30 - 12:00 CST	Salon C	6012 Observation and modelling of snow and glacier processes - Part	Christopher Marsh
10:30 - 12:00 CST	Salon D	8022 Changing Chemical Loads in Evolving Watershed - Part 3	Serghei Bocaniov
12:00 - 13:30 CST		LUNCH (provided)	
13:30 - 15:00 CST	Gallery A	7051 The Polar Night Experiment (PONEX) Aircraft Campaign in Inuvik - Part 2	Zen Mariani
13:30 - 15:00 CST	Gallery A	7052 The Polar Night Experiment (PONEX) Part 3 - Campaign discussion – open to all	Zen Mariani
13:30 - 15:00 CST	Gallery B	10030 Discussions on development, evaluation and analysis of ocean circulation and biogeochemical models or Developing Ocean Modelling Capacity in Canada - Part 1	Paul Myers
13:30 - 15:00	Gallery C	8030 General Hydrology - Part 1	Barret Kurylyk

CST			
13:30 - 15:00 CST	Gallery D	3051 Peatland disturbance and policy in Canada - Part 2	Adam Kirkwood
13:30 - 15:00 CST	Salon B	4051 Transforming Canada's Weather Services for a Resilient Future - Part 2	Erik de Groot
13:30 - 15:00 CST	Salon C	6013 Observation and modelling of snow and glacier processes - Part 4	Christopher Marsh
13:30 - 15:00 CST	Salon D	9010 Advances and applications of artificial intelligence in meteorology	Miguel Tremblay
15:00 - 15:30 CST		COFFEE BREAK	
15:30 - 17:00 CST	Gallery A	4052 Enhancing Collaboration for Weather Preparedness in Canada	Jim Abraham
15:30 - 17:00 CST	Gallery B	10031 Discussions on development, evaluation and analysis of ocean circulation and biogeochemical models or Developing Ocean Modelling Capacity in Canada - Part 2	Paul Myers
15:30 - 17:00 CST	Gallery C	8031 General Hydrology - Part 2	Barret Kurylyk
15:30 - 17:00 CST	Gallery D	5010 Deep understanding of weather and climate extremes through regional climate modeling	Alejandro Di Luca
18:00 - 21:00 CST		AWARDS BANQUET	
May 29, 2025	**Thursday - Day 4**		
09:00 - 10:00 CST	Salon B/C	1005 Plenary - Thirty-Five Years of Atmospheric Remote Sensing from Satellite Platforms – A University of Saskatchewan	Christopher Marsh

		Perspective	
09:00 - 10:00 CST	Salon D	1006 Plenary - Maybe we can't solve this one: Eutrophication, harmful algal blooms, and a conversation on the place of water science in environmental problem solving	Christopher Marsh
10:00 - 10:30 CST		COFFEE BREAK	
10:30 - 12:00 CST	Gallery A	5030 ClimatEx: Downscaling for Weather and Climate Extremes	Adam Monahan
10:30 - 12:00 CST	Gallery B	8050 Hydrometeorology of lakes and reservoirs	Murray Mackay
10:30 - 17:00 CST	Gallery D	NEMO Workshop	
10:30 - 12:00 CST	Salon B	9020 Applications of AI and machine learning to the atmosphere/ocean/climate system - Part 1	Joseph Fitzgerald
10:30 - 12:00 CST	Salon C	8032 General Hydrology - Part 3	Barret Kurylyk Lauren Somers
10:30 - 12:00 CST	Salon D	3010 Biogeochemistry of boreal ecosystems	Nora Casson
12:00 - 13:30 CST		LUNCH (provided)	
13:30 - 15:00 CST	Gallery A	5050 Weather, Climate, and Environmental Extremes	Elizaveta Malinina
13:30 - 15:00 CST	Salon B	9021 Applications of AI and machine learning to the atmosphere/ocean/climate system - Part 2	Joseph Fitzgerald
13:30 -	Salon C	8033 General Hydrology - Part 4	Lauren

15:00 CST			Somers Barret Kurylyk
13:30 - 15:00 CST	Salon D	3060 Potential of Canadian peatlands as nature-based climate solutions Maria Strack	

Information and Legend for Sessions, Plenaries and Abstracts

Sessions and Abstracts are listed in the order presented.

Convenors and Session information precedes session abstracts and are **in bold**.

Plenaries and Public Lecture are in blue / bold

Please use search pdf using keywords, author name or session date / time.

Day 0 – 25 May 2025

Dr. Corinne Schuster-Wallace
Global Institute for Water Security, University of Saskatchewan

BIO

Dr. Corinne Schuster-Wallace is the Executive Director of the Global Institute for Water Security and faculty member in the Department of Geography and Planning, University of Saskatchewan, Canada. Previously positions include Senior Research Fellow for UNU Institute for Water, Environment, and Health and the Public Health Agency of Canada. She founded the Women Plus Water community and is the inaugural Chair of Cansu Global's Science, Innovation, Technology, and Education (SITE) initiative. In 2023 she was recognized as a Water Shero by the Red Dot Foundation. Her research utilises a coupled systems approach to water-related human health in rural, remote, and marginalised communities. Her work integrates university and community, different knowledge systems, and research, practice, and teaching. Coupling environmental and social systems provides a comprehensive understanding of socio-environmental determinants of health and how inequities and intersectionality along with knowledge, attitudes, and practices affect health and wellbeing. These are critical considerations in building climate resilience and more equitable and sustainable water resources management approaches.

Session: Public Lecture - Changing Waterscapes; Resilient Futures Conférence publique - Paysages aquatiques en mutation; avenirs résilients

25/05/2025
19:00

ID: 12576 Invited plenary speaker

Changing Waterscapes; Resilient Futures / Paysages aquatiques en mutation; avenirs résilients

Corinne Schuster-Wallace [1]

[1] Global Institute for Water Security, University of Saskatchewan

Presented by / Présenté par: *Corinne Schuster-Wallace*
Contact: craig.smith@ec.gc.ca

The amount, timing, intensity, and type of precipitation (e.g., rain, snow, hail) is changing to varying degrees across the Prairies, Canada, and around the world. As a result of these changes and associated uncertainty, our waterscapes are changing. This means that when we need water and when water is available may not coincide. Yet we need water to sustain all life, to underpin food and energy security, for strong economies, and for vibrant communities. From a water management perspective, there are only two options – increase supply or reduce demand. Much of this management occurs beyond natural water systems and water sectors. This requires us to recognize and harness beneficial practices across all sectors; to consider trade-offs and co-benefits associated with policies and operations; and, to build resilience across and not just within sectors, societies, and watersheds.

La quantité, le moment, l'intensité et le type de précipitations (pluie, neige, grêle) changent à des degrés divers dans les Prairies, au Canada et dans le monde entier. En raison de ces changements et de l'incertitude qui y est associée, nos paysages aquatiques changent. Cela signifie que le moment où nous avons besoin d'eau et le moment où l'eau est disponible ne coïncident pas forcément. Pourtant, nous avons besoin d'eau pour maintenir toutes les formes de vie, pour soutenir la sécurité alimentaire et énergétique, pour des économies fortes et pour des communautés dynamiques. Du point de vue de la gestion de l'eau, il n'y a que deux options : augmenter l'offre ou réduire la demande. Une grande partie de cette gestion s'effectue au-delà des systèmes et des secteurs naturels de l'eau. Cela nous oblige à reconnaître et à exploiter les pratiques bénéfiques dans tous les secteurs, à prendre en compte les compromis et les co-bénéfices

associés aux politiques et aux opérations, et à renforcer la résilience dans tous les secteurs, sociétés et bassins hydrographiques, et pas seulement au sein de ceux-ci.

Day 1 – 26 May 2025

Session: 1001 Plenary - The importance of EDI in 2025
Plénière - L'importance de l'EDI en 2025

26/05/2025
09:00

ID: 12574 Invited plenary speaker

The importance of EDI in 2025

Joseph Shea [1] , *Maria Chadid Hernandez* [2]

[1] University of Northern British Columbia

[2] University of Northern British Columbia

Presented by / Présenté par: *Joseph Shea*

Dr. Joseph Shea

BIO

Department of Geography, Earth, and Environmental Science
University of Northern British Columbia

Joseph Shea is an Associate Professor in the Department of Geography, Earth, and Environmental Science at the University of Northern British Columbia, where he leads the Mountain Snow Hydrology Lab (www.moshlab.org). His research is usually focused on the mountains, where he uses field observations,

remote sensing, and modelling to study glaciers, snowpacks, hydrology, and climate change impacts. He recently co-led the "Mountain Environments" chapter of the Canadian Mountain Assessment that explored scientific and Indigenous knowledge of mountain regions in Canada, and is a co-investigator in the Hidden Figures Project on racism, whiteness, and epistemic oppression in the Canadian Academy.

Contact: joseph.shea@unbc.ca

Science thrives in equitable, inclusive, and diverse spaces. Yet available evidence suggests we are still far from reaching these goals in Canadian geoscience fields. Over the past two years, the Hidden Figures project has explored racism, whiteness, and erasure in the Canadian academy across the disciplines of political science, neuroscience, and geoscience. This presentation will summarize some key results of the Hidden Figures project as it relates to the geosciences in Canada, including our novel work on academic conference dynamics, university syllabi analysis, a forthcoming edited book, and a podcast. We will focus on the importance of EDI, lessons learned from the Hidden Figures project and issue a collective call to action to both protect the progress that has been made and to go further and pursue fundamental, systemic change: as Kamala Harris recently said, 'fear is contagious, but so is courage'.

Session: 2010 Atmosphere, Ocean, and Climate Dynamics

Convenors:
Adam Monahan (UVic)
Ron McTaggart-Cowan (ECCC)
Marek Stastna (U Waterloo)
Mike Waite (U Waterloo)

This session combines submissions that document studies of the dynamics of the atmosphere, oceans and/or climate system. The scope of the session is deliberately broad in order to include research that spans the full range of spatial and temporal scales. Studies of the dynamics of mesoscale processes that act on hourly timescales are as welcome in this session as those that document the evolution of planetary-scale structures in a changing climate. Such investigations may include theoretical, diagnostic and modelling studies that employ the latest analytic and prediction techniques, including those based on machine learning. However, any topic that is relevant to atmosphere, ocean, or climate dynamics will fit well into this session.

Session: 2010 Atmosphere, Ocean, and Climate Dynamics - 26/05/2025
Part 1 Dynamique de l'atmosphère, des océans et du climat 10:30

- Partie 1

ID: 12199 Contributed abstract

Understanding the impact of Forest Fires on Weather Patterns and Atmospheric circulations using an integrated Fire-Weather Forecasting Model

Md Razib Vhuiyan [1] , *Francesco S. R. Pausata* [2] , *Ashu Dastoor* [3]

[1] UQAM

[2] UQAM

[3] ECCC, Droval, Quebec

Presented by / Présenté par: *Md Razib Vhuiyan*
Contact: vhuiyan.md_razib@courrier.uqam.ca

Wildfires are critical environmental phenomena that not only devastate ecosystems but also significantly influence weather patterns and atmospheric circulations. The interplay between wildfire smoke, aerosols, and meteorological processes can have profound localized and regional impacts, particularly during intense fire events. Here, we examine the impacts of wildfire smoke on weather using a regional climate model with interactive aerosol and chemistry components (WRF-SFIRE-CHEM)., Using three nested domains at 36 km, 12 km, and 4 km horizontal resolution, we perform two set of simulations driven by Global Ensemble Forecast System (GEFS) data from August 11 to August 20, 2020: one incorporating with active fires and one as a control without fires. The results reveal significant local effects, including surface cooling of up to 2.8 °C caused by the aerosol particles. Fine particles with diameter below 2.5 um (PM2.5) reaches a burden of 3400 mgm^{-2}, accompanied by a reduction in downwelling shortwave radiation by 335 Wm^{-2}. In the mid-troposphere, warming peaks at 0.6 °C near the 800 hPa level due to the absorption of solar radiation by black carbon aerosols. Smoke further reduces the planetary boundary layer height by up to 916 m and decreases 10-meter wind speed by 1.9 $m\ s^{-1}$, stabilizing the atmosphere and suppressing vertical mixing. Despite the ignition of five fires, plume heights remain lower due to weaker updrafts and likely limited fuel availability. Our findings highlight that a week-long wildfire smoke primarily impacts local weather without significantly affecting synoptic scale dynamics. The study emphasizes the importance of accurately representing smoke aerosols and fire-plume dynamics in weather models to improve local forecasts during wildfire events.

Session: 2010 Atmosphere, Ocean, and Climate Dynamics - Part 1 Dynamique de l'atmosphère, des océans et du climat - Partie 1

26/05/2025 10:45

ID: 12204 Contributed abstract

Virtual

Layering of Dust Aerosols and Interactions with the Atmospheric Boundary Layer over the Taklimakan Desert: New Insights from Ground-Based Sounding Observations

Qing He [1] , *Tianliang Zhao* [2] , *Jinglong Li* [3] , *Lu Meng* [4]

[1] Institute of Desert Meteorology, China Meteorological Administration, Urumqi, China

[2] Nanjing University of Information Science &Technology, Nanjing, China

[3] College of Geographic Science and Tourism, Xinjiang Normal University, Urumqi, China

[4] Institute of Desert Meteorology, China Meteorological Administration, Urumqi, China

Presented by / Présenté par: *Qing He*

Contact: qinghe@idm.cn

The Taklimakan Desert (TD) is one of the most dust-prone regions globally, with its dusty atmospheric conditions significantly influencing regional and global climate systems. However, limited observational evidence exists on the interaction between deep atmospheric boundary layers (ABL) and dust aerosols, as well as on the vertical stratification and transport of dust. In April and May 2022, we conducted the first particle-sounding experiments in the TD, and observed in the dust-prone regions of the southern margin of the basin (Hotan and Minfeng), using ground-based aerosol Lidar (GBQL-01) measurements, complemented by Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation(CALIPSO) satellite data and WRF-Chem simulations. Our findings revealed a unique stratified vertical structure of the daytime ABL induced by dust aerosols, including an ultra-thick residual layer (RL) reaching 1800–2600 m, with peak aerosol concentrations of 477 μg/m³. On heavy dust days, the ABL was divided into the convective boundary layer (CBL), a capping inversion layer (CIL), RL, and residual capping inversion layer (RCIL). Dust aerosols caused atmospheric warming up to 1.0 K/day at the top of the dust layer, suppressing CBL growth and dust transport. In Hotan and Minfeng, vertical dust transport reached up to 4 km and 3 km, respectively, with significant stratification within 1 km as well as dust aerosol layers at approximately 3 km. Topographic barriers like the Tianshan Mountains and the northern slopes of the Tibetan Plateau altered wind patterns, encouraging dusty weather outbreaks. Even after such events subsided, suspended dust with concentrations of 300–400 μg/m³ persisted at altitudes near 4 km. This study provides key insights into the roles of aerosol–radiation interactions, transport mechanisms, and topography in shaping dust event dynamics in arid desert regions, offering critical references for climate and environmental research.

Session: 2010 Atmosphere, Ocean, and Climate Dynamics - Part 1 Dynamique de l'atmosphère, des océans et du climat - Partie 1

26/05/2025 11:00

ID: 12206 Contributed abstract

Virtual

Cloud-to-Ground Lightning Trends in Canada and Regions of the United States North of 40°N 1999-2023

William Burrows [1] , *Bohdan Kochtubajda* [2] , *Gabor Fricsa* [3]

1

2 MSC

3 MSC

Presented by / Présenté par: *William Burrows*
Contact: william.burrows@ec.gc.ca

An assessment of the temporal and spatial trends in lightning activity in Canada and adjacent United States was undertaken using cloud-to-ground (CG) stroke data collected by the Canadian Lightning Detection Network from 1999 to 2023. The nonparametric Mann-Kendall test was used to identify monotonic trends in the data. The direction of trends was determined by the slope of a linear fit to the data. Common perceptions are that lightning will increase due to climate change, but at least in temperate latitudes, based on trends shown here the full picture is more nuanced. Total and negative-polarity CG lightning has shown a steady decline nationally in the observing period. The decline is most pronounced in Central Canada (Ontario and Quebec) and adjacent regions of the United States. Declines have also been detected over the eastern Prairies (SK and MB) and Atlantic Canada. An increasing trend, however, has been observed in the three northern territories, northern BC and northern AB. Sizeable areas of upward-trending positive CG lightning within wildfire environments have been detected. Observed trends in CG lightning may be explained by long-term changes in the continental-scale general circulation that are likely due to the onset of the positive phase of the Pacific Decadal Oscillation coupled with ENSO events occurring in a climate warming background.

Session: 2010 Atmosphere, Ocean, and Climate Dynamics - Part 1 Dynamique de l'atmosphère, des océans et du climat - Partie 1

26/05/2025 11:15

ID: 12352 Contributed abstract

Virtual

Operational implementation and update of the Nowcast of Weather Element on Grid system

Weiguang Chang [1] , *Robert Harris* [2] , *Zhiyong Huang* [3] , *Frédéric Dubuis* [4] , *Victor Chung* [5] , *Didier Davignon* [6]

[1] Environment and Climate Change Canada
[2] Environment and Climate Change Canada
[3] Environment and Climate Change Canada
[4] Environment and Climate Change Canada
[5] Environment and Climate Change Canada
[6] Environment and Climate Change Canada

Presented by / Présenté par: *Weiguang Chang*
Contact: weiguang.chang@ec.gc.ca

The Nowcast of Weather Element on Grid (NCWEonG) has been in operation with an experimental status at the Canadian Meteorological Center since May 2024. The system starts with an hourly 2D near-surface mesoscale analysis, and produces hourly nowcast of weather element on grid at 2.5km resolution up to 6 hours. It combines observations of surface stations, satellites, radar and lightning with post-processed ECCC’s High Resolution Deterministic Prediction System (HRDPS). In addition, sub-hourly production of cloud and precipitation is also included.

This presentation first addresses the operational implementation, such as data quality and delay, latency of production, and maintenance. It then shows the challenges related to cloud and precipitation analysis and nowcasting, as well as other issues found after the first installation. The latest update to the system is presented, including some technical changes, the use of new satellite data and the application of innovative techniques. Verification scores show improvement in the new version of the NCWEonG, while helping narrow down aspects that still require attention. Based on those lessons learnt, a plan for future improvements is discussed.

Session: 2010 Atmosphere, Ocean, and Climate Dynamics - Part 1 Dynamique de l'atmosphère, des océans et du climat - Partie 1

26/05/2025 11:30

ID: 12514 Contributed abstract

Optimizing the Weather Research and Forecasting model in a region of steep slopes (Quesnel Lake Basin, British Columbia)

Parvin Ghafarian [1] , *Peter Jackson* [2] , *Stephen Dery* [3]

[1] University of Northern British Columbia

[2] University of Northern British Columbia

[3] University of Northern British Columbia

Presented by / Présenté par: *Parvin Ghafarian*

Contact: peterj@unbc.ca

Steep slope areas present challenges for commonly used numerical weather prediction models, as they can generate numerical errors and cause the model to become unstable. In this study, the Weather Research and Forecasting (WRF) model version 4.5.2 was used to simulate the surface wind field over Quesnel Lake (British Columbia), characterized by steep slopes with inclines exceeding 80 degrees. The simulation employed four nested domains with resolutions of 9 km, 3 km, 1 km, and 333 m, with a 15-minute time step. Data from seven meteorological stations in the Quesnel Lake basin were used for evaluation. Statistical parameters BIAS, Mean Absolute Error (MAE), Root Mean Square Error (RMSE), and Standard Deviation (STDE) were used for comparison. To successfully run the model, adjustments were made in the dynamics section, including enabling w_damping to reduce numerical noise and instability. Additionally, epssm was employed to control computational instability and improve model stability in high-resolution simulations and complex terrain. In the model's physics section, two boundary layer schemes, MYJ and YSU, as well as two longwave radiation schemes, PRTM and PRTMG, were used to examine the model's sensitivity in estimating certain surface layer parameters such as wind speed, temperature, and relative humidity. The results of this research showed that wind speed, temperature, and relative humidity parameters are sensitive to the choice of different physical schemes for the boundary layer and long-wave radiation. The model output indicates that wind speed and temperature values have been overestimated. Additionally, the estimation error for relative humidity is significant compared to wind speed and temperature, with relative humidity values being underestimated.

ID: 12543 Contributed abstract

Severe Hailstorms in Two Climate Regimes: A Comparative Study of the Canadian Prairies and Bangladesh

Mostofa Kamal [1] , *Yanping Li* [2]

[1] University of Saskatchewan

[2] University of Saskatchewan

Presented by / Présenté par: *Mostofa Kamal*
Contact: mostofa.kamal@usask.ca

Severe hailstorms are a common hazard in both Bangladesh and the Canadian Prairies, despite their different climatic regimes. In the Canadian Prairies, hailstorms occur primarily in summer (June–September), while in Bangladesh, they peak during both pre-monsoon (March–June) and post-monsoon (October–November) seasons. While hailstorms cause significant damage in both regions, Bangladesh is disproportionately affected due to lack of crop and property insurance, socio-economic vulnerability, and inadequate severe weather forecasting by the Bangladesh Meteorological Department. Observations indicate an increasing frequency of severe hailstorms in both regions, yet their dynamical and thermodynamical characteristics remain poorly understood. This study conducts a cross-regional analysis of 24 severe hail events (12 per region) to identify large- and local-scale processes influencing hail formation. Using ERA5 reanalysis data, composite analyses were performed to examine key trigger and propagation mechanisms, improving our understanding of severe hailstorm dynamics. Our study reveals that despite being in different continents and climatic regimes, severe hail events in both the Canadian Prairies and Bangladesh primarily occur in the late afternoon and evening. Large-scale dynamics play a crucial role, with the mid-latitude jet stream driving hail formation in the Canadian Prairies, while the Western Disturbance and Subtropical jet stream influence hailstorms in Bangladesh. Orographic features, such as the Rocky Mountains in Canada and the Himalayas and Meghalaya Plateau in Bangladesh, act as key local-scale triggers. We find that Storm Relative Helicity (SRH), Vertical Wind Shear, Downdraft Convective Available Potential Energy (DCAPE), and mixing ratios strongly correlate with hail size. Among these, lower-level SRH is the most critical dynamic variable in both regions. Despite their semi-arid and tropical humid climates, both regions experience severe hail due to a balance between vertical wind shear and mixing ratios. Our findings improve understanding of

hailstorm characteristics and provide valuable insights for operational meteorologists and climate scientists.

Session: 8010 Advances in forest ecohydrology Progrès en matière d'écohydrologie forestière

Convenors:

Audrey Maheu, Université du Québec en Outaouais

Magali Nehemy, Trent University

Sheena Spencer, BC Ministry of Forests

Jason Leach, Canadian Forest Service

Forests dominate much of Canada's landscape and are a critical source of freshwater resources, provide natural infrastructure for flood protection and drinking water supply, and support habitat for culturally and economically important aquatic species. Forest ecosystems are undergoing unprecedent change due to climate variability and disturbances such as wildfire, resource extraction, and urbanization. Novel insights on forest-water relationships from plot to watershed scales are needed to inform effective management approaches. We invite both empirical and modelling studies and contributions that provide new understanding and perspectives on ecohydrological and biogeochemical processes within forested ecosystems, such as evapotranspiration, streamflow generation, and water quality.

Session: 8010 Advances in forest ecohydrology Progrès en matière d'écohydrologie forestière **26/05/2025 10:45**

ID: 12350 Contributed abstract

Assessing Post-Wildfire Hillslope Runoff and Erosion in the Nechako Watershed, BC, using a Rainfall Simulator

Michael Samoil [1] , *Phil Owens* [2] , *Faran Ali* [3] , *Brendan Miller* [4]

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Presented by / Présenté par: *Michael Samoil*
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With wildfire seasons becoming increasingly severe in recent years across British Columbia, the amount of disturbed soil that is prone to runoff and erosional processes is

also increasing. Being able to understand how these processes are occurring and how they are impacting the local hydrological system are important requirements for protecting water resources and aquatic habitats. While the initial impacts of a wildfire are obvious, a need to understand the secondary impacts is also required to help with mitigating long term impacts and to increase the recovery of the local system. The field work was completed one year after a 2023 wildfire in central BC. This research looked into how runoff and soil erosion on hillslopes varied between different soil burn severities and steepness of slopes by using a field-portable rainfall simulator. The collected erosion samples were then analyzed to determine particle size composition, organic matter content, and geochemical (e.g., metals) content. This will create an understanding of how much runoff and erosion occurs after a fire and what material is eroded from the surface as a result. With this information, a hazard map will be produced to highlight where potential issues may occur due to runoff and erosion near riparian areas and infrastructure such as roads. Preliminary results suggests that there is an increase in both runoff and erosion with increasing soil burn severity and slope steepness. The final results of this work will contribute to better understanding some of the secondary impacts and provide support for local communities to better assess and recover from wildfires.

Session: 8010 Advances in forest ecohydrology Progrès en matière d'écohydrologie forestière **26/05/2025 11:00**

ID: 12470 Contributed abstract

Modelling subcanopy microclimate and fuel moisture modelling using the Fuel Moisture System

Derek van der Kamp [1]

1

Presented by / Présenté par: *Derek van der Kamp*
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As part of the ongoing update of the Canadian Forest Fire Danger Rating System, the Canadian Forest Service is developing the Fuel Moisture System (FMS), which will allow users to estimate microclimates and fuel moisture for specific stand types and locations. The FMS comprises a suite of models for estimating weather conditions given: observations from nearby weather stations or gridded model output; information about the stand of interest, such as canopy cover; and terrain position. It also includes a suite of fuel moisture models. Here we present work examining the skill of these models in predicting observed microclimatic conditions and fuel moisture within stands across different forest types. The models for each weather variable (temperature, absolute humidity, wind speed, precipitation, and solar radiation) as well as the fuel moisture models are trained separately using observations before being combined into a full model for predicting fuel moisture. We will also present a sensitivity analysis of the fuel moisture model. This analysis will help us determine where the largest sources of uncertainty are when estimating in-stand fuel moisture, and where to focus our attention for future refinements of the models. Our analysis shows that temperature and absolute humidity are the most skillfully predicted, while the subcanopy wind model has the

poorest skill. The fuel moisture model skill varied, depending on the site. The sensitivity analysis demonstrated that the fuel moisture model was most sensitive to temperature and absolute humidity, and that accurate modelling of these two variables is important for accurate fuel moisture modelling.

Session: 8010 Advances in forest ecohydrology Progrès en matière d'écohydrologie forestière **26/05/2025 11:15**

ID: 12249 Contributed abstract

Upscaled ET in mountainous area with different topographic and vegetation conditions in Canadian Rockies

Rulan Xiao [1] , *Richard Petrone* [2]

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Presented by / Présenté par: *Rulan Xiao*
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The Canadian Rocky Mountains serve as the primary water source for Alberta, Saskatchewan, and Manitoba, supplying approximately 87% of the Saskatchewan River Basin's water for domestic, industrial, and agricultural applications, as well as for downstream communities and ecosystems. However, rising temperatures in Western Canada, with winter temperatures in the Rockies increasing by 2.6°C since the 1960s, pose significant challenges to alpine ecosystems, which are particularly sensitive to climate change. Understanding evapotranspiration (ET), water use efficiency (WUE), and forest growth phases are critical for assessing water cycling in these environments that are undergoing this change. Despite this, research gaps persist regarding the response of juvenile forests to climate change in the Canadian Rockies, particularly in areas with various topographic and vegetation conditions where ET and WUE remain understudied. Existing research is often limited in scale and composition, necessitating a more comprehensive investigation of the interactions between forest structure, topography, and climatic factors.
Traditional measurements such as Eddy Covariance (EC) present accurate high frequency results, however, its scale depends on the footprint area, which varies significantly in alpine regions. This study aims to upscale ET estimates from the stand to watershed level to assess climate change impacts on large-scale water use. By integrating satellite remote sensing indices with ground measurements, including Eddy covariance and sapflow measurements, this research will evaluate the feasibility of mapping ET in subalpine forests under similar environmental conditions. Additionally, physically-based models will be utilized to address potential errors introduced by variations in terrain and forest composition, improving the accuracy of ET estimation at broader spatial scales.

Session: 8010 Advances in forest ecohydrology Progrès en matière d'écohydrologie forestière 26/05/2025 11:30

ID: 12405 Contributed abstract

Investigating temporal relationships between soil moisture and plant water content using impedance probes in boreal forests

Kayla Wicks [1] , *Alexandre Roy* [2] , *Michael Cosh* [3] , *Aaron Berg* [4]

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Presented by / Présenté par: *Kayla Wicks*
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Water storage within the hydraulic systems of trees is critical for buffering daily transpiration demands, depending on soil moisture (SM) availability. In Canada's boreal forests, SM is crucial for ecosystem functioning and is used for seasonal weather prediction. Changes in climate have led to a gradual drying of the forest floor, making these forests more vulnerable to drought and wildfires. While monitoring soil water availability in forests is essential, few studies have measured it, largely due to logistical challenges of accessing remote areas. Validated retrieval of forest SM and plant water content from remote sensing instruments is one of the long-standing unresolved issues hindering the advances in hydrology, ecology, and understanding of the Earth system. The fundamental reason for the lack of progress is the lack of adequate reference data, particularly in forested environments. The SMAP Validation Experiment 2022 Boreal (SMAPVEX22-Boreal) addressed this gap by conducting a comprehensive field experiment in central Saskatchewan's coniferous forests. An intensive in situ monitoring network was deployed, featuring continuous measurements of hourly SM and plant water content. This campaign, unprecedented in scope and scale, included the installation of hydra probes into 26 trees of various species adjacent to an existing SM monitoring network. Preliminary results demonstrated a strong correlation (~ 0.75) between soil and plant xylem real dielectric constant (RDC) throughout the summer season. Ongoing analysis is focused on more detailed comparisons of specie-specific relationships between SM and xylem RDC such as understand the lag correlation between these measurements. This research is anticipated to be of value for the improvement passive microwave satellite measurements of soil moisture and vegetation optical depth in coniferous environments.

Session: 8010 Advances in forest ecohydrology Progrès en matière d'écohydrologie forestière 26/05/2025 11:45

ID: 12512 Contributed abstract

Variability in transpiration source water is influenced by embolism resistance across topographic gradients in the Eastern Amazon rainforest

Magali Nehemy [1], *Caio R. C. Mattos* [2], *Rafael S. Oliveira* [3], *Marina Hirota* [4], *Ying Fan* [5], *Monique B. Schlickmann* [6], *Deliane Penha* [7], *Leandro Giacomin* [8], *Julliene S. G. M. Silva* [9], *Mayda Rocha* [10], *Gleicy A. Rodrigues* [11], *Jeffrey McDonnell* [12]

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Presented by / Présenté par: *Magali Nehemy*
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Transpiration is responsible for up to 70% of the regional rainfall in the Amazon during the dry season due to precipitation recycling. Nonetheless, the origin, spatial patterns of transpiration, and the principal plant hydraulic factors influencing these sources are not well understood. In this study, we examine the sources of transpiration along a topographical gradient in the eastern Amazon's Tapajós National Forest. We utilize embolism resistance data collected from the dominant tree species and same studied location. We investigate: i) the sources of transpiration, and ii) the variations in transpiration origin and depth across topographical gradients and among species with varying embolism. Our findings indicate that on hilltops, the sources of transpiration during the dry season are predominantly shallow soil water, replenished by rainfall from the same season. Conversely, in valleys, the sources of transpiration include both shallow and deep soil water, influenced by both dry and wet season rainfalls. The patterns observed in transpiration sources are primarily attributed to differences in species' embolism resistance, which also reveal distinct trade-offs between species located on hills and valleys. The clear link between embolism resistance and the depth of water uptake at both topographical sites, which affects the age of transpiration, could be instrumental in improving how vegetation water use is parameterized in land surface models.

Session: 10020 Biological, physical, and chemical oceanographic research to enhance and support resilient and healthy marine ecosystems - Part 1 Recherche océanographique biologique, physique et chimique visant à améliorer et à soutenir des écosystèmes marins sains et résistants - Partie 1

Convenors:

- Heather Andres, Fisheries and Oceans Canada

- Gwénaëlle Chaillou, Institut des Sciences de la MER (ISMER), Université du Québec à Rimouski
- Martine Lizotte, Fisheries and Oceans Canada
- Gary Maillet, Fisheries and Oceans Canada
- Nancy Soontiens, Fisheries and Oceans Canada

The interplay of physical, chemical and biological oceanographic conditions forms the foundation of marine ecosystems and partly determines their productivity and health. The health of marine ecosystems can exhibit natural variations and can also be directly and indirectly affected by human activities, such as anthropogenic emissions of carbon dioxide, aquaculture, exploratory drilling, shipping and fishing activity, tourism, etc.. This session aims to explore the linkages between physical, chemical and biological oceanographic processes and their impacts on ecosystems, as well as how those linkages vary and change via natural and human causes. Further, studies aiming to characterize ecosystem status and health by incorporating oceanographic data are encouraged. Specific topics may include:
• Marine carbon dioxide removal,
• Environmental controls on and changes to primary and secondary productivity, either through observational or modelling studies,
• Oceanographic impacts of changing sea ice and surface freshwater (from land, glacial melt, icebergs and hydrological cycle changes), as well as other climate changes,
• Ocean acidification, deoxygenation and other changes to habitat suitability,
• Seasonal predictability of oceanographic conditions,
• Extreme events, and
• Environmental conditions and indices applied to the study of marine ecosystems.

Session: 10020 Biological, physical, and chemical oceanographic research to enhance and support resilient and healthy marine ecosystems - Part 1 Recherche océanographique biologique, physique et chimique visant à améliorer et à soutenir des écosystèmes marins sains et résistants - Partie 1	**26/05/2025 10:30**

ID: 12378 Contributed abstract

Timing and controls of spring restratification on the Newfoundland and Labrador Shelf based on GLORYS12v1 data

Heather Andres [1] , *Nancy Soontiens* [2] , *Jared Penney* [3] , *Frederic Cyr* [4]

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Presented by / Présenté par: *Heather Andres*
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As the basis of the marine food web, phytoplankton play a key role in the productivity of the Newfoundland and Labrador (NL) continental shelf environment. The timing of the spring phytoplankton bloom is of particular interest in regard to its alignment in time with the spawning of a variety of marine species that (directly or indirectly) rely on phytoplankton as a food source. The timing of the spring phytoplankton bloom in NL from year to year has been previously correlated with the timing of the start of spring sea ice retreat (Wu et al., 2007) and the timing of the spring stratification minimum (Cyr et al., 2024). Sea ice retreat can contribute to spring restratification through the release of meltwater, but surface heating may also be important in some locations. We will present climatological seasonal cycles for stratification at multiple locations on the NL Shelf using both Atlantic Zone Monitoring Program data and output from the GLORYS12v1 model. This model under-estimates peak stratification values, but it explains nearly half of inter-annual variations during the spring. We will discuss the relative timing of restratification and the importance of surface freshening and surface heating depending on location on the NL Shelf. Finally, we will connect the timing of restratification to sea ice changes in the simulations.

Session: 10020 Biological, physical, and chemical oceanographic research to enhance and support resilient and healthy marine ecosystems - Part 1 Recherche océanographique biologique, physique et chimique visant à améliorer et à soutenir des écosystèmes marins sains et résistants - Partie 1 **26/05/2025 10:45**

ID: 12535 Contributed abstract
Virtual

Modelling analysis of the spring phytoplankton bloom on the Newfoundland shelf under climatological forcing conditions

Jared Penney [1] , *Changheng Chen* [2] , *Nancy Soontiens* [3] , *David Bélanger* [4] , *Frédéric Cyr* [5] , *Aaron Adamack* [6]

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Presented by / Présenté par: *Jared Penney*

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In the Newfoundland and Labrador shelf ecosystems, the spring phytoplankton bloom is an important annual event as its timing and duration will affect the development of higher trophic level species. Phytoplankton growth is susceptible to factors such as the availability of nutrients and light and grazing by predators. However, the physical environment also influences the capacity for bloom development through how much it allows phytoplankton to mix throughout the water column. On the Newfoundland and Labrador shelves, past research has suggested a connection between the timing of the spring bloom and restratification of well-mixed winter waters due to surface freshening (Wu et al., 2007; Cyr et al., 2023). In this presentation, we explore the relationship of the spring bloom phenology on the Newfoundland shelf to typical environmental forcing conditions using a one-dimensional coupled biogeochemical-physical nutrient-phytoplankton-zooplankton detritus (NPZD) model. First, we derived forcing conditions for the 1993-2022 climatological period representing typical meteorological conditions and freshwater fluxes at the long-term monitoring Station 27 (47.55°N, 52.59°W) from weather station data and the GLORYS12 reanalysis product, respectively. Relevant biogeochemical fields are derived from data collected as part of the Atlantic Zone Monitoring Program (AZMP). Second, we perturbed these forcing conditions in order to examine their potential influence on the bloom. For example, we examine the effects of earlier than normal seasonal warming or anomalously strong wind events on bloom properties.

Session: 10020 Biological, physical, and chemical oceanographic research to enhance and support resilient and healthy marine ecosystems - Part 1 Recherche océanographique biologique, physique et chimique visant à améliorer et à soutenir des écosystèmes marins sains et résistants - Partie 1	**26/05/2025 11:00**

ID: 12440 Contributed abstract
Virtual

On indexing habitat suitability in the Gulf of St. Lawrence

Rick Danielson [1] , *Jing Tao* [2] , *Hui Shen* [3] , *Will Perrie* [4]

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Presented by / Présenté par: *Rick Danielson*
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The North Atlantic right whale (NARW) is a critically endangered species whose foraging habitat has been routinely revisited by satellite remote sensing for decades. Since 2015, NARW sightings have become more frequent in the Gulf of St. Lawrence, where whales prey on zooplankton. In an effort to avoid injury by ship strikes or entanglement in fishing gear, there is a need to monitor NARW using existing environmental measurements. Although not designed for this purpose alone, satellite observations are a familiar component of marine ecosystem composite indices, in part because interannual variations in surface temperature and roughness can be used as a proxy of plankton development at the base of the food chain. However, it is equally important to be able to guide and select the components of a composite index according to how well these are related to NARW presence. Models of association can be shown to vary in their reliance on spatiotemporal coverage. In the context of interannual variations, we propose to include nonlinearity (i.e., to accommodate rectified behaviour of processes at shorter scales) in measurement models of biophysical association in an effort to build an index of habitat suitability in this region.

Session: 10020 Biological, physical, and chemical oceanographic research to enhance and support resilient and healthy marine ecosystems - Part 1 Recherche océanographique biologique, physique et chimique visant à améliorer et à soutenir des écosystèmes marins sains et résistants - Partie 1	**26/05/2025 11:15**

ID: 12320 Contributed abstract

Examining hydrodynamic connectivity among Marine Protected Areas in Atlantic

Canadian waters based on trajectories of bioparticles with various movement capabilities

Kyoko Ohashi [1] , *Jinyu Sheng* [2] , *Sarah Smith* [3] , *Bruce G. Hatcher* [4]

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Presented by / Présenté par: *Kyoko Ohashi*

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Increasing Marine Protected Areas (MPAs) is one of the measures in Canada's plan to protect 30% of its ocean space by 2030. Given the costs and potential benefits of MPAs, their selection must be optimized according to their goals, one of which is to optimize ecological connectivity amongst marine populations. Numerical particle-tracking experiments driven by realistic circulation fields can provide estimates of the extent to which larval and juvenile marine animals are retained in their MPAs of origin or travel to other MPAs during time intervals of interest. Passive particles (i.e. those whose movements are determined only by ocean currents) can represent the early, dispersive life history stages (e.g. eggs & larvae) of many marine organisms, while particles with directed swimming behaviours are used to represent later life stages of some species. In this study we combine the output of a coupled ocean circulation-sea ice model of the northwest Atlantic Ocean with a numerical particle-tracking model to simulate the time-averaged, large-scale patterns of dispersal of characteristic marine animals originating from existing and proposed MPAs in Atlantic Canadian waters. The swimming behaviours programmed in the particle-tracking model include diel vertical migration, horizontal swimming in random directions or towards lower salinity. Numerical experiments are conducted under both present and projected future conditions to predict how the existing patterns of ecological connectivity among MPAs might be affected by changes in oceanic conditions during an altered climate.

ID: 12453 Contributed abstract

Applying Doppler Sonar Techniques in Northern Newfoundland for Fish Tracking Near Mussel Farms

Shane Anderson [1] , *Len Zedel* [2] , *Olivia Gibb* [3]

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Presented by / Présenté par: *Shane Anderson*

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In Newfoundland & Labrador, aquaculture is a very important industry, providing job stability for residents of the province, as fishing is one of the main occupations. A concern with aquaculture operations is how they might impact the local ocean ecosystem. We present one way to detect seasonal and spatial changes in ecosystem characteristics by using Acoustic Doppler Current Profilers (ADCP's). These instruments provide records of acoustic backscatter that can be used to continuously monitor the presence of fish and zooplankton in the water column. This project focuses on observations from Notre Dame Bay in Newfoundland from August 2021 to August 2022. One 300 kHz ADCP was placed in the bay near operating mussel farms, a second unit was placed at the mouth of the bay. From the data, no clear distinctions in observations are seen with proximity of the farms. However, we were able to clearly observe various detections of fish of different sizes. Throughout the year, it was found that there were typically between 50 - 200 detections per day, spanning over target strengths of -30 dB to -60 dB. Furthermore, from the volume backscatter data, the seasonal cycle of zooplankton can also be observed, with very little difference between the two instrument locations. We compare these acoustic observations with available field observations of water properties and plankton surveys.

Session: 12010 General Geodesy and Geodynamics Géodésie générale et

géodynamique

Convenors:
Ismael Foroughi, Canadian Geodetic Survey, Natural Resources Canada
Michael Sheng, University of New Brunswick

This session is open to all aspects of geodesy and geodynamics that are not covered by other sessions. This includes innovations in reference systems, gravity field and geoid modelling, positioning, navigation, and timing through a range of ground and space geodetic techniques including but not limited to gravimetry, GNSS and inertial positioning, as well as combinations of geodetic observations and applications of geodetic measurements. Investigations into interpretation and application of the geodetic signal as a tool for understanding Earth’s rotation and polar motion; precise orbit determination; and analysis or prediction of ocean, atmosphere and internal processes of the Earth; or geodynamic processes and deformation at various scales; are also encouraged. Submissions dealing with practical applications of geodetic techniques in engineering or navigation are within the scope of this session.

Session: 12010 General Geodesy and Geodynamics Géodésie générale et géodynamique **26/05/2025 10:30**

ID: 12216 Contributed abstract

Understanding the Northern Canadian Shield: Moho Depth, Anisotropy, and Tectonics from Receiver Functions

Sina Sabermahani [1] , *Andrew Frederiksen* [2]

[1] University of Manitoba
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Presented by / Présenté par: *Sina Sabermahani*
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While extensively studied and well understood in certain regions, the Canadian Shield still presents significant challenges and uncertainties in its northern areas, particularly within the Churchill Province. Two major unresolved aspects in this region are the precise determination of Moho depth and the characterization of anisotropy. Addressing these gaps, this study utilizes a state-of-the-art technique, DeepRFQC, to rigorously analyze all available receiver function signals across the area. This method enables the selection of only high-quality signals, ensuring the reliability of subsequent analyses.

We utilized H-k stacking and Harmonic Decomposition to analyze the lithospheric structure of the region. The calculated k values showed a strong agreement with gravity data, indicating the reliability of the analysis. Harmonic Decomposition revealed anisotropy patterns consistent with the regional stress field, offering a clearer understanding of the tectonic processes. These results suggest that the observed seismic anisotropy is closely related to the region's predominantly NE-SW geological

structures.

Session: 12010 General Geodesy and Geodynamics Géodésie générale et géodynamique **26/05/2025 10:45**

ID: 12396 Contributed abstract

Spatial heterogeneity scales in the thermal evolution of long-term mantle convection models

Fadhli Atarita [1] , *Petar Glisovic* [2] , *Alexander Braun* [3]

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Presented by / Présenté par: *Fadhli Atarita*
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Thermal heterogeneity within the Earth exhibits multi-scale characteristics, shaped by mantle convection, lithospheric structures and core-mantle coupling over billions of years following the Moon-forming giant impact. To evaluate the significance of spatial scales in modelling the early Earth, particularly the long-term implications of the impact, we analyze the spatial scale dependency of mantle convection models, focusing on thermal structures. A reference model was developed based on constraints from the mantle’s cooling history and present-day effective viscosity profile estimates. Using this framework, we examined three-dimensional mantle convection models at multiple spatial resolutions (32 and 64 spherical harmonic degrees) with 129 radial nodes over a 4.5 Gyr timespan. Initial thermal perturbation models were generated with controlled randomness in scales, all subjected to free-slip and plate-like surface boundary conditions. Our simulations show that mantle convection reaches a quasi-steady state (with respect to spatial scales) within 1 Gyr, with low-degree structures remaining dominant and stable over long timescales. The initial distribution of thermal scales is found to have minimal influence on the evolution of thermal heterogeneities. These findings provide initial insights into how the Moon-forming impact may have influenced the Earth's long-term thermal evolution. By focusing on thermal structures as indicators of multi-scale heterogeneity, we highlight the critical role of temperature in planetary evolution. However, mantle heterogeneity is also governed by complex thermo-chemical interactions, underscoring the need for further investigation into the influence of spatial scales at relevant regions such as the uppermost mantle and the core-mantle boundary.

Session: 12010 General Geodesy and Geodynamics Géodésie générale et géodynamique **26/05/2025 11:00**

ID: 12544 Contributed abstract

Increasing tides in the Gulf of Maine/Bay of Fundy system: Assessing the crustal-tilt response

Pierre-Michel Rouleau [1]

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Presented by / Présenté par: *Pierre-Michel Rouleau*
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The amplitude of the principal semi-diurnal (M2) marine tides in the Bay of Fundy and Gulf of Maine has been fluctuating over the past century, with a significant positive trend of the order of cm/y. The crustal response to the associated increase in tidal stress poses several questions, especially regarding the stability of weak faults within the sea-bottom formations. Despite the fact that the Bay of Fundy generates the largest tidal-loading stresses on Earth, the surface response to the ambient stress field has not been measured since the advent of GPS/GNSS and Quantum technology. The only data available are a small set of ground-point measurements from short base-length tiltmeters, which now constitutes a snapshot of the crustal deformation over the 1970-1980 decade. Since then, major improvements in all aspects of tidal loading – fine-scale ocean tide models, refined crustal models, tidal loading computations – offer ways to update the prediction of loading tilts. Here, such loading-tilt calculations are presented for comparison with those published to infer crustal structure from the set of available tilt data around the Bay of Fundy. Such calculations can be used to plan an eventual deployment of modern GPS antenna in Atlantic Canada, aimed at monitoring crustal deformation as the ocean tides evolve in response to climate change.

Session: 12010 General Geodesy and Geodynamics Géodésie générale et géodynamique **26/05/2025 11:15**

ID: 12393 Contributed abstract

On the role of SWOT observations for water level monitoring in flood prone regions of Thailand

Netsai Wiboonwipa [1] , *Stephanie Bringeland* [2] , *Georgia Fotopoulos* [3] , *Alexander Braun* [4]

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Presented by / Présenté par: *Netsai Wiboonwipa*
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Thailand typically experiences frequent large-scale flood events towards the end of the wet season (May–October), driven by intense monsoonal precipitation and the hydrological complexities of the Mekong River. These floods often cause damage to agriculture and infrastructure, affecting local communities. Flood dynamics in the Mekong River are strongly influenced by tributary inflows during the monsoon season, yet traditional in-situ gauge networks are confined to the mainstream, leaving critical tributary contributions unmonitored. This study integrates water level data from the Ice, Cloud and Water Elevation (ICESat 2), CryoSat 2, and the Surface Water and Ocean Topography (SWOT) missions, with in-situ gauge measurements. Data pre-processing was performed to address systematic biases and harmonize vertical datum discrepancies across satellite missions, ensuring consistency in water level estimates. Results focus on the September 2024 flood in the region monitored by the Chiang Saen station. Findings suggest that tributary inflows play a significant role contributing to high water levels compared to upstream flows at Chiang Saen. The incorporation of SWOT observations to the water level monitoring workflow in addition to other satellite altimetry observations provides a more comprehensive snapshot of the flood prone area. Analysis of Gravity Recovery and Climate Experiment (GRACE) observations provide additional insight into large-scale hydrological processes and cumulative tributary inflows in the region. Ultimately, a multi-satellite approach bridges the observational gap in tributary monitoring and improves flood forecasting underscoring the importance of satellite altimetry and geodetic satellite missions for sustainable development goals including UNSDG Goal 6 (Clean Water and Sanitation) and Goal 13 (Climate Action).

Session: 12010 General Geodesy and Geodynamics Géodésie générale et géodynamique **26/05/2025 11:30**

ID: 12484 Contributed abstract

Effects of the hydrosphere on topographical mass density

Michael Sheng [1] , *Cliff Shaw* [2] , *Ismael Foroughi* [3] , *Robert Kingdon* [4]

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Presented by / Présenté par: *Michael Sheng*
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Current topographical mass density models for Earth are contaminated by inconsistent handling of hydrological features. In these models, inland water bodies (such as lakes and rivers) and ice-covered regions (like ice sheets and glaciers) are either ignored or assumed to have depths extending all the way to the boundary surface (i.e., the entire topographic thickness is treated as water or ice). While the latter is clearly unrealistic, the former can also introduce substantial errors into the resulting models.

This study leverages data from the ICESat-2 satellite mission to investigate how ice and water affect the density estimates of the underlying rock and to quantify the errors introduced into topographical mass density models due to the various treatments of these hydrological features over Canada and the United States.

Session: 12010 General Geodesy and Geodynamics Géodésie générale et géodynamique **26/05/2025 11:45**

ID: 12551 Contributed abstract

Title: Deciphering Topographical Density Effects on the Relationship Between Geoid and Orthometric Height

Dechen Wangmo [1] , *Robert Kingdon* [2] , *Petr Vanícek* [3] , *Marcelo Santos* [4]

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Presented by / Présenté par: *Marcelo Santos*
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Geoid and orthometric height computation traditionally assume a constant topographical density of 2670 kg/m³, overlooking significant lateral density variations. This study investigates the impact of these variations on geoid height (N) and orthometric height (H), focusing on the complex topography of Colorado. By incorporating the UNB_TopoDens2v02 density model, we assess the influence of lateral density variations on geoid and orthometric height computations, as well as their relationship.
Using the SHGeo software, two geoid models were computed to quantify the effects of density variations. Results indicate geoid differences ranging from -0.09 m to 0.086 m, particularly in mountainous regions. Additionally, rigorous orthometric height computations reveal discrepancies of -0.12 m to 0.07 m due to density-induced variations in Helmert mean gravity. The relationship between N and H is also affected, with net differences ranging from -0.038 m to 0.004 m, indicating that density variations do not fully cancel out.
Validation using GSVS17 survey data confirms that integrating laterally varying density models improves geoid and orthometric height accuracy. These findings highlight the necessity of incorporating variable density models in geoid and height computations and the understanding the relation between them to enhance geodetic precision, particularly in regions with significant topographic complexity. This research advances geodetic methodologies, offering a more accurate framework for geoid modeling and height determination.

Session: 7040 Satellite Earth Observation: A unique view of our planet and a critical need for Canada's resilient future - Part 1 Observation de la Terre par satellite : Une vue unique de notre planète et un besoin essentiel pour l'avenir de

la résilience du Canada - Partie 1

Convenors:
Kaley Walker, University of Toronto;
Adam Bourassa, University of Saskatchewan

Satellite Earth observation (SEO) provides a unique global perspective on our planet's atmosphere and surface, including the oceans, land, vegetation, ice, and snow. Current and planned satellite missions from Canada and international agencies have provided and will provide a wealth of new information about the Earth system and that can be used to investigate a wide range of environmental and scientific questions.

Resourceful, Resilient, Ready: Canada's Strategy for Satellite Earth Observation provides a plan for Canada to more effectively leverage satellite earth observation (SEO) to address key priorities, including climate change mitigation and adaptation. This strategy will help to inform Canada's plans for SEO for the next decade and ensure Canada will maximize utilization and benefits of SEO.

This session encourages contributions from across the full SEO value chain, upstream, midstream and downstream, to illustrate the activities currently underway in Canada, involving industry, academia and government. This includes new measurement technologies and techniques, both passive and active; mission development; retrieval algorithms; demonstration and calibration of instruments; validation of satellite products; assimilation of data into numerical models; scientific results and discoveries; operational utilization and development of services.

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ID: 12253 Contributed abstract

The Government of Canada's First Operational InSAR-Based Volcano Monitoring System

Mandip Sond [1] , *Drew Rotheram-Clarke* [2] , *Timothy Beattie* [3] , *Chloe Lam* [4] , *Nicholas Ackerley* [5] , *Melanie Kelman* [6] , *Yannick LeMoigne* [7]

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Presented by / Présenté par: *Mandip Sond*
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The west coast of Canada is home to 348 known volcanic vents, dating to the Pleistocene or more recent, with at least 54 of these remaining active during the Holocene. Despite this, the threat posed by volcanic activity is often underestimated, owing to the lack of recent eruptions and limited routine monitoring. Significant historical eruptions include the ~220 BP Tseax Cone eruption, which resulted in approximately 2,000 fatalities among the Nisga'a First Nations people, and the ~2360 BP Plinian eruption of Mount Meager, which had an estimated Volcanic Explosivity Index (VEI) of 4.

In 2021, the Geological Survey of Canada (GSC) conducted a volcanic threat assessment using the United States Geological Survey's (USGS) National Volcano Early Warning System methodology. This study classified Mount Meager and Mount Garibaldi as "very high threat" volcanoes, while Mount Cayley, Mount Price, and Mount Edziza were classified as "high threat." At the time of the study, the federal government did not conduct routine monitoring for magmatic unrest at these sites.

The RADARSAT Constellation Mission (RCM), launched in 2019, enables systematic volcano monitoring in Canada through high-revisit Synthetic Aperture Radar (SAR). This study introduces the Government of Canada's first operational InSAR-based monitoring system. We detail the cloud-based infrastructure of our fully automated system, describing how it ingests, processes, stores, and disseminates InSAR data. These data provide timely, critical information to researchers at the Canadian Hazards Information Service (CHIS) and the GSC. We demonstrate how frequent SAR acquisitions facilitate the detection of magmatic unrest, addressing challenges such as temporal decorrelation and maximum observable displacement rates. Select results from the RCM Global Volcano Watch Background mission validate system performance, underscoring its cost-effective, wide-area monitoring capabilities.

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ID: 12550 Contributed abstract

An Overview of the January 2024 MAPLE Workshop - Focus on Satellite Earth Observation

Mengistu Wolde [1] , *Richard Leatch* [2] , *Stewart Cober* [3] , *Philip Gabriel* [4] , *Leonid Nichman* [5] , *Juan Pablo Arroyo-Mora* [6] , *John Liggio* [7] , *Alexei Korolev* [8] , *Daniel Michelson* [9] , *Margaret Kalacska* [10]

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Presented by / Présenté par: *Mengistu Wolde*

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The Medium-long range Aircraft PLatform for Environmental research (MAPLE) is Canada's next-generation airborne laboratory for environmental and atmospheric studies, replacing the aging Convair-580 aircraft. MAPLE will be developed to support interdisciplinary research in Earth System Sciences (ESS). MAPLE will support the Satellite Earth Observation (SEO) value chain, from proof of concept of new technologies to advancing technology and science readiness levels. Furthermore, enabling new satellite calibrations, validation of spaceborne observations, refinement of retrieval algorithms, and integration of airborne and space-based measurements. Recognizing the critical role of research aircraft in ESS, including SEO, the National Research Council of Canada (NRC) hosted the MAPLE workshop (Jan 10–12, 2024) with over 100 national and international experts from academia, government, and industry to prioritize scientific needs and specify technical requirements for the MAPLE aircraft. Key applications discussed include (1) satellite validation, (2) acquisition of new knowledge on cloud microphysics properties, critical for evolving how such properties and processes are represented in weather, climate and air quality models (3) high-resolution atmospheric and surface measurements, (4) data assimilation for improved forecasting, and (5) advancing airborne remote sensing technologies to enhance synergy with space-based observations. MAPLE's long endurance and range, flexible payload options, and high-altitude capabilities will enhance Canada's SEO strategy. This presentation summarizes workshop outcomes, emphasizing MAPLE's future role in supporting satellite validation and advancing SEO research as a National Facility.

Session: 7040 Satellite Earth Observation: A unique view of our planet and a critical need for Canada's resilient future - Part 1 Observation de la Terre par satellite : Une vue unique de notre planète et un besoin essentiel pour l'avenir de la résilience du Canada - Partie 1 **26/05/2025 11:00**

ID: 12370 Contributed abstract
Virtual

Recent Advancements in Canadian Operational Remote Sensing Production and Services

Jonathan Belletête [1] , *Ahmed Mahidjiba* [2] , *Rabah Hachelaf* [3] , *Ilyass Hajji* [4] , *Corinne Simard* [5] , *Najib Djamai* [6]

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Presented by / Présenté par: *Jonathan Belletête*
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The Operational Remote Sensing section (CMOT) of the Meteorological Service of Canada (MSC) at Environment and Climate Change Canada (ECCC) has achieved significant milestones in operational meteorological data production and accessibility.

Key advancements include the transition from GOES-16 to GOES-19, ensuring continuous high-quality satellite observations for Canadian weather monitoring. An update will be provided on the operationalization of the Surface Precipitation Type (SPTP) product, which enhances public access to critical precipitation information.

Additionally, CMOT has implemented a significantly improved national radar composite, now available on public government platforms, providing enhanced precipitation monitoring and situational awareness.

The integration of Artificial Intelligence (AI) and Machine Learning (ML) in radar extrapolation has further refined short-term precipitation forecasting, offering more accurate and timely nowcasts. CMOT will also provide an update on the Open Data Project, which promotes greater accessibility to meteorological radar datasets and fosters collaboration within the scientific community.

This presentation will highlight these key achievements and explore future directions aimed at further enhancing operational meteorological services in Canada.

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ID: 12436 Contributed abstract

Ku-band radar for snow water equivalent (and other) applications: Status of the Terrestrial Snow Mass Mission

Chris Derksen [1] , *Benoit Montpetit* [2] , *Vincent Vionnet* [3] , *Vincent Fortin* [4] , *Courtney Bayer* [5] , *Marco Carrera* [6] , *Nicolas Leroux* [7] , *Julien Meloche* [8] , *Christopher Marsh* [9] , *J Bergeron* [10] , *F Strachan* [11] , *P Plourde* [12]

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Presented by / Présenté par: *Christopher Marsh*
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Freshwater delivered by seasonal snow melt is of the utmost importance for the health and well-being of people and ecosystems across midlatitude, northern, and mountain regions, yet poses risks by contributing to costly and damaging flood events. The current lack of information on how much water is stored as snow (expressed as the 'snow water equivalent' or SWE), and how it varies in space and time, limits the hydrological, climate, and weather services provided by Environment and Climate Change Canada (ECCC). To address this knowledge gap, ECCC, the Canadian Space Agency (CSA), and Natural Resources Canada (NRCan) are working in partnership to implement a Ku-band synthetic aperture radar (SAR) mission presently named the 'Terrestrial Snow Mass Mission' – TSMM. A technical concept capable of providing dual-polarization (VV/VH), moderate resolution (500 m), wide swath (~250 km), and high duty cycle (~25% SAR-on time) Ku-band radar measurements at two frequencies (13.5; 17.25 GHz) is under development. Ku-band radar is a desirable approach for a terrestrial snow mass mission because these measurements are sensitive to SWE through the volume scattering properties of dry snow and can identify the wet versus dry state of snow cover.

This presentation will provide an update on the mission status, including:
(1) Implementation of computationally efficient SWE retrieval techniques, based on the use of physical snow modeling to provide initial estimates of snow microstructure which can effectively parameterize forward model simulations for prediction of snow volume scattering.
(2) Testbed experiments facilitated by the recently developed TSMM simulator.
(3) Analysis of airborne Ku-band radar measurements acquired across Canada with the 'CryoSAR' instrument operated by the University of Waterloo.
(4) Key policy drivers which anchor mission development, including ensuring resilient adaption to climate change, enhanced environmental prediction, and ensuring strategic water supply information is available to support Canadian stakeholders.

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26/05/2025 11:45

ID: 12385 Contributed abstract
Virtual

The EarthCARE mission : Overview and scientific highlights since launch

Jason Cole [1] , *Howard Barker* [2] , *Zhipeng Qu* [3] , *Meriem Kacimi* [4] , *Robin Hogan* [5] , *Shannon Mason* [6] , *Gerd-Jan van Zadelhoff* [7] , *Bernat Puigdomenech Treserras* [8] , *Pavlos Kollias* [9] , *Dave Donovan* [10] , *Almudena Velazquez* [11] , *Nicolas Clerbaux* [12]

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Presented by / Présenté par: *Zhipeng Qu*
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The EarthCARE satellite mission is comprised of four instruments: a cloud profiling radar (CPR), a high spectral resolution lidar (ATLID), a multispectral image (MSI) and a broad band radiometer (BRR). These four instruments fly on a single satellite platform and are aligned to make concurrent observations of clouds, aerosols and radiation allowing new

insights into processes and interactions. The observations are used as input to retrieval algorithms, using either single instruments or combining multiple instruments, to provide a range of clouds, aerosol and radiation properties. To assess the quality of the retrievals, the EarthCARE mission uses forward radiative transfer calculations using 1D radiative transfer and 3D radiative transfer, the latter a first for an atmospheric satellite mission, and BBR observations to perform continuous radiative assessment of the retrievals.

The satellite launched on 29 May 2024 and following an extensive commissioning phase, data is now becoming available to the public with a plan for all data to be publicly available by the end of 2025. Since launch, EarthCARE has already been able to take new and high-quality observations, providing new observations of vertical motions within convective clouds and high-quality cloud properties using CPR, aerosol properties and high-altitude clouds using ATLID and high-resolution broadband radiation observations using BBR. Examples of these new observations will be presented including a scene spanning from central Europe to central Africa showing the results from observations to radiative closure assessment.

Session: 8040 Global Water Futures: Solutions to water threats in an era of global change - Part 1 L'avenir de l'eau dans le monde : Solutions aux menaces pesant sur l'eau à l'ère du changement planétaire - Partie 1

Convenors:
John Pomeroy, University of Saskatchewan, john.pomeroy@usask.ca
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Our water is at risk—in Canada and globally, we are facing unprecedented water-related challenges. Half of the world's population depend on water from cold regions, and while Canada is home to 20 per cent of the world's freshwater reserves, it has some of the highest warming rates which adversely affect infrastructure, ecosystems and human health. Facing these challenges, water scientists in Canada and globally are asking the question, "how can we best forecast, prepare for and manage water futures in the face of dramatically increasing risks?" Global Water Futures (GWF; 2016–2025) is a major Canadian research consortium that came together to address this grand challenge. Its overarching goal is to deliver risk management solutions—informed by leading-edge water science and supported by innovative decision-making tools—to manage water futures in Canada and other cold regions. With GWF coming to its conclusion, it is timely and important to share its scientific outcomes and synthesize the complete set of findings to ensure that these are useful and actionable to society. This effort is underway and the session brings together key thematic and regional components of the synthesis. Submissions on related GWF advances in cold regions water and climate science, utilization of GWF models or results, community and user engagement, and knowledge mobilization are encouraged.

Session: 8040 Global Water Futures: Solutions to water threats in an era of global change - Part 1 L'avenir de l'eau dans le monde : Solutions aux menaces pesant sur l'eau à l'ère du changement planétaire - Partie 1 **26/05/2025 10:30**

ID: 12315 Contributed abstract

Projected changes in climate and meteorological extremes over Canada in the 21st century – advancements and findings from the Global Water Futures program

Chris DeBeer [1] , *Julie Thériault* [2] , *John Hanesiak* [3] , *Francis Zwiers* [4] , *Stephen Déry* [5] , *Barrie Bonsal* [6] , *Ronald Stewart* [7] , *Yanping Li* [8] , *Zhenhua Li* [9] , *John Pomeroy* [10]

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Presented by / Présenté par: *Chris DeBeer*
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Global temperatures have risen by about 1.1 to 1.3°C from pre-industrial times and this is projected to continue under the current emissions trajectory, with as much as 5°C of global warming expected by late this century. At higher latitudes, such as across Canada, warming has been much greater and projections for the future show that annual and seasonal temperatures could rise by 10 or more degrees Celsius in some places. This warming is already having many impacts on the global climate system and meteorological extremes such as heatwaves, droughts, and intense precipitation. With continued climate change, warming will be accompanied by increasing extreme and unprecedented (in human history) meteorological events and an intensification of the global hydrological cycle. In Canada, the Global Water Futures program (GWF; www.globalwaterfutures.ca) undertook extensive studies to improve understanding of how climate change influences water availability and extreme events, guided by very specific questions posed by an extensive community of partners and knowledge users. This presentation briefly summarizes the GWF projects and work under its Hydrometeorology and Climate Change theme before reviewing the outcomes, contextualized by our user questions and concerns. Topics include high-intensity and extreme heavy precipitation, atmospheric rivers, freezing rain and hazardous accreting

precipitation, wet snow and snow-to-rain transition, damaging hail and meso-scale convective systems, and meteorological drought. The findings are presented in more detail in a GWF synthesis currently being developed as a major outcome of the program, to be completed in the spring–summer of 2025.

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ID: 12335 Contributed abstract

Improving hydrological process representation in a hyper resolution, snow-drift resolving model

Donovan Allum [1] , *Christopher Marsh* [2] , *Alain Pietroniro* [3] , *John Pomeroy* [4]

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Presented by / Présenté par: *Donovan Allum*

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Next Generation hydrological model development was a key objective of the Global Water Futures programme. Modules for improved hydrological representation have been added to an existing next-generation modelling framework for snow redistribution and ablation processes, the Canadian Hydrological Model (CHM), to facilitate the calculation of runoff. CHM is a spatially distributed, hyper-resolution, parallelized, three-dimensional, modular variable resolution mesh model. The variable resolution mesh requires significantly fewer computational elements than traditional raster-based approaches and so can run efficiently over continental domains at the highest resolution necessary to resolve the dominant physical processes. CHM currently calculates blowing snow, intercepted snow and avalanching snow redistribution, sublimation, radiation on slopes, windflow over complex terrain, energy balance snowmelt, and flow through snowpacks on variable resolution triangles as fine as 50 m to achieve snowdrift-resolving scales. Additional algorithms were adapted to the CHM framework for infiltration into frozen and

unfrozen soils, subsurface moisture storage and flow, and Penman-Monteith evapotranspiration using algorithms employed in the Cold Regions Hydrological Model. The added hydrological processes, their implementation in CHM, order of operations issues, and results in a variable resolution mesh framework are described along with preliminary simulation results and evaluation against research basin observations from the Global Water Futures Observatories network.

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ID: 12495 Contributed abstract

Implementation of an Insect infestation routine into the coupled MESH-CLASSIC hydrologic-LSM

Daniel Mutton [1] , *Dan Princz* [2] , *Bruce Davison* [3] , *M. Altaf Arain* [4]

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Presented by / Présenté par: *Daniel Mutton*

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The MESH-CLASSIC model is an integrated version of the Mod´elisation Environmentale Communautaire Surface and Hydrology system (MESH) hydrologic model, and the Canadian Land Surface Scheme Including Biogeochemical Cycles (CLASSIC) land surface model. It was developed to investigate the impact of hydrologic processes on biogeochemistry at the site and catchment scale. MESH is an official operation hydrologic model deployed by the Environment and Climate Change Canada in and is widely used by the Canadian hydrological modelling community.
Neither MESH, nor CLASSIC has historically included a module to represent insect infestation, however, this disturbance is becoming more common within Canadian watersheds and understanding the impacts of insect infestation on carbon and water

cycling is imperative.

The Marauding Insect Module (MIM) was originally developed for the Integrated Biosphere Simulator (IBIS) and includes representation of three different outbreaking insect strategies common to North America, the first is for a broadleaf defoliator (based on the tent caterpillar and gypsy moth), the second is for a needleleaf defoliator (based on the eastern spruce budworm), and the third is for a needleleaf killer (based on the mountain pine beetle). The model performance during each infestation was compared to flux measurements taken at a site in North America that underwent a corresponding infestation to ascertain the accuracy of the representation.

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ID: 12564 Contributed abstract

Spatiotemporal prediction of future groundwater surface under climate change scenarios using a hybrid WA-NIO and geospatial methods in Saskatchewan.

Ahmed Shawky Okasha [1] , *Mohamed Khafagy* [2] , *Sarah Dickson-Anderson* [3] , *Corinne Schuster-Wallace* [4]

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Presented by / Présenté par: *Ahmed Shawky Okasha*

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Climate change and shifting water demands from population growth affect groundwater availability. However, the scarcity of groundwater level (GWL) measurements limits our ability to reliably assess variations in the groundwater surface (GWS). This study develops a coupled, time-series prediction and geospatial interpolation tool for predicting GWS variations. The tool was trained and validated using data from the Judith River Aquifer in southwestern Saskatchewan to predict future GWS under climate change

scenarios.
Available historical time series include: i) sparse GWLs spatially and temporally distributed among 139 boreholes (1970-2017); ii) monthly GWLs (1966-2022) from two wells of the Saskatchewan observation well network; and iii) total monthly precipitation and mean temperature from CMIP6 scenarios. The data were split 70 - 30 for training and validation purposes. The hybrid wavelet-nonlinear input-output model (WA-NIO) was trained using climate data to predict GWLs at the borehole locations. The continuous GWS was interpolated using geospatial techniques, including inverse-distance weighting (IDW), Kriging regression, and radial basis functions (RBFs). The model was tested using cross-validation, where predicted and observed GWLs were compared using the correlation coefficient, normalized root mean square error and Nash-Sutcliffe coefficient. The results show that RBFs achieved the highest prediction accuracy for GWS, while IDW was the least accurate. Future GWS of the aquifer is predicted to gradually decrease by varying amounts dependent on the climate scenario applied (e.g., 6 m using the green road scenario and 20 m using the fossil-fueled development). The study provides a valuable tool to assess groundwater variations in data-scarce zones.

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ID: 12559 Contributed abstract

Further revealing the invisible resource: a synthesis of Global Water Futures Groundwater Research

David Rudolph [1] , *Ashleigh Duffy* [2] , *Chris DeBeer* [3] , *Darrell Corkal* [4] , *Elliott Skierszkan* [5] , *Grant Ferguson* [6] , *Stacey Dumanski* [7] , *Monica Morrison* [8]

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Presented by / Présenté par: *David Rudolph*
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As the Global Water Futures (GWF) program concludes, key developments in Canadian groundwater research are being synthesized. In a response to user questions, this work emphasizes that sustainable groundwater management requires continuous monitoring, modeling and water quality testing. GWF offers evidence to inform and support Canada's understanding of its groundwater resources, made possible through collaborations among researchers, government agencies, industries, and communities. Key findings include enhanced awareness of elevated geogenic metal(loid) concentrations in certain northern groundwaters, and discovery that thawing permafrost presents a previously unknown risk towards mobilizing these metal(loid)s such as arsenic and uranium into northern water resources. In the Yukon and Northwest Territories, regionally specific methodologies are being developed for Northern Groundwater Vulnerability Assessment to protect aquifers and wells. Across Prairie regions, low groundwater recharge rates and alteration of the subsurface water balance by oil and gas activities raise concerns about sustainable use and contamination risks. Also on the Prairies, new information on groundwater ages reveals insights into potential groundwater use and renewability as a resource. In urban watersheds, municipal water wells can affect both groundwater and surface water flows, impressing the need to account for subsurface conditions in hydrologic modelling. In addition, groundwater sustains the baseflow of critical to mountain hydrology. North America is already encountering groundwater resource scarcity through increasing demand with overarching accessibility issues and a lack of continuous data coverage. This research stresses the importance of continuous monitoring, incorporating groundwater flow into hydrologic modeling, and further investigating the ages and quality of waters at greater depths to guide to regulate activities that affect this shared resource.

Session: 3030 General Biogeoscience Biogéosciences générales

Convenors:
Britt Hall, University of Regina (Co-convener)
Colin McCarter, Nipissing University (Co-convener)

Biogeosciences underpins many critical ecosystem processes, often working at the intersection of multiple disciplines. This session will highlight the diversity of research investigating ecosystem processes from a biogeoscientific/biogeochemical perspective. We invite a broad range of research contributions from across Canadian biogeosciences that use, but are not limited to, in situ field studies, laboratory experiments, numerical modelling, method/sensor development, remote sensing or other approaches. General topics can, but are not limited to, include biogeochemical function of natural or managed ecosystem, quantifying the impacts of climate and land-use change on water/nutrient/element/sediment fluxes, measuring or modelling the effects of ecological communities on ecosystem dynamics or long-term change, or developing and testing new sensor systems and measurement techniques.

Session: 3030 General Biogeoscience Biogéosciences générales **26/05/2025 10:30**

ID: 12581 Contributed abstract

General discussion / state of the science

Sophie Wilkinson [1]

[1] Simon Fraser University

Presented by / Présenté par: *Sophie Wilkinson*
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General discussion / state of the science

Session: 3030 General Biogeoscience Biogéosciences générales **26/05/2025 11:00**

ID: 12251 Contributed abstract

Assessing the value of constructed wetlands with emergent vegetation as a Nature-Based Climate Solution: insights from Southern Ontario

Alexandra Haak [1] , *Gail Chmura* [2] , *Florin Pendea* [3]

[1] Lakehead University

[2] McGill University

[3] Lakehead University

Presented by / Présenté par: *Alexandra Haak*
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Constructed wetlands (CW) are multifunctional natural-like systems created for wastewater treatment, biomass production, water storage and flood retention, and wildlife habitat. Vegetated CW can also sequester carbon (C) in their soils and potentially contribute to mitigation of anthropogenic greenhouse gas (GHG) emissions. Although research has quantified GHG emissions in some Canadian CW, it is largely unclear whether these systems can help or hinder Canada's GHG emissions reduction efforts.
In this study, we report the GHG fluxes from two constructed wetlands from Southern Ontario (Canada) vegetated primarily by Typha latifolia, one permanently flooded and one with a variable hydroperiod. Greenhouse gas fluxes (CO2, CH4, and N2O) were measured seasonally using the static (dark) chamber method. Ecosystem respiration (CO2 emissions) was significantly higher in the permanently flooded wetland when compared to the intermittently flooded system during all seasons except winter. The annual average CO2 emissions in the permanently flooded wetland was 170±121 mg m-2 hour-1, while in the drier wetland the CO2 emissions were 94±52 mg m-2 hour-1.

Average methane emissions were over 21 times higher in the permanently flooded wetland (9.81±19 mg m-2 hour-1) compared to the seasonally flooded wetland (0.43±0.5 mg m-2 hour-1) peaking during summer at the latter site, but during fall at the former. Winter CH4 emissions under frozen water surface conditions in the permanently flooded system were comparable to the summer values at the drier site underscoring the importance of measuring cold season emissions in constructed wetlands for a robust annual GHG flux assessment. Nitrous oxide emissions were negligible throughout except during spring at the intermittently flooded wetland where they reached 42.5±41 µg m-2 hour-1. Our results suggest that hydrological control in constructed wetlands is essential to reducing their global warming potential as reduced flooding in the fall and winter could lead to substantially lower CH4 emissions.

Session: 3030 General Biogeoscience Biogéosciences générales **26/05/2025 11:15**

ID: 12368 Contributed abstract

Estimating Forage and Grassland Productivity using Earth Observation

Catherine Champagne [1] , *Dongzhi Qi* [2] , *Yinsuo Zhang* [3] , *Jiangui Liu* [4] , *Jiali Shang* [5] , *Emily Lindsay* [6] , *Antoun El Khoury* [7] , *Bill Houston* [8] , *Aston Chipanshi* [9] , *Anne Smith* [10]

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Presented by / Présenté par: *Catherine Champagne*

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Landscape productivity plays an important role in carbon and nitrogen cycles and is a key element of nature based climate solutions. Estimating inter-annual changes in productivity is generally done through process-based modelling, land cover mapping and simple metrics of vegetation condition from Earth Observation satellites. These methods have evolved over time to become more precise, with a goal to replace proxy measures of productivity (e.g. crop yield and vegetation indices) with more physically based estimates that are tailored to specific vegetation types. Grassland ecosystems and perennial agriculture are systems which store carbon as both above and below ground biomass. Quantifying this amount of biomass using Earth Observation satellites has been complicated by the complexity of identifying native grasslands, managed rangelands and seeded forages from other land cover or agricultural land use types. AAFC scientists have adapted an Earth observation based model for estimating above ground gross primary productivity (GPP) of grassland and forage biomass from the Grasscast model used for forecasting forage production in the United States. The model uses weekly maximum Normalized Difference Vegetation Index (NDVI) data derived from MODIS-Terra in combination with model estimated Actual Evapotranspiration (AET) to estimate grassland productivity and was calibrated to Canadian conditions using a database of biomass samples collected by federal and provincial government agencies over the past 30 years . The Grasscast-Canada model was then applied to run in a hindcast mode to estimate seasonal GPP over a 20 year period, and correlate to biomass simulated using traditional process based models and independent field samples for the Canadian prairies. Preliminary results show MODIS NDVI provides moderately accurate estimates of grassland productivity across most of the sites in the Prairies (R2 = 0.51) . Comparisons between estimates from MODIS data and that simulated using the Environmental Policy Integrated Climate (EPIC) model will be presented.

Session: 3030 General Biogeoscience Biogéosciences générales **26/05/2025 11:30**

ID: 12195 Contributed abstract

Wildfire, Degradation and Climate Change: A Triple Threat for the Northern Peatland Carbon Sink

Sophie Wilkinson [1]

[1] Simon Fraser University

Presented by / Présenté par: *Sophie Wilkinson*
Contact: sophie_wilkinson@sfu.ca

The northern peatland carbon sink is critical for the regulation of the Earth's climate, however, it is experiencing increasing stressors due to both anthropogenic and climate-mediated disturbances. This talk will discuss the processes by which, and impact of, compounding disturbances on northern peatlands and present a large-scale modelling effort to quantify the effect on medium-term (100-yr) carbon dynamics. Direct, anthropogenic disturbance such as peatland drainage for horticultural, agricultural, forestry or development purposes, disrupts the ecohydrological feedbacks that promote the resilience of peatlands to other disturbances. Climate change stressors such as long-term drying and increased severity of drought can have similar or compounding effects. When degraded ecosystems are impacted by wildfire they tend to burn much more severely than their pristine counterparts, releasing around ten times more carbon into the atmosphere. There is considerable spatial variability in carbon losses due to variation in peat properties and ecohydrological conditions. Further, there is limited understanding of the post-fire carbon fluxes in degraded systems and the potential to exacerbate or dampen the initial carbon losses. To better understand the impact of these disturbance interactions on the globally-important northern peatland carbon stock, we collated empirical datasets from natural, degraded and restored peatlands in non-permafrost regions to model net ecosystem exchange and methane fluxes, integrating peatland degradation status, wildfire combustion severity and post-fire dynamics. Here, I present the results of our study including the likely impacts of climate change over the remainder of the century.

Session: 2011 Atmosphere, Ocean, and Climate Dynamics - Part 2 Dynamique de l'atmosphère, des océans et du climat - Partie 2

Convenors:
Adam Monahan (UVic)
Ron McTaggart-Cowan (ECCC)
Marek Stastna (U Waterloo)
Mike Waite (U Waterloo)

This session combines submissions that document studies of the dynamics of the atmosphere, oceans and/or climate system. The scope of the session is deliberately broad in order to include research that spans the full range of spatial and temporal scales. Studies of the dynamics of mesoscale processes that act on hourly timescales are as welcome in this session as those that document the evolution of planetary-scale structures in a changing climate. Such investigations may include theoretical, diagnostic and modelling studies that employ the latest analytic and prediction techniques, including those based on machine learning. However, any topic that is relevant to atmosphere, ocean, or climate dynamics will fit well into this session.

Session: 2011 Atmosphere, Ocean, and Climate Dynamics - Part 2
Dynamique de l'atmosphère, des océans et du climat - Partie 2 **26/05/2025 13:45**

ID: 12296 Contributed abstract

Excitation of Internal Waves by Turbulent Stratified Shear Flow

Akash Kav [1] , *Bruce Sutherland* [2]

[1] University of Alberta
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Presented by / Présenté par: *Akash Kav*
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Previously performed laboratory experiments showed turbulence in stratified fluid excites internal waves in a narrow frequency band despite the turbulence having a relatively broad frequency spectrum (e.g. Dohan & Sutherland (2003), Aguilar & Sutherland (2006), Clark & Sutherland (2010)). Here we perform direct numerical simulations of turbulent shear flow with applied uniform stratification to examine the generation of internal waves. For a wide range of buoyancy frequencies, the waves are shown to be radiated with phase lines at an angle of approximately 45 degrees to the vertical, which is consistent with laboratory experiments. The amplitude of the waves increases if the applied buoyancy frequency is larger. Using Dynamic Mode Decomposition, we extract the structures of turbulence and overlying stratification which correspond to the observed frequency of the internal waves. This shows that the waves are excited from within the turbulence, rather than at the turbulent - non-turbulent interface.

Session: 2011 Atmosphere, Ocean, and Climate Dynamics - Part 2
Dynamique de l'atmosphère, des océans et du climat - Partie 2 **26/05/2025 14:00**

ID: 12546 Contributed abstract
Virtual

Plankton Blooms in the North Atlantic

Francis Poulin [1] , *Andrew Watford* [2]

[1]

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Presented by / Présenté par: *Francis Poulin*
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The North Atlantic is an energetic system that is the home of a very rich ecosystem. The Gulf Stream transports warm waters from the Gulf of Mexico and this can support many ecological systems. It has been observed that there are phytoplankton blooms that occur every year in the subtropic gyre, but predicting when and how this occurs, is a very difficult problem.

Using Oceananigans.jl and climatological data for the temperature, salinity and wind forcing, we simulate a single gyre in the context of the subtropical gyre in the North Atlantic, with a simple planktonic model that includes Nutrients, Phytoplankton, Zooplankton and Detritus (NPZD). Our numerical simulations generate plankton blooms on a yearly basis that are most pronounced in the north east and south west portions of the domain. This allows us to make estimates on when the bloom begins, how long it lasts, where it originates and where the plankton are transported to. Even though there are some significant differences from observations, this is a significant step forward in quantifying plankton blooms in the North Atlantic.

Session: 2011 Atmosphere, Ocean, and Climate Dynamics - Part 2
Dynamique de l'atmosphère, des océans et du climat - Partie 2 **26/05/2025 14:15**

ID: 12211 Contributed abstract

Simulated Changes in Large-scale Atmospheric Circulation Energetics from Volcanic Aerosol Forcing

Anatoly Poroshenko [1] , *Matthew Toohey* [2]

[1] University of Saskatchewan

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Presented by / Présenté par: *Anatoly Poroshenko*
Contact: cdy016@mail.usask.ca

Understanding the response of large-scale atmospheric circulation to radiative forcing agents is important for climate prediction. The radiative forcing from volcanic stratospheric aerosol is one of the most important natural climate forcings, with impacts on surface temperature and atmospheric dynamics. In this study, we explore changes in the energetic properties of the Hadley and Ferrel systems under the influence of radiative forcing associated with large volcanic eruptions in multi-model simulations performed as part of the Model Intercomparison Project on the Climatic Response to Volcanic Forcing (VolMIP) within the Coupled Model Intercomparison Project Phase 6 (CMIP6). In the Earth's atmosphere, the Hadley and Ferrel systems are examples of thermally direct (warm air rises and cold air sinks) and indirect (cold air rises and warm air sinks) circulations, respectively. Being the part of Lorenz cycle of energy transformation in the atmosphere, the direct circulation converts zonal-mean available potential energy into zonal-mean kinetic energy. The indirect circulation in the midlatitude, however, converts some of the zonal-mean kinetic energy back into zonal-mean available potential energy. Averaged over the 4 models that provided the required model output from the VolMIP Pinatubo simulations, the mean power associated with the Hadley system in preindustrial simulations is 236 TW. The mean decrease of the power in VolMIP simulations of the 1991 Pinatubo eruption is 7.58 TW (3.22%) for the first post-eruption northern-hemisphere (NH) winter and 6.59 TW (2.80%) for the second one. For the Ferrel system, the preindustrial mean DJF power is 326 TW, and post-volcanic anomalies are 16.3 TW (5.00%) and 18.3 TW (5.61%) in NH winters 1 and 2, showing a stronger anomaly in the second NH winter than the first one. In additional VolMIP experiments, we also explore the response of the Hadley and Ferrel cells to the relatively strong forcing associated with the 1815 Tambora eruption and find the Hadley system weakening by 15.3 TW (6.48%) and 11.5 TW (4.90%) for the first two NH winters. We explore how post-eruption changes in the meridional atmospheric circulation strength and the cells' location can be explained with simple theoretical models of atmospheric thermodynamics.

Session: 2011 Atmosphere, Ocean, and Climate Dynamics - Part 2
Dynamique de l'atmosphère, des océans et du climat - Partie 2 **26/05/2025 14:30**

ID: 12340 Contributed abstract
Virtual

The Sudden Stratospheric Warming events in the Antarctic in 2024

Yucheng Zi [1] , *Zhenxia Long* [2] , *Jinyu Sheng* [3] , *Gaopeng Lu* [4] , *Will Perrie* [5] , *Ziniu Xiao* [6]

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[2] Fisheries and Oceans Canada, Bedford Institute of Oceanography

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Presented by / Présenté par: *Yucheng Zi*

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In July and August 2024, two consecutive stratospheric sudden warming (SSW) events (termed as SW07 and SW08) occurred over Antarctica, both featuring a rapid 17 °C temperature rise at 10 hPa and significant stratospheric polar vortex (SPV) deceleration. SW07 occurred at the earliest winter time of the year recorded in the satellite era (1979 to present). It is found that significant sea ice loss in the Ross Sea and the Amundsen Sea in Antarctica prior to SW07 created favorable conditions for the development of strong blocking highs, which affected stratospheric warming through nonlinear planetary waves. Furthermore, the stratospheric preconditioning significantly amplified the intensity of the planetary waves. A downward-propagating negative Southern Annular Mode (SAM) signal after SW07 supported blocking highs, creating a favorable circulation for planetary wave perturbations before SW08. In addition, enhanced ozone transport from low latitudes to the pole during SW07 and SW08 led to ozone recovery.

Session: 5080 Climate - Community, Service and Education Climat - Communauté, Services et Éducation

Convenor: Julie Thériault

Related to scientific studies and/or information sharing about the climate, including studies on slowly varying aspects of the Earth's systems, as well as past and future conditions, using various approaches.

This session covers many topics, including but not limited to education, community science and data collection, data dissemination, and other activities such all studies related to climate services and communicating climate change-related risks.

Session: 5080 Climate - Community, Service and Education Climat - Communauté, Services et Éducation **26/05/2025 13:30**

ID: 12510 Contributed abstract

Concerned citizens making impact on Canada’s Net Zero challenge

Charles Lin [1] , *Kate Rayner* [2] , *James Lin* [3] , *Stephen Phoon* [4] , *Shy Yi Chu* [5] , *Veronika Kosova* [6]

[1] 2019 Fellow, Advanced Leadership Initiative, Harvard University; Former Director General, Atmospheric Science and Technology, Environment and Climate Change Canada; Former Department Chair, Atmospheric and Oceanic Sciences, McGill University

[2] 2024 BA Alumni, University of Toronto

[3] 2016 PhD Alumni, Department of Economics, University of Alberta

[4] Professor, Seneca Business, Seneca Polytechnic; John Dobson Enactus Fellow

[5] 2008 MSc Alumni, Environmental Change Institute, University of Oxford; 2006 BA Alumni, McGill School of Environment, McGill University

[6] 2011 Master's degree in Law Alumni, Faculty of Law, Comenius University

Presented by / Présenté par: *Charles Lin*
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The Canadian federal government has committed the country to reach “Net Zero” anthropogenic CO2 emissions by 2050 in accordance with the Paris Agreement, where emissions are balanced by removals. Different jurisdictions in Canada have also adopted their own net zero plans. The city of Toronto aims to reduce its community-wide emissions to net zero by 2040 – one of the most ambitious municipal targets in North America. Governments, corporations and citizens all have a role in the net zero journey. Impact Net Zero (INZ) is a group of concerned citizens who have created a movement and online presence (https://impactnetzero.ca/) to inform and engage Canadians on this journey. Our primary focus is on scalable actions by citizens in creating awareness and impact. In this talk, we discuss our current work on reducing food waste, focusing on the environmental impact including greenhouse gas emissions, and potential actions by citizens on reducing household food waste. We work with community organizations, youth groups, and food rescue organizations in Toronto. We also discuss the importance of narratives and story-telling in communicating climate change to the public to create engagement and to spur action.

Session: 5080 Climate - Community, Service and Education Climat - Communauté, Services et Éducation **26/05/2025 13:45**

ID: 12480 Contributed abstract

Assessing the impact of the Williston Reservoir on climate conditions in nearby areas

Siraj ul Islam [1] , *Behnoosh Roknaldini* [2]

[1] University of Northern British Columbia
[2] University of Northern British Columbia

Presented by / Présenté par: *Siraj ul Islam*
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This study assesses the impact of Williston Reservoir on the local climate in the traditional territory of the Tsay Keh Dene Nation in northern British Columbia. We analyzed changes in mean state and variability of several climatic variables in the vicinity of the reservoir using ERA5 and ERA5-land reanalysis and in-situ weather station data for 1981-2019. The findings reveal that the Williston Reservoir leads to an annual temperature increase of 2.5°C in its vicinity. It also notably narrows the diurnal air temperature range by 3.5°C, particularly between September to December. The reservoir's capacity to store heat during the summer and release it in the fall greatly influences air temperature fluctuations during the fall. Additionally, it increases evaporation by up to 25% and precipitation by 15% within a 10 km buffer zone, driven mainly by increased convective available potential energy. The wind speed also increases during the fall season. These findings have important implications for developing regional climate predictions and mitigation plans in the context of human activities.

Session: 5080 Climate - Community, Service and Education Climat - Communauté, Services et Éducation **26/05/2025 14:00**

ID: 12318 Contributed abstract

A Novel Deep Reinforcement Learning Approach for Optimizing Coastal Flood Risk Mitigation Under Climate Change

Saeed Saviz Naeini [1] , *Reda Snaiki* [2]

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Presented by / Présenté par: *Saeed Saviz Naeini*
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Hurricane-induced coastal flooding is a major cause of destructive damage, economic losses, and fatalities, particularly in vulnerable coastal regions of Atlantic Canada. While various mitigation strategies, such as sea walls and flood barriers, have been employed to reduce inundation risk, selecting the most effective measure while considering system constraints, such as budget limitations, spatial restrictions, and environmental

regulations, remains challenging. This study proposes a data-driven framework based on deep reinforcement learning (DRL) to identify the most effective and feasible mitigation strategies for vulnerable locations along the Canadian Atlantic coastline, accounting for the effects of climate change. The framework consists of two key components: risk modeling under several climate scenarios and reinforcement learning optimization. The goal is to minimize risk under changing climate scenarios. Specifically, hazard probabilities are first generated using a simplified coastal flooding model coupled with 10,000 years of synthetic storm simulations for both present and future climate conditions. These hazard probabilities, combined with exposure and vulnerability data, are used to create coastal flood risk maps under multiple storm scenarios. Subsequently, DRL is employed to optimize mitigation strategies by treating the problem as a sequential decision-making process. The state space consists of risk probabilities across different scenarios at the selected locations, while the action space includes various mitigation measures, such as determining the length, height, and placement of sea walls. The reward function is designed to minimize expected damage and mitigation costs while maximizing risk reduction benefits, ensuring the effectiveness of strategies across multiple flood scenarios. The environment dynamically updates as mitigation actions change hazard exposure, allowing the model to learn adaptive strategies over time. This approach provides an adaptable decision-making tool for coastal flood mitigation, offering an optimized balance between cost, effectiveness, and long-term resilience in the face of climate change.

Session: 5080 Climate - Community, Service and Education Climat - Communauté, Services et Éducation **26/05/2025 14:15**

ID: 12386 Contributed abstract

Analyzing the Effects of Restrictions and Incentive Programs for Outdoor Residential Water Usage Reduction

Nicholas Guthro [1] , *Aditi Bhaskar* [2] , *Tanya Heikkila* [3]

[1] University of Colorado Boulder
[2] University of Colorado Boulder
[3] University of Colorado Denver

Presented by / Présenté par: *Nicholas Guthro*
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Intensifying climate change increases the risk of urban water supply shortages and infrastructure challenges, motivating and resulting in water usage policies to reduce residential water usage. Many urban areas have identified outdoor usage as a primary target for reducing demand. To achieve this demand reduction, urban areas have begun implementing various policies such as watering restrictions and lawn removal rebates. This study compiled various water reduction strategies, climatic data, and water cost rates in seven urban areas in the Colorado River Basin to determine each influence on outdoor water usage. Water reduction policies were compiled using a media analysis of multiple key terms relating to individual cities and water providers. The outdoor water usage data was estimated after compiling residential usage data from utilities and applying a mixture of the minimum month method and smart metering estimates to segregate indoor and outdoor usage. This work finds that higher temperatures result in

higher water usage rates. At the same time, the implementation of incentives and mandatory and voluntary restriction programs all saw significant reductions in water usage. Mandatory restriction programs were expected to have the largest influence on reducing water usage. Voluntary restriction programs were linked with a larger reduction in usage compared to incentive programs, potentially showing that the design of incentive and rebate programs needs to be adjusted to achieve the reduction goals of cities.

Session: 5080 Climate - Community, Service and Education Climat - Communauté, Services et Éducation **26/05/2025 14:30**

ID: 12192 Contributed abstract

Virtual

Estimating Population-based Wildfire Smoke Exposure

Carlyn Matz [1] , *Melissa MacDonald* [2] , *Celine Audette* [3]

[1] Health Canada

[2] Environment and Climate Change Canada

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Presented by / Présenté par: *Melissa MacDonald*

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Wildfires are a source of air pollution, especially PM2.5, and have impacts on air quality in communities in proximity to and at great distances from the fires. Compared to point sources, wildfire smoke exposures are seasonal and episodic, with exposure levels and durations that can vary considerably. Exposure to wildfire smoke is associated with numerous health effects, including an increased risk of premature mortality, exacerbation of asthma and chronic obstructive pulmonary disease, and an increased risk of cardiovascular effects. In Canada, the health risks of wildfire smoke are communicated to the public via Government of Canada tools, including the Air Quality Health Index and air quality alerts. To support the public health response for wildfire smoke events, it is important to understand the populations at risk from wildfire smoke. To this end, a population-based exposure metric was developed based on air quality metrics and population counts. This metric, measured as person-days, quantifies the number of people at risk of experiencing adverse health effects of wildfire smoke during a given time period. Data from the 2023 wildfire season was used to develop and evaluate the wildfire smoke exposure metric. The greatest numbers of person-days were associated with population centres and regions that experienced periods of prolonged and/or intense smoke exposure. Compared to counting of air quality alerts, this metric incorporates the size of the population exposed to wildfire smoke, as a greater number of adverse health impacts would be anticipated in larger populations. This approach could be expanded to other environmental or extreme weather conditions.

Session: 10021 Biological, physical, and chemical oceanographic research to enhance and support resilient and healthy marine ecosystems - Part 2 Recherche océanographique biologique, physique et chimique visant à améliorer et à soutenir des écosystèmes marins sains et résistants - Partie 2

Convenors:
- Heather Andres, Fisheries and Oceans Canada
- Gwénaëlle Chaillou, Institut des Sciences de la MER (ISMER), Université du Québec à Rimouski
- Martine Lizotte, Fisheries and Oceans Canada
- Gary Maillet, Fisheries and Oceans Canada
- Nancy Soontiens, Fisheries and Oceans Canada

The interplay of physical, chemical and biological oceanographic conditions forms the foundation of marine ecosystems and partly determines their productivity and health. The health of marine ecosystems can exhibit natural variations and can also be directly and indirectly affected by human activities, such as anthropogenic emissions of carbon dioxide, aquaculture, exploratory drilling, shipping and fishing activity, tourism, etc.. This session aims to explore the linkages between physical, chemical and biological oceanographic processes and their impacts on ecosystems, as well as how those linkages vary and change via natural and human causes. Further, studies aiming to characterize ecosystem status and health by incorporating oceanographic data are encouraged. Specific topics may include:
• Marine carbon dioxide removal,
• Environmental controls on and changes to primary and secondary productivity, either through observational or modelling studies,
• Oceanographic impacts of changing sea ice and surface freshwater (from land, glacial melt, icebergs and hydrological cycle changes), as well as other climate changes,
• Ocean acidification, deoxygenation and other changes to habitat suitability,
• Seasonal predictability of oceanographic conditions,
• Extreme events, and
• Environmental conditions and indices applied to the study of marine ecosystems.

Session: 10021 Biological, physical, and chemical oceanographic research to enhance and support resilient and healthy marine ecosystems - Part 2 Recherche océanographique biologique, physique et chimique visant à améliorer et à soutenir des écosystèmes marins sains et résistants - Partie 2	**26/05/2025 13:30**

ID: 12214 Contributed abstract

In-situ assessment of the fate of sunken biomass and carbon sequestration potential in the deep ocean: multiple insights into biogeochemical cycling from a benthic lander experiment

Kohen Bauer [1] , *Paulo Correa* [2] , *Alex Lupin* [3] , *Fabio De Leo* [4]

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Presented by / Présenté par: *Kohen Bauer*
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Approaches for atmospheric carbon dioxide removal (CDR) are gaining traction as potential tools for mitigating further planetary warming and avoiding anthropogenically-driven climate catastrophe. Accordingly, nature-based ocean-related (o)CDR approaches (herein referred to as oCDR) aim to enhance oceanic carbon uptake and storage by leveraging natural biogeochemical cycles to boost the ocean's capacity to sequester atmospheric CO2. One proposed approach involves sinking marine biomass, which has converted inorganic carbon to organic carbon at the ocean's surface, into the deep-sea to limit re-exchange with the atmosphere. While some conceptual and numerical models imply large oCDR potential associated with macro algae cultivation and sinking(1–3), several limitations and concerns temper the optimism surrounding this pathway(4). For example, major unanswered questions about this approach remain, including how much carbon might actually be sequestered as well as potential ecological impacts to deep-sea benthic environments where sunken biomass is proposed to reside. To provide new insights and address several outstanding questions on the fate of sunken biomass in the deep ocean, here we conducted a controlled benthic lander study in the Cascadia Basin of the Northeast Pacific Ocean. We provide high resolution in-situ estimates of kelp decomposition in an oxygen minimum zone (OMZ), evaluate the ecological risk to benthic ecosystems associated with kelp sinking, and develop conceptual and numerical models of carbon and oxygen biogeochemical cycling to inform future sequestration strategies.

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Session: 10021 Biological, physical, and chemical oceanographic research to enhance and support resilient and healthy marine ecosystems - Part 2 Recherche océanographique biologique, physique et chimique visant à améliorer et à soutenir des écosystèmes marins sains et résistants - Partie 2 **26/05/2025 13:45**

ID: 12500 Contributed abstract

Ordering of redox reactions over an evolving time series in a reducing fjord

Roberta C. Hamme [1], *C. Erinn Raftery* [2], *Claire Onak* [3], *Tia Anderlini* [4], *Annaliese Meyer* [5], *Tim M. Conway* [6], *Jay Cullen* [7]

[1] University of Victoria

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Presented by / Présenté par: *Roberta Hamme*

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The global expansion of oxygen deficient waters is altering the biogeochemistry of our oceans, locally reducing bioavailable nitrogen and increasing concentrations of reduced species like trace metals and sulfide. In the absence of oxygen, a host of other oxidants are used by bacteria to degrade organic matter. These reactions typically proceed through a cascade defined by their energy production potential from highest to lowest yield. This ordering of redox reactions has largely been studied through spatial gradients in sediment pore waters and in the water columns of anoxic basins. Here, we study the same phenomenon temporally, using data from a time series of cruises in Saanich Inlet, a fjord in SW British Columbia that experiences seasonally varying anoxia in its deeper

waters. Our dataset begins during two deep-water flushing events that brought oxygen and nitrate to the deepest waters of the inlet and then follows the progression toward ever more reducing conditions. At the start, we observe decreasing nitrate and increasing manganese and nitrogen gas concentrations, suggesting that denitrification and manganese reduction occur simultaneously once oxygen is depleted. After that stage, we observe iron and sulfide begin to increase, also simultaneously. Understanding these dynamics in Saanich Inlet will inform reaction progression during mixing of oxygenated waters with the edges of larger, globally relevant oxygen deficient zones.

Session: 10021 Biological, physical, and chemical oceanographic research to enhance and support resilient and healthy marine ecosystems - Part 2 Recherche océanographique biologique, physique et chimique visant à améliorer et à soutenir des écosystèmes marins sains et résistants - Partie 2	**26/05/2025 14:00**

ID: 12523 Contributed abstract

A New Generation Of Optical Sensors For Ocean Research

Eduardo Vaz [1] , *Stef Stimson* [2]

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Presented by / Présenté par: *Héctor Álvrarez-Vázquez*
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For over five decades, RBR has been engaged in the development of high-accuracy and high-resolution oceanographic sensors designed for a wide range of aquatic environments. These sensors have been deployed in diverse settings, from polar regions in both hemispheres to deep ocean basins, coastal estuaries, and inland water bodies. The focus has consistently been on providing reliable measurements to support scientific research and environmental monitoring.

More recently, efforts have been directed toward the development of optical sensors tailored to the requirements of the Biogeochemical-Argo (BGC-Argo) program. This initiative emphasizes the need for sensors that combine high performance with long-term

stability while operating within strict power constraints. The challenge is to maintain the precision and durability required for long-duration autonomous deployments without excessive energy consumption.

This presentation will provide an overview of the ongoing development of optical sensors, including key design considerations and advancements in calibration methods. A comparative analysis of different design approaches will be discussed, highlighting the trade-offs involved in optimizing for power efficiency, measurement accuracy, and robustness in challenging oceanic conditions. The goal is to contribute to the broader understanding of sensor technology evolution in the context of autonomous biogeochemical observations

Session: 10021 Biological, physical, and chemical oceanographic research to enhance and support resilient and healthy marine ecosystems - Part 2 Recherche océanographique biologique, physique et chimique visant à améliorer et à soutenir des écosystèmes marins sains et résistants - Partie 2	**26/05/2025 14:15**

ID: 12491 Contributed abstract

Ocean Sound Speed Profile Measurement using a Pulse-Echo Technique

Mohammad Mousavi [1] , *Len Zedel* [2]

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Presented by / Présenté par: *Len Zedel*
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Accurate knowledge of the sound speed profile (SSP) is essential in ocean acoustics, influencing sonar performance and underwater navigation. The SSP can also provide indirect information on ocean temperature for environmental monitoring. Present methods of measurement including the use of Conductivity, Temperature, Depth (CTD) data or direct Sound Velocity Profilers (SVP) systems, require vessels to stop for data collection, which is costly and time-consuming, and can disrupt data collection. Alternatives that enable data collection from a moving vessel, include the use of eXpendable BathyThermographs (XBT), eXpendable Conductivity, Temperature, Depth

(XCTD) systems, or Moving Vessel Profilers (MVPs). While these approaches provide SSP data, they come with trade-offs that variously include the need for deck space, maintenance requirements, consumable components or compromises in accuracy. There are also considerations in cost particularly for large-scale or deep-water operations.

Our presentation focuses on an acoustic remote technique to estimate the ocean SSP using a single directional transmitter and at least two receivers. The method relies on measuring echo arrival times and using a time-delay profile to estimate both the average sound speed and the depths of ocean reflectors. By minimizing the root mean square error between the measured and theoretical time-delay profiles, the proposed approach reconstructs the SSP without requiring extensive sensor arrays. To validate this technique, we conduct simulations using a ray-based acoustic propagation model incorporating statistical fluctuations and environmental variations. Using the simulations, we explore results with variations in acoustic pulse length, transducer beam width, signal-to-noise ratio, and the density of reflectors. Results demonstrate that the proposed approach can accurately estimate a non-uniform SSP with a root mean square error of 2.1 m/s up to 125 m depth. These findings highlight the feasibility of this acoustic method for remote ocean sound speed monitoring.

Session: 7010 Enhancing Weather and Climate Monitoring Capacity through Collaboration Renforcer les capacités de surveillance météorologique et climatique par la collaboration

Convenors:
Kristine Confalone (Environment and Climate Change Canada)

Environment and Climate Change Canada's (ECCC) Meteorological Service of Canada (MSC) operates a surface observation network that is designed to provide weather and climate information as effectively as possible for a very large country, with substantial geographical and climatological diversity. In order to augment the information collected by this network, the MSC has been working with federal, provincial and territorial partners for a number of years on a multi-stakeholder, collaborative approach to monitoring, known as the Collaborative Monitoring Initiative. This Initiative is intended to leverage the long-term investments of all Canadian institutions in weather and climate observations and ensure they are monitored in an efficient, collaborative, and sustainable manner. Data from over 1400 stations of varying technologies, operated by federal, provincial and territorial partners have been brought into ECCC systems to date. These data are integrated into weather models to support forecasting activities, and where possible, made available to the public. A federal-provincial-territorial forum was also established in early 2020 with the purpose of improving communication amongst weather and climate monitoring stakeholders, sharing standards and best practices, and exploring potential for cross-regional collaboration. Despite these successes, network operators still face several challenges when it comes to data accessibility, quality and interoperability. Future priorities for collaboration will focus on addressing these challenges and supporting the long-term resilience of weather monitoring networks through the adoption of national standards and development of a national approach to data management, including metadata sharing, data quality and archiving.

Session: 7010 Enhancing Weather and Climate Monitoring Capacity through Collaboration Renforcer les capacités de surveillance météorologique et climatique par la collaboration

26/05/2025 13:30

ID: 12565 Contributed abstract

MSC's Collaborative Monitoring Initiative & the Canadian Council for Weather and Climate Monitoring

Kristine Confalone [1] , *Sean McLeod* [2] , *Christopher Linklater* [3]

[1] Environment and Climate Change Canada
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Presented by / Présenté par: *Kristine Confalone*
Contact: kristine.confalone@ec.gc.ca

The MSC has been working with federal, provincial and territorial partners for a number of years on a multi-stakeholder, collaborative approach to monitoring, known as the Collaborative Monitoring Initiative. This Initiative is intended to leverage the long-term investments of all Canadian institutions in weather and climate observations and ensure they are monitored in an efficient, collaborative, and sustainable manner. Data from over 1400 stations of varying technologies, operated by federal, provincial and territorial partners have been brought into ECCC systems to date. These data are integrated into weather models to support forecasting activities, and where possible, made available to the public.
A federal-provincial-territorial forum, known as the Canadian Council for Weather and Climate Monitoring or CWAC, was also established in early 2020 with the purpose of improving communication amongst weather and climate monitoring stakeholders, sharing standards and best practices, and exploring potential for cross-regional collaboration. Discussions and activities have focused on key operational and data management priorities. Successes include the development of an inventory and risk assessment of common telemetry systems currently in use by weather and climate monitoring network operators in Canada; the endorsement of a National Data Management Strategy to increase the value of shared data through adoption of common approaches, standards and tools; the creation of a National Dataset Catalogue to increase discoverability of weather and climate data in Canada; and the enabling of collaboration and exploration of opportunities to collectively advance common priorities, including sharing of operational challenges and approaches to improve or innovate network operations and data management. Future priorities for collaboration will focus on addressing these challenges and supporting the long-term resilience of weather monitoring networks through the adoption of national standards and development of a national approach to data management, including metadata sharing, data quality and

archiving.

Session: 7010 Enhancing Weather and Climate Monitoring Capacity through Collaboration Renforcer les capacités de surveillance météorologique et climatique par la collaboration

26/05/2025 13:45

ID: 12314 Contributed abstract

Developing best practices for Internet of Things (IoT) agricultural sensor networks to support on-farm decision-making

Jean-Thomas Denault [1] , *Trevor Coates* [2] , *Mathew Richards* [3] , *Jackson Eyres* [4] , *William Santary* [5] , *Vivan Tran* [6] , *Andrew VanderZaag* [7] , *Kayla Moore* [8] , *Rani Ramachandran* [9] , *Catherine Champagne* [10]

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Presented by / Présenté par: *Jean-Thomas Denault*
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Building a resilient agriculture sector requires investment in farming solutions driven by real-time data. While Agriculture and Agri-Food Canada (AAFC) has a long history of acquiring high quality meteorological and environmental data, providing ready access to these data in near real time to multiple users remains a challenge. The standardization of Internet-of-Things (IoT) protocols creates an opportunity to improve the tools we use to collect and disseminate data. The Long-Range Wide Area Network (LoRaWAN) communication protocol is ideally suited to measurements at the farm scale capable of incorporating data from spatially distributed wireless low-power sensors.
The poster will present the IoT architecture being developed using an Amazon Web Service cloud environment using ChirpStack network server and Grafana visualization tools. This project serves as a proof-of-concept to support the development of best practices and the path towards the integration of IoT devices and the creation of a cloud-based custom analytics and visualization platform following Government of Canada standards. This cloud solution will enable easy collaboration with other researchers, take in data from other systems, and easily expand the types of IoT devices used by this platform.

The proof-of-concept will integrate data coming from three reference sites (Tier 1) and spatially distributed IoT sensor nodes (Tier 2) to assess soil moisture and supporting agrometeorological quality parameters. Two reference sites are associated with the Real-time in situ soil moisture for agriculture network (Brandon, MB and Ottawa, ON) and one with a long-term soil moisture monitoring station (Lethbridge, AB). Data integration, data accessibility and interoperability challenges will be explored to support farm management decisions, such as irrigation scheduling.

Session: 7010 Enhancing Weather and Climate Monitoring Capacity through Collaboration Renforcer les capacités de surveillance météorologique et climatique par la collaboration **26/05/2025 14:00**

ID: 12292 Contributed abstract

From Deep Freeze to Chinook Breeze: Enhancing Winter Weather Forecasts in the Peace Region of Northern Alberta and British Columbia

Lynn Engel [1]

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Presented by / Présenté par: *Lynn Engel*
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The Peace Region of northern Alberta and British Columbia (BC) experiences extreme temperature and wind patterns during the winter season. Arctic air masses settle into the region, bringing cold temperatures ranging from -20°C to -40°C. Chinook down-slope winds, originating from the Rocky Mountains, can bring warm, dry air, and windstorms. These two temperature regimes—cold and warm—can persist for weeks or switch back and forth frequently. Modern weather simulations are being developed and tested to improve the accuracy of extreme winter temperature forecasts in the Peace Region.
Improving winter temperature forecasting is important to BC Hydro for several reasons. First, it is critical for the safety of the residents of Peace River, Alberta, due to ice jamming and flooding hazards on the Peace River. Second, it aids in managing hydroelectric power production. Ice on the Peace River must be sufficiently thick—or absent downstream—to allow for safe water release from the generating station at Site C, Fort St. John, BC. BC Hydro has determined that temperatures near the river in the valley bottom are an important input variable for ice forecast models. Unfortunately, regional airport weather stations are located at higher altitudes on adjacent plateaus, and the region features extensive topography.
A field campaign was undertaken in the winter of 2025 in the town of Peace River, Alberta. Direct weather observations with fine vertical resolution were obtained using radiosonde balloons. The challenges of winter fieldwork and preliminary results will be discussed in the presentation.

Session: 7010 Enhancing Weather and Climate Monitoring Capacity through Collaboration Renforcer les capacités de surveillance **26/05/2025 14:15**

ID: 12220 Contributed abstract

Improvements to the estimation of unfrozen water content in frozen soils: A Dielectric Constitutive Model

Quentin "Quinn" Sapin [1] , *Elise Devoie* [2]

[1] Queen's University

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Presented by / Présenté par: *Quentin "Quinn" Sapin*
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Capacitance based sensors are frequently used both in the field and in the lab to establish the unfrozen water content in freezing soils. The measurement of unfrozen water content in those sensors is derived from a bulk measurement of dielectric permittivity ε using a conversion curve relating the permittivity to volume fractions of solid soil grains, liquid water, ice, and air. The current conversion curve from dielectric permittivity to unfrozen water content used in most commercially available sensors is the Topp 1980 equation, an empirical third-degree polynomial fit made on a large dataset of wetting and drying experiments. The use of this conversion curve for unfrozen water measurements in partially frozen soils is problematic because it is i) an empirical fit of an agglomerated set of largely different soils, ii) not validated for cryotic conditions, iii) disconnected from the crystal nucleation nature of ice formation and iv) require extensive and time-consuming procedures to adapt to specific samples. Soils are wildly heterogeneous and the mechanism that inhibit or assist freezing in them varies greatly in strength and importance from sample to sample. The only indicator used to infer freezing in capacitance sensors is a decrease in a soil's apparent dielectric permittivity. However, many other mechanisms other than ice nucleation can alter a material's dielectric permittivity which the Topp, 1980 and many other conversion curves do not consider. As a result, the current converted measurements tend to be clustered regardless of soil type, dramatically under-predict the unfrozen water content at very low temperatures, and exhibit unphysical phase changes at low positive temperatures. This talk aims to present an error informed adaptive conversion curve from dielectric permittivity to unfrozen water content with a constitutive model that accounts for different mechanisms that may alter a soil's apparent dielectric permittivity.

Session: 7010 Enhancing Weather and Climate Monitoring Capacity through Collaboration Renforcer les capacités de surveillance météorologique et climatique par la collaboration

26/05/2025 14:30

ID: 12311 Invited session speaker

Virtual

The Northern Mesonet Project: Creation of an interconnected network of surface weather station networks

Connell Miller [1]

1 Canadian Severe Storms Laboratory

Presented by / Présenté par: *Connell Miller*
Contact: connell.miller@uwo.ca

Surface weather stations are a critical technology for understanding severe convective storms (SCS) due to their unique capabilities. While weather radar effectively detects precipitation and wind patterns aloft, its limitation is its inability to capture crucial surface-level weather where it matters the most for people and property. Documenting and analyzing such events offer invaluable insights into their causes, impacts, and potential future occurrences.

Existing surface weather stations in Canada frequently face several known limitations that impede their effectiveness, especially when it comes to SCS. In general, Canadian surface weather stations are widely spaced which often fail to capture highly localized SCS events. Additionally, the operation of these stations is managed by different federal and provincial agencies, which makes it difficult to utilize existing surface weather stations for nowcasting SCS. Furthermore, it poses challenges in collecting data after an event.

This is the reason for the creation of Northern Mesonet Project (NMP), a new program under the Canadian Severe Storms Laboratory, which aims to better monitor severe convective storms by increasing the spatial density of real-time advanced weather observations, and enhancing data availability & quality for severe weather analysis and prediction. This presentation will specifically highlight the Canadian Mesonet Portal, a central repository and access point established by NMP to address some of the limitations faced by Canadian surface weather stations. By connecting over 30 individual surface weather station networks, the Canadian Mesonet Portal provides a unified platform for accessing over 2800 publicly available surface weather observations across Canada.

Session: 7041 Satellite Earth Observation: A unique view of our planet and a critical need for Canada's resilient future - Part 2 Observation de la Terre par satellite : Une vue unique de notre planète et un besoin essentiel pour l'avenir de la résilience du Canada - Partie 2

Convenors:
Kaley Walker, University of Toronto;
Adam Bourassa, University of Saskatchewan

Satellite Earth observation (SEO) provides a unique global perspective on our planet's atmosphere and surface, including the oceans, land, vegetation, ice, and snow. Current and planned satellite missions from Canada and international agencies have provided and will provide a wealth of new information about the Earth system and that can be used to investigate a wide range of environmental and scientific questions.

Resourceful, Resilient, Ready: Canada’s Strategy for Satellite Earth Observation provides a plan for Canada to more effectively leverage satellite earth observation (SEO) to address key priorities, including climate change mitigation and adaptation. This strategy will help to inform Canada’s plans for SEO for the next decade and ensure Canada will maximize utilization and benefits of SEO.

This session encourages contributions from across the full SEO value chain, upstream, midstream and downstream, to illustrate the activities currently underway in Canada, involving industry, academia and government. This includes new measurement technologies and techniques, both passive and active; mission development; retrieval algorithms; demonstration and calibration of instruments; validation of satellite products; assimilation of data into numerical models; scientific results and discoveries; operational utilization and development of services.

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ID: 12260 Contributed abstract

HAWCsat: The limb profiling elements of the Canadian HAWC mission

Adam Bourassa [1] , *Doug Degenstein* [2] , *Jeff Langille* [3] , *Daniel Zawada* [4] , *Landon Rieger* [5] , *Jean-Pierre Blanchet* [6] , *Yann Blanchard* [7] , *Kaley Walker* [8]

[1] University of Saskatchewan
[2] University of Saskatchewan
[3] University of Saskatchewan
[4] University of Saskatchewan
[5] Environment and Climate Change Canada
[6] Université du Québec à Montréal
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Presented by / Présenté par: *Adam Bourassa*
Contact: adam.bourassa@usask.ca

The HAWC (High-altitude Aerosol, Water Vapour, and Clouds) satellite mission is a planned Canadian contribution to the larger NASA Atmosphere Observing System (AOS) mission, which is planned for launch in 2030-2031. HAWC includes the TICFIRE far-infrared imaging radiometer on the NASA AOS-Sky satellite (see presentation by Blanchard et al in this session) and two limb profiling instruments, ALI (Aerosol Limb Imager) and SHOW (Spatial Heterodyne Observations of Water), on a Canadian satellite called HAWCsat. This presentation will review the HAWC mission concept and the scientific objectives, and present recent developments on the instrumentation and retrieval algorithms for the limb profiling instruments ALI and SHOW.

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ID: 12353 Contributed abstract

Comparing Simulated Measurements of Aerosols from MPLCAN and the Aerosol Limb Imager

Emily Tracey [1] , *Landon Rieger* [2] , *Adam Bourassa* [3] , *Victoria Pinnegar* [4] , *Robert Sica* [5]

1

2 Environment and Climate Change Canada

3 University of Saskatchewan

4 Western University

5 Western University

Presented by / Présenté par: *Emily Tracey*

Contact: etracey4@uwo.ca

Aerosols play an important role in Earth's radiative balance, however, considerable uncertainty remains on their overall climate impact. The Aerosol Limb Imager (ALI) is a satellite instrument that will provide high-sensitivity measurements of aerosol in the upper troposphere and stratosphere. These aerosol layers are variable due to the influences of forest fires and volcanic eruptions. ALI will be on the High-Altitude Aerosols, Water Vapour and Clouds (HAWC) Canadian satellite which is a part of the NASA-led Atmosphere Observing System (AOS).

I am investigating the integration of ALI with ground-based remote-sensing measurements from The Canadian Micro-Pulse Lidar Network (MPLCAN). MPLCAN consists of seven micro-pulse lidars (MPLs) across Canada. The MPLs can detect aerosols produced from wildfire smoke, volcanic ash, dust sources, and anthropogenic pollutants. MPLCAN has potential to validate ALI measurements and extend their vertical coverage.

I will present simulated coincident measurements from ALI and MPLCAN for various atmospheric conditions including a wildfire smoke layer. The ALI retrieved quantities are not directly comparable to the MPL backscatter coefficient measurements, so assumptions must be made about the constituents and optical properties of the atmosphere to compare them. The ALI retrieved quantities were converted to a MPL backscatter measurement using two methods. First, Mie scattering theory was used

based on the ALI retrievals of aerosol particle size to calculate the backscatter coefficient. The second method used a lidar ratio from literature to convert from ALI extinction to backscatter. I will summarize how MPLCAN and ALI can be used together to better characterize aerosol layers and how the optimal conditions differ between the instruments.

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ID: 12313 Contributed abstract
Virtual

Lessons Learned from Far-Infrared Observations to Prepare for the AOS and HAWC Missions

Yann Blanchard [1] , *Jean-Pierre Blanchet* [2] , *Raphaël Peroni* [3] , *Atif Taoussi* [4] , *Patrick Grenier* [5]

[1] UQAM - ESCER

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Presented by / Présenté par: *Yann Blanchard*
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Observations in the far-infrared (FIR) spectral region are essential for advancing our understanding of the Earth's radiation budget and cloud processes, yet it remains largely unexplored from space. Many key atmospheric constituents, such as ice clouds and water vapor, have strong radiative effects in this spectral range, making FIR measurements crucial for improving climate and weather models. To bridge this observational gap, Canada has proposed the High-altitude Aerosols, Water vapor, and Clouds (HAWC) observation system, which will include TICFIRE, a nadir-viewing imaging radiometer covering the mid- to far-infrared. TICFIRE is planned to fly onboard

the AOS-Sky spacecraft, a key component of NASA’s Atmosphere Observing System (AOS), with a scheduled launch in 2032.
A key aspect of the mission development is the continuous refinement of the TICFIRE instrument simulator, which is essential for predicting measurement performance and improving retrieval algorithms. To enhance its accuracy, we leverage comparisons with observations from existing FIR-capable instruments operating from the ground, from aircraft during measurement campaigns over Canada, and from space. By assessing the consistency between simulated and observed measurements, we identify potential biases and improve the representation of the cloud microphysical and radiative properties within the simulator.
In this work, we will present the latest developments of the simulator, the validation methodologies implemented, and their implications for the mission. These advancements will enhance the accuracy of FIR observations, maximizing the scientific return of TICFIRE. Additionally, they will support the preparation for synergies with HAWC and AOS instruments, ensuring a more comprehensive approach for understanding the aerosol-cloud-radiation-water vapour interactions.

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ID: 12547 Contributed abstract
Virtual

Testing the TICFIREsim Satellite Instrument Simulator during ARM-EPCAPE Campaign.

Atif Taoussi [1] , *JEAN-PIERRE BLANCHET* [2] , *YANN BLANCHARD* [3] , *RODRIGO MUNOZ ALPIZAR* [4] , *ADAM BOURASSA* [5] , *DOUG DEGENSTEIN* [6] , *JEFF LANGILLE* [7] , *DANIEL ZAWADA* [8] , *JONATHAN GERO* [9]

[1] UQAM

[2] UQAM

[3] UQAM

[4] ECCC

[5] USASK

[6] USASK

[7] USASK

[8] USASK

[9] UWISC

Presented by / Présenté par: *Atif Taoussi*
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Validating atmospheric simulation models is essential for improving our understanding of cloud-radiation interactions, particularly in the far-infrared spectral range. This study evaluates the accuracy of TICFIREsim, the TICFIRE instrument simulator, through two comparative analyses: one under clear-sky conditions and another in the presence of clouds. The simulations are assessed using observations from AERI, and the tandem ALI-SHOW instruments, along with atmospheric profiles from the ECCC's RAQDPS numerical weather prediction model. The experiment took place during two concurring campaigns, the ER-2 airborne campaign and the Atmospheric Radiation Measurements (ARM) Eastern Pacific Cloud Aerosol Precipitation Experiment (EPCAPE) campaign over La Jolla in November and December 2023. The objective is to verify TICFIREsim ability to reproduce spectral radiance measurements by comparing observations and the simulation model. First, we compare clear-sky cases, from AERI spectral radiance measurements at the La Jolla ground station. Next, in cloudy conditions, we extend the analysis to high altitudes using data from ALI and SHOW, at 21 km on the ER-2 aircraft. RAQDPS atmospheric profiles are used to provide meteorological conditions. Preliminary results from the clear-sky comparison shows a good agreement between TICFIREsim and AERI measurements, reinforcing the model's capability to simulate far-infrared radiances. The ongoing analysis of cloudy conditions will provide further insights into TICFIREsim performance in more complex atmospheric scenarios and the comparison with the coincident observations of ALI and SHOW help to explore synergy.. The findings contribute to refining cloud and aerosol models and to support AOS (NASA) and the Canadian HAWC missions.

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ID: 12265 Contributed abstract

A comparison of the Arctic “radiator fin” effect between CanAM model and satellite observations

Han Haung [1] , *Yi Huang* [2]

[1] McGill University

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Presented by / Présenté par: *Han Haung*

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Satellite observations reveal a prominent increasing trend of the Outgoing Longwave Radiation (OLR) in the Arctic region, which is unique among all regions across the globe and suggests the Arctic acts as “radiator fins” to radiate excess heat of Earth to space in a warming climate. An intuitive related question is how well Canadian models simulate this effect. To answer this question, we use both satellite observations and CanAM model simulations to investigate the causes of such distinct “radiator fin” effect in the Arctic and make comparisons. Using a set of spectrally decomposed radiative kernels, we find that the kernel-diagnosed results can well explain the OLR changes in the observations and model simulations, which proves the validity of this method. Moreover, we find that compared to other regions such as the tropics, the prominent observed trend in the Arctic results from a stronger surface and atmospheric warming and a less offsetting greenhouse effect of water vapor. Further decomposition in spectral bands signifies the importance of the far-infrared region, where the unbalanced radiative responses to temperature and humidity changes show a noticeable non-Simpsonian behavior and lead to significant increase of OLR.

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ID: 12363 Contributed abstract

A 15-Year Climatology of Free Tropospheric Relative Humidity and Temperature Determined from Simultaneous Vibrational-Rotational Raman Lidar Measurements

Vasura Jayaweera [1] , *Robert Sica* [2] , *Alexander Haefele* [3] , *Giovanni Martucci* [4]

[1] Western University

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Presented by / Présenté par: *Vasura Jayaweera*
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Water vapor is the dominant greenhouse gas and plays a pivotal role in determining Earth’s future climate. As atmospheric temperatures rise, water vapor concentrations also increase, creating a positive feedback loop that further accelerates warming (Dessler et al., 2013; Held and Soden, 2000). In this context, accurately measuring water vapor and temperature profiles in the troposphere is crucial for detecting long-term trends and understanding climate feedback mechanisms. Raman lidars are well suited for this purpose, enabling simultaneous measurements of atmospheric temperature and water vapor mixing ratio.

The Raman Lidar for Meteorological Observations (RALMO), located at MeteoSwiss in Payerne, Switzerland, has been operational since 2007. RALMO operates near-continuously and automatically, collecting temperature and water vapor profiles up to the tropopause. To ensure reliable long-term measurements, careful calibration and instrument monitoring are essential. In this work, we use a new technique we have developed, the solar background calibration, to calibrate the rotational Raman temperature lidar. This calibration technique minimizes the possibility of the daily operational radiosondes introducing non-geophysical trends into the dataset. We then directly retrieve relative humidity and temperature from the lidar measurements using the method developed by Gamage et al. (2020).

Using fifteen years of RALMO measurements (2010–2024), we are generating a comprehensive relative humidity and temperature climatology for the troposphere. The dataset offers valuable insights into how water vapor and temperature profiles evolve seasonally and over multiple years, and will allow us to determine trends in both variables as a function of altitude. Our findings will aid in assessing whether significant changes in relative humidity or temperature have occurred, and whether these changes are consistent with expected climate feedbacks. These measurements will also be useful in conjunction with satellite measurements, such as those to be made from the upcoming Canadian HAWC mission.

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Session: 8041 Global Water Futures: Solutions to water threats in an era of global change - Part 2 L'avenir de l'eau dans le monde : Solutions aux menaces pesant sur l'eau à l'ère du changement planétaire - Partie 2

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Our water is at risk—in Canada and globally, we are facing unprecedented water-related challenges. Half of the world's population depend on water from cold regions, and while Canada is home to 20 per cent of the world's freshwater reserves, it has some of the highest warming rates which adversely affect infrastructure, ecosystems and human health. Facing these challenges, water scientists in Canada and globally are asking the question, "how can we best forecast, prepare for and manage water futures in the face of dramatically increasing risks?" Global Water Futures (GWF; 2016–2025) is a major Canadian research consortium that came together to address this grand challenge. Its overarching goal is to deliver risk management solutions—informed by leading-edge water science and supported by innovative decision-making tools—to manage water futures in Canada and other cold regions. With GWF coming to its conclusion, it is timely and important to share its scientific outcomes and synthesize the complete set of findings to ensure that these are useful and actionable to society. This effort is underway and the session brings together key thematic and regional components of the synthesis. Submissions on related GWF advances in cold regions water and climate science, utilization of GWF models or results, community and user engagement, and knowledge mobilization are encouraged.

Session: 8041 Global Water Futures: Solutions to water threats in an era of global change - Part 2 L'avenir de l'eau dans le monde : Solutions aux menaces pesant sur l'eau à l'ère du changement planétaire - Partie 2 **26/05/2025 13:30**

ID: 12325 Contributed abstract

Determining the effects of changes in climate and drainage on Canadian Prairie hydrology

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Presented by / Présenté par: *Kevin Shook*
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The Canadian Prairie region is cold and semi-arid. Given the importance of cold- regions hydrological processes and their likelihood to be affected by increased air temperatures, the combined effects of climate change and drainage of surface depressional storage on the region's hydrology are complex. Although the Cold Region Hydrological Modelling (CRHM) platform has been used successfully to model individual basins within this region, development of large-scale models is constrained by highly uncertain parameterisation. Simplification of parameterisation was achieved here by dividing the region's basins into 7 classes and developing a characteristic CRHM "virtual basin" model for each class. Because of CRHM's physical basis and simpler parameter identification, no calibration was required. Each virtual basin model was forced with historical meteorological data to evaluate the a) the model's responses against recorded streamflows, snow accumulation and soil moisture data and b) to provide baseline modelled values of the variables of interest. The virtual basin models were then re-run using varying delta values of precipitation and air temperature to determine the sensitivity of hydrological responses to changing climate and depression drainage. Results show that a) the virtual basin modelling approach has utility, b) differing classes of basins respond differently to changes in climate and drainage, c) increases in drainage increase streamflows without apparent tipping points, d) the effects of changes in climate will be manifest differently in differing parts of the region, indicating that localized adaptation strategies will be required. Examples of these findings are presented.

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ID: 12328 Contributed abstract

Modelling Sediment Fluxes in Cold Regions Agricultural Basins – Impacts of Climate and Land Use Change on the Canadian Prairies

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Presented by / Présenté par: *Peter Lawford*
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Sediment transport from small prairie basins has been associated with transport of nutrients and is a key process in water quality assessments. Risks from water-driven sediment erosion in agricultural regions are nonstationary due to a variety of anthropogenic factors. Drainage or rehabilitation of ponds and wetlands, modifications to cropping practices, and changing snowpack and rainfall characteristics due to climate change all factor in to a changing erosion risk. Capturing this variation in modelling tools requires a mechanistic approach emphasizing the primary hydrological processes that result in overland flow in the region of interest. Processes endemic to Canadian Prairies include energy-driven snowpack evolution, wind transport of snow, depressional storage of runoff, and seasonally frozen soils with soil thaw during the seasonal wet period.

Such processes are captured by the modular, flexible, physically based Cold Regions Hydrological Modelling platform, developed for application in cold agricultural regions such as the Canadian Prairies. The platform includes water quality modules and has been modified here to include enhanced sediment erosion physics and used as foundation for a large-scale modelling framework. The configured framework is applied to 4175 'virtual' basins from Hydrosheds footprints covering the Prairies ecozone, forced with 70 years of ERA5-land reanalysis data to cover variations in climate. Model scenarios include modification of pond depression coverage and summerfallow-to-continuous cropping strategies. Visual spatial maps and statistical regression on regionally clustered data are used to evaluate relative contributions and long-term trends. The findings provide insights into erosion risks under future conditions and inform sustainable watershed management strategies.

ID: 12539 Contributed abstract

Assessing differences in hydrological response of tile drains within a Southern Ontario agricultural catchment

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Presented by / Présenté par: *Larissa Gospodyn*
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Understanding when and how water moves through an agricultural field can improve our understanding of nutrient transport. Runoff discharged through agricultural drainage tiles is generated by a combination of sources and we often seek to quantify and characterize these contributions to better understand hydrological processes and nutrient transport. However, within a catchment, there is heterogeneity in tile responses that are often not characterized in catchment-scale studies. The objective of this study is to determine how hydrological responses vary in tile drains located in different topographic positions within a catchment and whether response during hydrological events differs with season, antecedent moisture conditions or storm characteristics. Continuous discharge and electrical conductivity (EC) data were measured in three tiles and the receiving stream between October 2023 to July 2024 in a small, 2.7 km2 headwater agricultural catchment in Southern Ontario, with supplemental sampling during a subset of events. Tiles were selected to represent fields of differing topographic location in the catchment. Discrete samples were collected from shallow groundwater wells within the drained fields and composite precipitation samples were collected during rain events. Samples were analysed for EC and major ions for use as tracers in a hydrograph separation analysis of events. Timing and proportion of the separated flow components was used to investigate differences in tile response and was compared to antecedent moisture conditions and event characteristics. Results show that tiles within a catchment are not synchronous in their response to precipitation and snowmelt. Spatial and temporal differences were found in the relative contributions of flow components and these differences will be discussed.

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ID: 12397 Contributed abstract

A Strategy for Developing Resilience in a Terminal Lake through Public Consultation and Better Water Management Tools

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Presented by / Présenté par: *Richard Lawford*
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Terminal lakes are sensitive to water balances of the lake and of the watersheds draining into the lake. Climate and landscape changes often can explain the longer-term variability of their lake levels. Few lakes in North America exhibit larger variability and change than Devils Lake in North Dakota. Multi-decadal trends in its lake levels have produced long-term flooding and changed the perspectives of some area residents about the future use of the lake and the need for greater flood protection. To build resilience in this lake, the flooding must be constrained within certain boundaries. The question is "What are the best and most desired boundaries?".

This talk looks at the steps that are proposed for developing a resilience strategy that is best suited to meeting the desires of the Devils Lake community for lake levels. This requires ensuring that the community is fully informed of the hydroclimatological and socioeconomic factors as well as future trends that may affect lake levels. Subsequently, an assessment of the desires of the informed community would be carried out. Thirdly a series of possible water management and policy actions must be developed that can bring the lake levels to the desired levels and can enable strategies for increasing the stability of the lake levels by adding or removing water as different weather and climate trends unfold. The resilience strategy would provide as much stability as possible to Devils Lake, the city, and its surroundings, under a wide range of hydroclimate scenarios.

The possibility of using these principles in other situations where environmental trends and inadvertent non-productive human interventions occur could be a useful model for developing short- and long-term actions that could reduce uncertainties for the environment as well as investors and long-term economic developments.

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ID: 12531 Contributed abstract

GWF Innovations For More Resilient Agricultural Watersheds

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Canada's $150 billion agriculture sector faces increasing risks from droughts, floods, heat domes, hail, wind, extreme climate events, and changing hydroclimatic factors. One of Canada's largest land use sectors, agriculture relies on a suitable climate and healthy water resources, soils and ecosystems. Agriculture must also manage its own impacts on natural resources. This paper highlights selected GWF research to help strengthen agricultural resilience. GWF scientists coupled two existing models to create the Cold Regions Agricultural Hydrology Model, to explore future climate scenarios and guide agricultural adaptations. GWF created a prairie watershed classification system and the Prairie Hydrology Design and Analysis Product, to help land and water resource managers understand and manage changing climate, hydrological conditions, land use, agricultural drainage, and infrastructure design. GWF advanced scientific knowledge of agricultural Best Management Practices (BMPs) to address agricultural drainage issues, and to reduce transport of agricultural nutrients into water supplies. GWF found that nutrient management BMPs are place-specific and must suit local landscapes, soils, geography, climate, hydrology and farm practices. Nutrient reduction BMPs may work in one region, but not another, and are affected by cold region factors such as freeze-thaw cycles and seasonal runoff. Working with diverse stakeholders, GWF found that agricultural sector participation is critical in developing and implementing BMPs to reduce risks to business, livelihoods, and the environment. Economic and ecological trade-offs, resolution of competing interests and conflicts, and understanding behavioural patterns and BMP uptake are crucial factors. Specific agricultural watershed planning goals must be set at larger regional scales to effectively manage changing risks. Agricultural BMP performance at watershed scales must be monitored over long timespans to determine their effectiveness, and BMPs adjusted as needed to achieve desired outcomes.

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ID: 12489 Contributed abstract

GWF advances in lake eutrophication science

Philippe Van Cappellen [1] , *Serghei Bocaniov* [2] , *Zahra Akbarzadeh* [3] , *Ali Reza Shahvaran* [4] , *Homa Kheyrollah Pour* [5] , *Jovana Radosavljevic* [6] , *Steph Slowinski* [7]

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Since the 1970s, the generally accepted management approach to mitigate cultural eutrophication of freshwater lakes consists in reducing the external inputs of the limiting macronutrient phosphorus (P) from the contributing watersheds. However, in many areas of the world, lakes continue to be plagued by eutrophication symptoms even after watershed P inputs have been decreased. In this presentation, we review key findings from the GWF-supported Lake Futures project that help explain this apparent incongruity. A global data analysis of temperate and cold-temperate lakes confirms that these ecosystems are experiencing a general trend towards earlier algal spring blooms driven by warmer surface water temperatures and reduced ice cover. Climate warming also accelerates coastal erosion that, in turn, acts as an additional source of nutrient enrichment. For Lake Erie, P input from shoreline erosion accounts for as much as 15% of the total P input to the lake. Furthermore, in the Laurentian Great lakes, changes in thermal structure favor increasing algal productivity in the littoral zone but decreasing productivity in the offshore waters. Such an opposing nearshore-offshore trend has been reconstructed at high spatial and temporal resolution for Western Lake Ontario using satellite remote sensing imagery. For smaller lakes, salinization is emerging as a critical, but overlooked, driver of eutrophication symptoms. Using a three-decade dataset for 100+ North American lakes, salinization is shown to reduce vertical mixing and intensify oxygen depletion as well as in-lake P recycling. Watershed urbanization, road density, and lake morphometry are the main predictors of salinization-driven deoxygenation. In conclusion, research conducted as part of the GWF program is delivering new evidence to inform lake management priorities.

Session: 3020 biogEosCiences peRspectives - Part 1 biogéosciences peRspectives - Partie 1

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This session aims to showcase science from early career researchers (ECRs) investigating ecosystem processes from a biogeosciences perspective. Research that demonstrates progress towards an improved understanding of biogeochemical processes and patterns, and/or advances in models are welcomed. In particular, we encourage presentations that seek to quantify biogeochemical functions of natural or managed environments; characterize measurement and modelling uncertainty in complex and heterogeneous landscapes; scale biophysical exchange processes; quantify the impacts of climate and land-use change on ecohydrological fluxes across ecosystems; or identify and evaluate the effects of extreme weather and disturbance phenomena on biogeochemical properties. Studies at local to landscape scales, with a focus on atmospheric, terrestrial, or aquatic systems will all be considered. Submissions from researchers at all career stages will be considered with presenting slots set aside for ECR (<7 years since terminal degree).

Session: 3020 biogEosCiences peRspectives - Part 1
biogéosciences peRspectives - Partie 1 **26/05/2025 13:30**

ID: 12207 Contributed abstract

Phosphorus mass balance of 11 temperate agricultural headwater catchments: Accumulating and depleting watersheds exhibit contrasting stream load patterns

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Presented by / Présenté par: *Kelly Biagi*
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Agriculture is one source of excess phosphorus (P) that contributes to the eutrophication of waters in the lower Great Lakes basin. To achieve P reduction goals set out by the Western Basin of Lake Erie Collaborative Agreement, a better understanding of phosphorus dynamics is needed. Five years (2015 – 2019) of agricultural stream water quality data were amalgamated with field-scale farm operator survey information collected within the same watersheds. These datasets provide a fine-scale annual P mass balance in 11 headwater streams within the lower Great Lakes basin. The specific objectives were to 1) quantify the annual P mass balance among 11 headwater catchments, 2) assess the variation in P inputs and removals and their influence on P

mass balances and 3) compare the P mass balance to historical conditions. The P mass balance was variable among watersheds (-10.8 to +24.1 kg P/ha/year). Headwater catchments within the same county showed considerable variability among P mass balances (e.g., -6.5 and +3.6 kg/ha/year), indicating that county scale P mass balance assessments are not always appropriate for individual watersheds. When separated, positive and negative total P mass balance exhibit contrasting trends with stream P loads. Watersheds with negative P mass balance had the highest P loss rates to streams, suggesting that this is not driven by excess P from applications. Interestingly, Olsen soil test phosphorus (STP) was significantly negatively correlated with stream P loads (p-val<0.05). Soil texture plays an important role in this correlation as clay-dominant watersheds have the highest P loads to streams followed by silt- and sand-dominated watersheds. The overall P mass balance has declined at all sites since the 1970’s, however stream losses have increased across all sites, suggesting a role of legacy P. A combination of coarse- and fine-scale assessments can target mitigation strategies, where soil STP and texture could be an important risk indicator.

Session: 3020 biogEosCiences peRspectives - Part 1
biogéosciences peRspectives - Partie 1 **26/05/2025 13:45**

ID: 12255 Contributed abstract

Agricultural wetland sediment release of GHGs under nutrient addition and changing water levels

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Presented by / Présenté par: *Ana Alvarez-Caiza*

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Pothole wetlands are biogeochemical hot spots transforming organic matter and nutrients into greenhouse gases (GHGs). These wetlands are abundant in the Canadian Prairies, the largest agricultural region in Canada, and potentially impact regional GHG budgets. Given that pothole wetlands are frequently surrounded by cropland, research is needed to understand the influence of nitrogen fertilizer addition on GHG fluxes from aquatic systems on this landscape. Pothole wetlands are unique in that water typically recedes during the growing season. Water level recession creates exposed sediments whose role in GHG budgets is not well documented. We investigated the impact of nitrogen fertilizer addition and water levels on carbon dioxide (CO2), nitrous oxide

(N_2O), and methane (CH_4) fluxes using intact sediment cores from three wetlands in Mistawasis Nêhiyawak, Saskatchewan. Multivariate analysis was used to determine the differences between the treatments (urea and blank) and water levels (4 cm, 0 cm, −2 cm, and −4 cm). The results showed that, under the urea treatment, N_2O fluxes exhibited significant differences across water levels, while CO_2 fluxes were primarily sensitive to water levels. As water levels dropped, CO_2 fluxes generally increased and CH_4 fluxes decreased—although most changes in CH_4 fluxes were not significant. Our findings highlight the importance of considering water recession in wetlands and the impact of nitrogen fertilizer application in surrounding agricultural areas on GHG fluxes from pothole wetlands. Considering these factors could help reduce uncertainty associated with prairie water bodies GHG fluxes in regional budgets.

Session: 3020 biogEosCiences peRspectives - Part 1
biogéosciences peRspectives - Partie 1 **26/05/2025 14:00**

ID: 12259 Contributed abstract

Heard it through the grapevine: Assessing the variability of evapotranspiration in two Canadian vineyards

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Presented by / Présenté par: *Jessica Williamson*
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Vineyards are highly heterogeneous systems where climate, soil and management parameters are capable of influencing water loss by evapotranspiration (ET) across many spatial and temporal scales. Water stress, which can be related to greater ET, may result in lower vigour and grape yield, while moderate water stress has been associated with improved grape and wine quality. This research was conducted across two separate vineyards in Beamsville and Jordan, Ontario, in the Niagara growing region during the 2022 growing season. To address vineyard variability in ET, a multi-method approach combining the use of a leaf-scale LI-6800 photosynthesis system, vine-scale sap flow sensors (Vinetalkers), block-scale atmometer ET gages, and vineyard-scale Eddy Covariance towers, was conceived. It was hypothesized that variability in climate-driven terroir controls would promote inconsistencies in crop ET between grape varietals at each vineyard. Results suggest that there is both spatial and temporal variability in evapotranspiration, especially regarding white versus red grape varietals, as well as

between phenological stages over the course of the growing season. Each method showed that there was an increase in ET during the middle of the growing season, when full canopy cover was present, and leaves showed no signs of water stress. ET rates typically declined towards harvest, which was associated with increased water stress and more optimal sugar concentrations in the grapes. Changes in air temperature, humidity, solar radiation and wind speed caused for variability in ET across each vineyard. This research, presents an opportunity for growers to understand the current state of their vineyards and the spatial and temporal variability of their vines, allowing them to make specific, non-uniform, management decisions to enhance grape yield and quality each growing season.

Session: 3020 biogEosCiences peRspectives - Part 1
biogéosciences peRspectives - Partie 1 **26/05/2025 14:15**

ID: 12478 Contributed abstract

Integrated terrestrial and hydrological carbon budgets for two small High Arctic watersheds on Melville Island, Nunavut

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Presented by / Présenté par: *Clara Schryer*

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The movement of carbon between terrestrial and aquatic stores and the atmosphere exerts an important control on atmospheric greenhouse gas concentrations, and thus the extent of climate change. Understanding the magnitude of these carbon fluxes is important for informing climate models. High Arctic regions are particularly key areas for carbon cycle research because they are understudied relative to other regions, and because accelerated climate change is altering many processes affecting carbon fluxes, with the net effect of these changes being poorly understood.
This research integrates measurements of carbon fluxes directly from terrestrial environments to the atmosphere with the less commonly studied losses of carbon through streams in a High Arctic site on Melville Island, Nunavut. These fluxes are measured and upscaled to the watershed scale in an integrated budget, allowing the total losses of carbon from the watersheds to be calculated, and the relative importance

of the different types of carbon fluxes to be compared.
Preliminary results suggest that terrestrial emissions of CO_2 are by far the most significant carbon flux, and that these emissions come primarily from sparsely to moderately vegetated areas, with highly vegetated areas being a slight net sink of CO_2, and unvegetated areas having no significant fluxes of CO_2. The overall carbon budget of the watersheds thus depends highly on the fraction of landcover types. Net CH_4 fluxes once again vary by landcover, with wet areas being CH_4 sources while dry areas are slight sinks, but these fluxes are much smaller than CO_2 fluxes, even when converting to CO_2 equivalence. Stream export of dissolved carbon mostly occurs during the snowmelt-associated discharge peak, but even at its highest, the fluxes of carbon through streams are very small compared to terrestrial emissions of CO_2.

Session: 3020 biogEosCiences peRspectives - Part 1
biogéosciences peRspectives - Partie 1 **26/05/2025 14:30**

ID: 12254 Contributed abstract

Synthesizing 60 years of peatland research in the Hudson Bay Lowlands: strengths and gaps in knowledge

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Presented by / Présenté par: *Adam Kirkwood*
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The Hudson Bay Lowland (HBL) is a peatland complex of global, regional, and local significance due to its immense carbon storage (~30 Pg), rich biodiversity, and cultural importance. However, it is unclear if existing research on peatlands in the region is sufficient for current and future assessment and monitoring needs, especially in relation to the production and release of greenhouse gases (GHG fluxes) from the region's extensive peatlands. We completed a systematic review of peatland relevant literature in the HBL and identified type, abundance, and location of existing data. We identified 299 publications, 191 of which met inclusion criteria, and find that decades of peatland

research (beginning in 1957) has generated a strong understanding of peatland development and carbon storage, with numerous studies on peatland ecohydrology and biogeochemistry. Paleoecology papers are the most well represented (n = 45, 24% of papers), followed by GHG flux studies which account for 19% of papers identified (n=37). Studies on GHG fluxes are geographically limited, and primarily constrained to three locations across the 372,000 km2 region. There is strong agreement across all studies that a warmer and drier climate will reduce the carbon sink strength of the region. Of the 36 studies reporting in-situ data, 15 were based on one year of measurement (often only during the growing season), five were based on two years of measurement, and only nine were based on measurements >2 years, where only six papers report non-growing season fluxes. Between short-term datasets, geographically limited representation, and strong interannual and spatial variability in GHG fluxes, data is inadequate for understanding/modelling future GHG fluxes. Given the strong regional warming and proposed industrial development, such as a Kawana ‘bi ‘kag (“Ring of Fire”) region in Northern Ontario, these knowledge gaps limit our understanding of future C balance in this globally important region.

Session: 7020 Greening and resilience of monitoring networks and programs
Écologisation et résilience des réseaux et programmes de surveillance

Convenors:
Michael Earle, Transformation, Innovation and Engineering Division, Meteorological Service of Canada, Dartmouth, NS
Paige Aldridge, Transformation, Innovation and Engineering Division, Meteorological Service of Canada, Burlington, ON
Shannon deGraaf, Transformation, Innovation and Engineering Division, Meteorological Service of Canada, Burlington, ON
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Weather and climate observations are critical to ensure public safety, keep people informed, and deepen our understanding of climate change. The monitoring networks and programs that enable these public good services can have detrimental environmental impacts, providing impetus for a transition toward greener technologies and approaches. At the same time, observing networks and programs are susceptible to vulnerabilities from the changing climate, motivating careful consideration of how they can be designed and operated to ensure their longevity, reliability, and resilience. As monitoring networks and programs evolve to meet growing demand for weather and climate data, greening and resilience are both critical considerations to promote long-term environmental and operational sustainability.

This session will provide a venue to discuss greener and more sustainable observing technologies and approaches, and to explore avenues to build resilience in observational networks and programs. Topics for discussions could include renewable energy options, emissions reductions, green technologies and services, life cycle assessments, and vulnerability analyses. The session will provide a forum to highlight initiatives and strategies that are planned, in progress, or completed, and to frame opportunities and challenges from both operational and policy viewpoints. At a higher level, the session aims to identify areas of alignment and collaboration among implicated stakeholders and foster a shift toward more environmentally sustainable and resilient approaches for weather and climate monitoring.

Session: 7020 Greening and resilience of monitoring networks and programs Écologisation et résilience des réseaux et programmes de surveillance

26/05/2025 15:30

ID: 12401 Contributed abstract

Advocacy and action: advancing the environmental sustainability of observing systems

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Presented by / Présenté par: *Paige Aldridge*
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Environmental observations are the backbone of the weather and climate enterprise, enabling predictions and services that protect lives and bolster economic resilience. In recent years, the global meteorological community has taken significant strides to advance the sustainable evolution of observing systems, aiming to balance operational mandates with environmental responsibility. Recognizing the importance of minimizing the environmental impacts of observing systems, the World Meteorological Organization (WMO) has driven global advocacy efforts through its environmental sustainability initiative, launched in 2021. Through international collaboration and engagement with industry, environmental sustainability is now embedded as a core objective in the WMO’s strategic plans. This shift reflects a growing commitment to integrating responsible environmental practices across all aspects of observation programs. Manufacturers and technology providers have been at the forefront of this transformation, developing innovative and sustainable solutions. From more resource-efficient approaches to eco-friendly materials and extended equipment lifespans, industry leaders are demonstrating that sustainability and technological advancement go hand in hand. With a roadmap focused on innovation, policy, collaboration, and capacity building, the path forward is one of opportunity. This presentation will highlight the WMO initiative’s progress to date and showcase emerging solutions, demonstrating how organizations and industry can collaboratively accelerate the transition toward more sustainable and resilient observing systems.

Session: 7020 Greening and resilience of monitoring networks and programs Écologisation et résilience des réseaux et programmes de surveillance

26/05/2025 15:45

ID: 12222 Contributed abstract

Virtual

Development and Testing of a Renewable Energy Power Standards for ECCC's AWS Network.

Jonathan Leblanc-Tanguay [1]

[1] ECCC

Presented by / Présenté par: *Jonathan Leblanc-Tanguay*
Contact: ryan.arseneault@ec.gc.ca

Automatic Weather Stations (AWS) across Canada record weather and climate data, often in remote areas where power service is either unavailable or overly reliant on fossil fuels. Consequently, over 25% of the AWS network managed by the Meteorological Service of Canada (MSC) requires renewable energy. MSC Operations currently use various power solutions like solar panels and wind turbines, however, there is no official standard for off-grid system installation to ensure data availability, proper equipment maintenance, training, and safety.
Three standard off-grid power configurations are proposed for the MSC's AWS network based on solar availability in three distinct Climate Zones: Zone 1, ideal for locations where solar energy is available year-round; Zone 2, where solar availability is challenged during the darkest months , and wind turbines may be required; and Zone 3, with 30 to 120 dark days per year, which requires hybrid solar and wind systems.
In November 2024, a Renewable Energy System (RES) was deployed at the Center for Atmospheric Research and Experiments (CARE) in Egbert, Ontario (Zone 1). Performance indicators will be monitored until June 2025 using a near real-time dashboard tracking system summarizing images, weather data, and error codes for troubleshooting and system analysis. This monitoring approach will ensure readiness for subsequent testing phases in Mount Pearl, Newfoundland (Zone 2) and Iqaluit, Nunavut (Zone 3).
This presentation will provide details of the three standard off-grid power configurations and share results from the RES testing at CARE. Key takeaways and implications for future testing phases will be discussed.

Session: 7020 Greening and resilience of monitoring networks and programs Écologisation et résilience des réseaux et programmes de surveillance

26/05/2025 16:00

ID: 12208 Contributed abstract

WindBorne Global Sounding Balloons: Sustainable and Resilient Observations

Todd Hutchinson [1] , *Andrey Sushko* [2] , *Kylie Holland* [3]

[1] WindBorne Systems
[2] WindBorne Systems
[3] WindBorne Systems

Presented by / Présenté par: *Todd Hutchinson*
Contact: todd.a.hutchinson@gmail.com

WindBorne Systems has developed a novel balloon-based observation system, enabling constellations of balloons to be flown throughout the troposphere for extended periods of time. Each balloon, known as a Global Sounding Balloon (GSB), can fly for weeks at a time while being remotely directed to ascend and descend repeatedly from a few hundred meters above the earth surface to the lower stratosphere, collecting vertical profiles of wind speed and direction, pressure, temperature, and humidity. As of late 2024, GSBs flew for an average of over 7 days, with some flights exceeding 50 days demonstrating the potential for very long duration flights.

In early 2023 WindBorne began operating a persistent constellation of GSBs, and by late 2024 the constellation averaged 28 GSBs aloft at any given time. Hundreds of vertical profiles of atmospheric data are now being collected throughout much of the world including in far remote locations (e.g., Pacific Ocean, northern Canada). The constellation size continues to grow not only due to more frequent launches, but also because the duration of each GSB flight is increasing. Technological advances over the next 1-2 years are expected to provide at least a doubling of the GSB average lifetime, requiring fewer GSB launches for larger constellation sizes. These advancements in flight lifetime, along with continued miniaturizations of GSB components, are enabling significantly more data collection per unit of waste.

Given the long-duration and navigable capabilities of GSBs (by using winds at various levels to propel towards target locations), WindBorne is now retrieving some GSBs after they land. When GSBs are near end of life, they will be navigated to areas where they may be retrieved and properly disposed of by WindBorne staff or local contractors. As the duration of GSBs continues to increase, WindBorne expects to recover many GSBs that are flown.

Session: 2030 Atmosphere - Theoretical to applied science - Part 1 Atmosphère - De la théorie à la science appliquée - Partie 1

Convenors:

Serge Desjardins
Julie Theriault

Related to scientific studies and/or information sharing about the atmosphere, including weather, meteorology, clouds and precipitation, air quality, atmospheric dynamic and extreme events, using various approaches.

This session covers many topics, including, but not limited to, theoretical research, model development, observation techniques, real-time monitoring, databases, diagnostic methods, data analysis and artificial intelligence.

Session: 2030 Atmosphere - Theoretical to applied science - Part 1 Atmosphère - De la théorie à la science appliquée - Partie 1 **26/05/2025 15:30**

ID: 12384 Contributed abstract

Airborne and ground-based analysis of an eastern Canadian smoke event from intense wildfires in northwestern Canada

Keyvan Ranjbar [1] , *Norm O'Neill* [2] , *Islam Gomaa* [3]

[1] Flight Research Laboratory, National Research Council Canada
[2] CARTEL, Dépt de géomatique appliquée, Université de Sherbrooke
[3] Construction Research Center, National Research Council

Presented by / Présenté par: *Keyvan Ranjbar*
Contact: keyvan.ranjbar@nrc-cnrc.gc.ca

During the month of August 2024, smoke from intense wildfires in northern British Columbia, Alberta, and the Canadian Northwest Territories spread across North America. Such events can significantly increase pollution levels on a continental scale, leading to both meteorological and climatological impacts. This includes direct radiative forcing from the smoke and indirect radiative forcing due to the influence of smoke on cloud formation. The Flight Research Laboratory of the National Research Council Canada (NRC) utilized their Twin Otter aircraft as part of the “Mitigation of Wildfire Smoke Impact” project. The NRC’s Twin Otter aircraft is a specialized and customizable research platform equipped with a variety of scientific instruments and sensors, including aerosol and gas-phase instruments, to collect atmospheric data.
On August 14, 2024, the NRC’s Twin Otter conducted multiple profiling loops over the Université de Sherbrooke’s micro-pulse lidar (MPLCAN), their PurpleAir PM2.5 surface sampler, the AERONET/AEROCAN sun photometer/sky radiometer (columnar sampler), and the SPARTAN microphysical and optical package to perform a synchronized analysis of the smoke data collected on that day.
Here, we will present preliminary findings from a wildfire smoke event detected inflight over Sherbrooke, QC. Preliminary results will include the coherence between the vertical profiles of the Twin Otter aerosol data and the MPLCAN lidar and the AEROCAN columnar measurements. Additionally, we will discuss the relationship between the airborne and columnar measurements, with the PurpleAir, and the SPARTAN surface measurements. Lastly, links with possible cloud nucleation events will be reported.

Session: 2030 Atmosphere - Theoretical to applied science - Part 1
Atmosphère - De la théorie à la science appliquée - Partie 1 **26/05/2025 15:45**

ID: 12266 Contributed abstract

Vertical distribution and transport of dust aerosol over and around Tibetan Plateau from Spaceborne Lidar

Xiaofeng Xu [1] , *Zixu Xiong* [2] , *Hao Wu* [3] , *Shixian Pan* [4]

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Presented by / Présenté par: *Xiaofeng Xu*
Contact: xxf@nuist.edu.cn

Tibetan Plateau (TP) and its surroundings play a vital role in the emission and transport of dust in Eastern Asia. Using observations from the CALIPSO (Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations) and the CATS (Cloud-Aerosol Transport System), the spatiotemporal distributions and diurnal variations of dust over the study region were presented. The variations of seasonal AOD and dust AOD (DAOD) over the research region were similar, showing the values decreasing from north to south and the higher values appearing in spring and summer. The yearly AOD over the Taklimakan Desert (TD) showed a significant increasing trend. It showed that the dust could exceed 6 km aloft TD in spring and summer, and could easily be transported to TP. In winter, the dust over TP was mainly from the Qaidam Basin due to the suppression effect of the inversion layer over the TD. The dust of Thar Desert and Indo Gangetic Plains (TDIP) reached the maximum of intensity and uplift height in summer, and was transported to TP mostly through the Yarlung Zangbo Grand Canyon aera in the longitudes of 90°-100°E. A long-standing dust layer with thickness of 1-2 km appeared over the whole region. The thickest dust layer over TD appeared in the southeast part. The dense dust top showed a consistency with boundary layer height (BLH) and reached the maximum after the noon. High wind speed and CAPE benefitted the emission and vertical transport of dust. The mountain-valley circulation also played an important role in the diurnal

variation of dust.

Session: 2030 Atmosphere - Theoretical to applied science - Part 1
Atmosphère - De la théorie à la science appliquée - Partie 1 **26/05/2025 16:00**

ID: 12438 Contributed abstract

Atmospheric Observations using the MPLCAN Micro-Pulse Lidar Network

Victoria Pinnegar [1] , *Robert Sica* [2] , *Ellsworth J. Welton* [3] , *Norman O'Neill* [4] , *Debra Wunch* [5] , *Aldona Wiacek* [6]

[1] Western University

[2] Western University

[3] NASA

[4] Universite de Sherbrooke

[5] University of Toronto

[6] St Mary's University

Presented by / Présenté par: *Victoria Pinnegar*
Contact: vpinnega@uwo.ca

Increased forest fire activity poses a risk to public health and has a long-term complex role in climate change. With the number and severity of such events increasing, it is vital to establish a baseline for monitoring and study. The Canadian Micro-Pulse Lidar Network (MPLCAN) is a growing micro-pulse lidar (MPL) network. These ground-based lidar profile the structure of the atmosphere in both height and time. The depolarization channels additionally help discriminate cloud phase and assist in discriminating aerosols from clouds. We can measure layers of smoke particles from the surface to above 10 km altitude at high spatial-temporal resolution (e.g. < 100 m and ~1min). Smoke particles can travel great distances and affect both ozone concentration and the atmosphere’s radiative balance. Currently, MPLs are deployed and operating in London, ON, Toronto, ON; Sherbrooke, QC, Sandy Cove (near Halifax)in the High Arctic (Eureka, NU), and at a recently deployed site, Stony Plain (AB). We also installed a new instrument at Cambridge Bay (NU), which will be operational in the near future. MPLNET processes

the measurements from MPLCAN in near real-time and makes the measurements publicly available each hour. These vertical profile measurements are both supported and complemented by AEROCAN/AERONET (columnar) measurements. We encourage interested parties to use these measurements for studying transport and will present examples of the available measurements with cases and trends over our network sites which highlight how the network can help in studies of air quality, and in particular wildfires.

Session: 2030 Atmosphere - Theoretical to applied science - Part 1
Atmosphère - De la théorie à la science appliquée - Partie 1 **26/05/2025 16:15**

ID: 12400 Contributed abstract
Virtual

The Environment and Climate Change Canada Ceilometer Pilot Project: Tracking Wildfire Smoke in Western Canada

Shannon Hicks-Jalali [1] , *Victoria Pinnegar* [2] , *Corinne Schiller* [3] , *Robert J. Sica* [4] , *Zen Mariani* [5] , *Daniel McLennan* [6] , *Chris Nayet* [7] , *Brayden Nilson* [8] , *Bruce Ainslie* [9]

[1] Environment and Climate Change Canada

[2] University of Western Ontario

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Presented by / Présenté par: *Shannon Hicks-Jalali*

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As Canadian fire seasons lengthen, wildfires are increasingly impacting the Canadian populace. Wildfire smoke is a serious health risk to the public, particularly the young, elderly, and people with comorbidities. Wildfire smoke is currently monitored at the surface by various sensors and the top-most layers by satellite, but there is a significant gap in information between. This gap hampers air quality and aviation forecasting as the height of smoke plumes is crucial in determining if, when, and where they will reach the surface and communities. As the impact of wildfires on Canadians increases, we require earlier notification of when smoke will arrive to provide adequate time to prepare. Lidars and ceilometers have proven to be capable of bridging the information gap between surface and satellite measurements. Networks such as the Canadian Micropulse Lidar Network, part of NASA's global Micropulse Lidar Network, and the European E-PROFILE network have been tracking smoke and other aerosols successfully across countries and continents for the past decade. To that end, Environment and Climate Change Canada (ECCC) began the Ceilometer Pilot Project in Edmonton, AB, in 2022 to use ceilometer data to improve air quality forecasting. Using a Vaisala CL51 and CL61, we have measured over 12 major smoke events in Western Canada. We have developed an automated plume height detection algorithm which provides our forward dispersion model with the time, height, and width of an observed plume. We are then able to project where that plume will go and if, when, and where it will reach the surface, up to 48 hours into the future. The predictions are provided to ECCC forecasters using a new prototype tool we have developed. We will discuss how this new information can help increase the lead-time for the prediction of smoke events both on the surface and aloft.

Session: 5020 Climate Variability and Predictability - Part 1 Variabilité et prévisibilité du climat - Partie 1

Convenors:
Hai Lin, Environment and Climate Change Canada
Bin Yu, Environment and Climate Change Canada

This session invites contributions that deal with climate variability and predictions on subseasonal, seasonal, interannual and decadal-interdecadal time scales. Contributions are solicited on topics including studies of the Madden-Julian Oscillation (MJO) and tropical waves, El Nino/Southern Oscillation (ENSO), atmospheric circulation patterns, tropical-extratropical-polar interactions and teleconnections, and impacts of these processes on predictability and predictions. Equally welcome are contributions on extended- and long-range weather forecasts, and predictions of climate variability on various time scales, including ensemble and initialization techniques, model development, forecast skill assessment, downscaling and calibration, and end-user value and applications. Results from diagnostic, modelling, model inter-comparison, and theoretical approaches are all welcome.

Session: 5020 Climate Variability and Predictability - Part 1
Variabilité et prévisibilité du climat - Partie 1 **26/05/2025 15:30**

ID: 12193 Invited session speaker

Unraveling Multi-Year Marine Heatwaves in the Gulf of Alaska: A Trans-Basin Perspective

Jin-Yi YU [1]

[1] University of California, Irvine

Presented by / Présenté par: *Jin-Yi YU*
Contact: jyyu@uci.edu

Multi-year marine heatwaves (MHWs) have emerged as a persistent feature in the Gulf of Alaska (GOA) over the past decade, with profound ecological and economic consequences. However, the region's pronounced seasonal cycle and weak atmosphere-ocean coupling present challenges to sustaining these prolonged warm anomalies.

This study integrates observational and modeling evidence to demonstrate that GOA MHWs are not isolated Pacific events but instead part of a larger trans-basin interaction. Specifically, trans-basin atmospheric wave trains and their associated Pacific-Atlantic interactions play a pivotal role in sustaining these events. This perspective establishes a crucial link between GOA MHWs, large-scale atmospheric wave dynamics, and inter-basin climate variability.

Furthermore, our findings suggest that Atlantic sea surface temperature anomalies may serve as early warning indicators for prolonged MHWs, highlighting the importance of an integrated monitoring approach across both the Pacific and Atlantic basins. This talk will explore the underlying physical mechanisms driving these interactions and their broader climate implications.

Session: 5020 Climate Variability and Predictability - Part 1
Variabilité et prévisibilité du climat - Partie 1 **26/05/2025 16:00**

ID: 12202 Contributed abstract

Interannual Variability of Summer Heatwaves Across the Northern Hemisphere: Insights from the Land Surface Energy Budget

Dingrui Cao [1] , *Hai Lin* [2] , *Yi Huang* [3] , *Jacques Derome* [4]

[1] Department of Atmospheric and Oceanic Sciences, McGill University

[2] Recherche en Prévision Numérique Atmosphérique, Environment and Climate Change Canada

[3] Department of Atmospheric and Oceanic Sciences, McGill University
[4] Department of Atmospheric and Oceanic Sciences, McGill University

Presented by / Présenté par: *Dingrui Cao*
Contact: dingrui.cao@mcgill.ca

Based on 40-year ERA5 reanalysis data, this study examines the interannual variability of summertime heatwave frequency over the Northern Hemisphere land regions and its association with local surface energy balance and atmospheric drivers. It is found that the contribution of moisture is region dependent. In general, frequent heatwaves in middle-to-high latitudes are associated with moist air. In the Indian and western North American regions, however, an increased number of heatwaves during summer is usually associated with a dry atmospheric condition, which is likely controlled by interannual variability of Indian monsoon circulation and soil moisture, respectively. By decomposing downward longwave radiation (DLR) anomalies using radiative kernels, we demonstrate that surface air warming predominantly enhances DLR across all regions. These findings provide new insights into heatwave characteristics and mechanisms across the Northern Hemisphere.

Session: 5020 Climate Variability and Predictability - Part 1
Variabilité et prévisibilité du climat - Partie 1 **26/05/2025 16:15**

ID: 12465 Contributed abstract

Climate Variability of Seasonal Wind Extreme Events in North America

Ameneh Mollasharifi Targhi [1] , *Adam Monahan* [2]

[1] UVic
[2] UVic

Presented by / Présenté par: *Ameneh Mollasharifi Targhi*
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This study investigates the climate variability and seasonal predictability of large-scale wind extreme events across North America, with a particular focus on their relationship with Pacific sea surface temperature (SST) patterns. Wind Droughts (WD) and Wind Floods (WF) are defined as prolonged seasonal anomalies in surface wind speed, with substantial implications for climate science and renewable energy systems. Using large ensembles of historical simulations from three climate models (CanESM2, CanRCM4, and CESM2), we analyze the frequency, spatial distribution, and predictability of these extreme events across six North American regions.
Time-series analysis reveals that WF events occur most frequently in northern regions during winter, while WD events are more prevalent in southern regions during summer. Composite wind and SST anomaly maps indicate distinct and largely opposing patterns associated with WF and WD events in most regions in North America. WD events are characterized by a band of warm anomalies in the Gulf of Alaska—occasionally extending into the subtropical and tropical Pacific—coupled with a contrasting band of

cold anomalies spanning from Asia to the eastern Pacific, whereas WF events display the opposite pattern. In the Southeast of North America (SENA), however, wind extremes exhibit a localized response with a reversed SST pattern, likely tied to the Pacific–North American (PNA) pattern.
Furthermore, our evaluation of the predictive skill of Pacific SST anomalies shows that WF events are more predictable than WD events, with extratropical Pacific SST anomalies enhancing predictability more effectively than equatorial or full-basin SST patterns. Importantly, the relationships between SST patterns and WD/WF events are predominantly statistically significant at the 5\% level, further bolstering confidence in SST-based seasonal predictability. These findings provide new insights into the large-scale drivers of wind extremes and their seasonal predictability, offering valuable implications for renewable energy resource management and climate modeling.

Session: 5020 Climate Variability and Predictability - Part 1
Variabilité et prévisibilité du climat - Partie 1 **26/05/2025 16:30**

ID: 12244 Contributed abstract

A Lagrangian diagnosis of the heating structure of the 2021 heatwave

Yuying Wei [1] , *Yi Huang* [2]

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Presented by / Présenté par: *Yuying Wei*
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Quantifying the contributions of physical processes leading to heatwaves is a prerequisite for understanding and predicting them. Previous heat budgets based on the Lagrangian method typically used the change in potential temperature as diabatic heating and do not attribute further the temperature changes caused by specific physical processes. This study goes one step further, to decompose the diabatic temperature changes to contributions by the radiation, latent heating and turbulent mixing by coupling the Lagrangian trajectory analysis with an offline radiative transfer model. We apply this framework to analyze the mechanisms leading to the 2021 North Western Pacific hot extreme. The heating budget results show that, while consistent warming occurs in the whole heatwave region, there is significant regional variability in terms of the importance of diabatic heating. At Lytton (50°N, 121.5°W), which experienced the highest temperature extremes, adiabatic processes dominate, while the surrounding region is largely driven by diabatic contributions. In the vertical thermal structure, the evolution and components of temperature show baroclinic features. Compared to the surface, the diabatic temperature at 500 hPa peaked 5 days before the heatwave, which results from anomalous latent heating. This inversion structure suppresses convection, allowing the heat to accumulate near the surface. Using the Rapid Radiative Transfer Model for the Global Circulation Model, we provided a more detailed diabatic decomposition and quantified the heating effect of anomalous water vapor from an atmospheric river originating from East Asia during the heatwave.

Session: 5020 Climate Variability and Predictability - Part 1
Variabilité et prévisibilité du climat - Partie 1 **26/05/2025 16:45**

ID: 12190 Contributed abstract

Projected changes of the Warm Arctic-Cold Continents pattern

Bin Yu [1] , *Hai Lin* [2] , *Dae I. Jeong* [3]

[1] ECCC
[2] ECCC
[3] ECCC

Presented by / Présenté par: *Bin Yu*
Contact: bin.yu@ec.gc.ca

The Warm Arctic-Cold Continents (WACC) pattern consists of two key components: the Warm Arctic-Cold Eurasia (WACE) and Warm Arctic-Cold North America (WACNA) patterns. Projected changes in WACE and WACNA under global warming, along with their formation mechanisms, are analyzed and compared using CanESM5 historical and scenario simulations. CanESM5 reasonably well simulates these patterns and their underlying mechanisms. Previous studies suggest that WACNA variability decreases with global warming, with a more pronounced decline in its Arctic action center. These changes are primarily attributed to alterations in meridional heat transport. Similarly, the variability of the WACE pattern decreases under global warming, with a comparably rapid decline in its Arctic action center. However, the changes in the WACE pattern are primarily driven by Arctic sea ice loss due to global warming. The reduction in sea ice diminishes surface temperature variability by weakening both zonal and meridional heat transport.

Session: 12030 Quantum Geodesy: A New Frontier Géodésie quantique : une nouvelle frontière

Convenors:
Dr. Catherine Robin, Canadian Geodetic Survey, Natural Resources Canada
Dr. Asif Iqbal, Office of the Chief Scientist, Natural Resources Canada

Quantum technologies have significant potential to provide new functionalities in geodesy and geophysics; some of these are already being integrated into traditional programs. This session invites contributions on the theoretical, instrumental, or applied aspects of quantum mechanics in geodesy and geophysics. Oral and poster submissions are welcome on a wide range of topics, including, but not limited to: atom interferometry for ground- and space-based gravimetry; laser interferometric ranging; frequency comparisons of ultra-precise optical clocks; optical links for measuring gravitational potential differences over extended distances; relativistic geodesy with atomic clocks; applications in defining and implementing height systems at local and global scales; next-generation gradiometry; satellite swarm tracking; enhancements to the accuracy of the International Atomic Time (TAI); and the deployment of high-performance clock networks to support GNSS and other space missions. Furthermore, the session also welcomes discussions on quantum technologies with prospective applications in geodesy and geophysics, such as quantum hyperspectral sensing, quantum imaging and lidar, quantum optimization techniques, and quantum electrometry and magnetometry.

Session: 12030 Quantum Geodesy: A New Frontier Géodésie quantique : une nouvelle frontière **26/05/2025 15:30**

ID: 12246 Contributed abstract

Exploring Quantum Computing for Flood Prediction: QSVR Model Simulation

Heather McGrath [1] , *Sohrab Ganjian* [2] , *Mozhdeh Shahbazi* [3] , *Olivier Bergeron* [4]

[1] Natural Resources Canada
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[3] Natural Resources Canada
[4] Natural Resources Canada

Presented by / Présenté par: *Heather McGrath*
Contact: heather.mcgrath@nrcan-rncan.gc.ca

Flood events are influenced by various hydrological and geophysical factors. Accurate predictions of flood characteristics, such as the maximum flood extent, water velocity and depth, are crucial for effective risk management and mitigation. In this study, we explore the potential of quantum computing in flood prediction, using the outputs from a simulated HEC-RAS flood dataset of Saskatoon River. Through the exploration of geophysical attributes such as geomorphons and Height Above Nearest Drainage (HAND), along with temporal hydrological variables like depth and velocity, we develop a Quantum Support Vector Regression (QSVR) model to predict future flood behaviour.

To assess the feasibility of quantum flood modelling, we conduct simulation of quantum computing and benchmark the QSVR model against classical machine learning approaches. Our findings indicate that quantum models show promise even in the Noisy Intermediate-Scale Quantum (NISQ) era, where hardware limitation still exist. This study provides an early step toward integrating quantum machine learning into hydrological modelling.

Session: 12030 Quantum Geodesy: A New Frontier Géodésie quantique : une nouvelle frontière **26/05/2025 15:45**

ID: 12319 Contributed abstract

Advancements in gravimetry: Comparing results from traditional absolute gravimeters with Canada’s first quantum gravimeter

Edouard G. H. Philippe [1] , *Bianca D'Aoust* [2] , *Mahmoud Abd El-Gelil* [3] , *John W. Crowley* [4]

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Presented by / Présenté par: *Edouard Guy Henri Philippe*
Contact: edouard.philippe@nrcan-rncan.gc.ca

The measurement of absolute gravity has long been conducte in Canada, first using the JILA gravimeter developed by the Joint Institute for Laboratory Astrophysics (JILA), and then with Micro-g LaCoste's A-10 and FG5 gravimeters. These instruments measure the vertical acceleration of the gravity by determining the time and displacement of a free fall mass in a vacuum chamber with high accuracy and precision (1µGal). While these absolute gravimeters remain the current standard for the measurement of gravity worldwide, they pose certain mechanical and technical limitations.
In recent years, advances in quantum technology and its miniaturization have enabled the development of a new generation of gravimeters known as quantum gravimeters. Among them, Exail's Atomic Quantum Gravimeter (AQG) introduces new possibilities for gravimetry, both in the laboratory and in the field.
This presentation will first explain how this new type of gravimeter operates, highlighting its advantages and limitations. The first laboratory results will then be presented and compared to previous results obtained using traditional absolute gravimeters. Finally, the strong potential of this technology for the future of laboratory and field gravimetry will be discussed.

Session: 12030 Quantum Geodesy: A New Frontier Géodésie quantique : une nouvelle frontière **26/05/2025 16:00**

ID: 12558 Contributed abstract

Virtual

Quantum remote sensing with Rydberg atoms at Natural Resources Canada

Christopher Wyenberg [1] , *Asif Iqbal* [2] , *Catherine Robin* [3] , *Andrew Todd* [4] , *James Shaffer* [5]

[1] Natural Resources Canada
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Presented by / Présenté par: *Christopher Wyenberg*
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Recent advancements in cold atoms and optical research have enabled precise control and measurement of atoms and photons at quantum mechanical scales. These breakthroughs have led to the development of quantum sensors, which leverage unique quantum properties to surpass the performance of traditional sensing technologies. The first part of this talk will highlight ongoing research initiatives and potential applications of quantum sensing in natural resource sectors. We will explore quantum sensing technologies at different stages of development and their applications in land and mineral exploration, forestry, and power distribution. The second part will focus on Rydberg sensing projects under the Government of Canada's Quantum Research & Development Initiative (QRDI). Rydberg atom devices offer advantages such as smaller size, lower interference, and enhanced tunability compared to conventional radiometers and RF antennas. We will discuss the development of a quantum radiometer and a numerical model to support its application in natural resource monitoring. Finally, we will examine the capabilities of quantum gravimeters and gradiometers, as well as their future applications in resource exploration and environmental monitoring.

Session: 12030 Quantum Geodesy: A New Frontier Géodésie quantique : une nouvelle frontière **26/05/2025 16:15**

ID: 12578 Contributed abstract

Atomic clocks and their applications on modern time keeping

Bin Jian [1]

[1] Natural Resources Canada

Presented by / Présenté par: *Bin Jian*
Contact: Bin.Jian@nrc-cnrc.gc.ca

In this presentation, I will first give a general introduction of the atomic clocks as quantum devices and explain how they are used for the global time keeping. I will then present the Cs fountain primary frequency standard operated in NRC time and frequency group, NRC-FCs2, which has been evaluated as the most accurate working fountain clock now and has been contributing to the steering of UTC/TAI since 2020. Next, I will show the generation of UTC(NRC), the official time of Canada, as a fountain steered timescale, a remote frequency comparison between NRC-FCs2 and the fountain clocks operated at PTB, Germany, through NRCan GPS PPP-AR links, as well as a most recent absolute frequency measurement of NRC strontium ion optical clock against NRC-FCs2. Finally, I will briefly discuss the future redefinition of the SI second and the challenges involved.

Session: 7042 Satellite Earth Observation: A unique view of our planet and a critical need for Canada's resilient future - Part 3 Observation de la Terre par satellite : Une vue unique de notre planète et un besoin essentiel pour l'avenir de la résilience du Canada - Partie 3

Convenors:
Kaley Walker, University of Toronto;

Adam Bourassa, University of Saskatchewan

Satellite Earth observation (SEO) provides a unique global perspective on our planet's atmosphere and surface, including the oceans, land, vegetation, ice, and snow. Current and planned satellite missions from Canada and international agencies have provided and will provide a wealth of new information about the Earth system and that can be used to investigate a wide range of environmental and scientific questions.

Resourceful, Resilient, Ready: Canada's Strategy for Satellite Earth Observation provides a plan for Canada to more effectively leverage satellite earth observation (SEO) to address key priorities, including climate change mitigation and adaptation. This strategy will help to inform Canada's plans for SEO for the next decade and ensure Canada will maximize utilization and benefits of SEO.

This session encourages contributions from across the full SEO value chain, upstream, midstream and downstream, to illustrate the activities currently underway in Canada, involving industry, academia and government. This includes new measurement technologies and techniques, both passive and active; mission development; retrieval algorithms; demonstration and calibration of instruments; validation of satellite products; assimilation of data into numerical models; scientific results and discoveries; operational utilization and development of services.

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ID: 12518 Contributed abstract

ACE-MAESTRO on CSA's SCISAT satellite in its 22nd year

C. Thomas McElroy [1] , *James Drummond* [2] , *Jiansheng Zou* [3] , *Paul Jeffery* [4] , *Kaley Walker* [5]

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Presented by / Présenté par: *C. Thomas McElroy*
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In two and a half months, MAESTRO (Measurement of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation), will have been operating on the Canadian Space Agency's SCISAT satellite for 22 years. MAESTRO is one of two instruments on the satellite, the other one being the Atmospheric Chemistry Experiment Fourier Transform Spectrometer (ACE FTS). MAESTRO was designed to measure NO2,

water vapour, ozone and aerosol in the atmosphere. The instrument will be briefly described and the retrieval algorithms will be outlined. Recent work toward improving the data processing will be shared. Some sample retrieved profiles of atmospheric constituents will be presented. A current comparison to other satellite data sets will be included. The instrument development was funded by the Canadian Space Agency (CSA) and Environment Canada. The data analysis has been supported since the launch of the satellite in August 2003, by the CSA.

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ID: 12448 Contributed abstract

The Canadian Atmospheric Chemistry Experiment: Recent Validation and Science Results

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Presented by / Présenté par: *Kaley Walker*
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The Canadian-led Atmospheric Chemistry Experiment (ACE) mission on board the SCISAT satellite has been making routine measurements of the Earth's atmosphere since February 2004. The long lifetime of ACE provides a valuable time series of composition measurements that contribute to our understanding of ozone recovery, climate change and pollutant emissions.

The SCISAT/ACE mission uses infrared and UV-visible spectroscopy to make its solar occultation measurements. The ACE Fourier Transform Spectrometer (ACE-FTS) is an infrared FTS operating between 750 and 4400 cm-1 and the ACE-MAESTRO (Measurements of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation) is a dual UV-visible-NIR spectrophotometer which was designed to extend the ACE wavelength coverage to the 280-1030 nm spectral region. From these measurements, altitude profiles of atmospheric trace gas species, temperature and pressure are retrieved.

The ACE data set can be combined with other data sets to provide the climate data records required for long term monitoring of ozone and related species and for initialization and testing of chemistry-climate models. In order to do this, it is essential to quantify the biases between the different instruments and investigate their changes over

the operational time period. Validation and comparison studies are a necessary component of this data assessment process. Highlights of validation and science results from the ACE mission will be presented in this paper along with mission and instrument status.

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ID: 12229 Contributed abstract

Variability and long-term changes of tropical cold point temperature and water vapor

Mona Zolghadrshojaee [1] , *Susann Tegtmeier* [2] , *Sean M. Davis* [3] , *Robin Pilch Kedzierski* [4]

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Presented by / Présenté par: *Mona Zolghadrshojaee*
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The tropical tropopause layer (TTL) is a critical region for understanding the exchange of air between the troposphere and stratosphere, influencing the chemical composition of the stratosphere and global energy budget. The cold point tropopause, where air parcels experience final dehydration, plays a key role in controlling stratospheric water vapor, a significant contributor to radiative processes and climate dynamics. This study leverages Global Navigation Satellite System Radio Occultation (GNSS-RO) and Microwave Limb Sounder (MLS) satellite data to investigate long-term trends in cold point temperatures, their spatial patterns, and implications for water vapor transport in the TTL over the past two decades.
Our findings indicate a warming trend of the cold point tropopause, with rates up to 0.7 K/decade during boreal winter and spring, marking a shift from cooling trends observed before 2000. The warming exhibits distinct longitudinal asymmetries, with the weakest trends over the central Pacific and strongest over the Atlantic. These patterns are linked to anti-correlated tropospheric temperature trends, suggesting a complex interplay of radiative effects, convection changes, and stratospheric circulation dynamics. Additionally, MLS water vapor data reveal positive trends for 2004–2021, consistent with the warming. The seasonal amplitude of cold point temperatures has decreased by ~7%, leading to a 5–6% reduction in the seasonal cycle of water vapor at 100 hPa. This diminished cycle propagates upward, manifesting as a reduced seasonal signal in the "tape recorder" effect over the last two decades.

This work underscores the value of satellite Earth observation in advancing our understanding of atmospheric processes and trends associated with climate change. In particular, the combined use of GNSS-RO and MLS data highlights how satellite measurements can help to better understand and quantify the interplay of changes in atmospheric dynamics and composition.

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ID: 12284 Contributed abstract

The OSIRIS Instrument on the Odin Satellite – Almost Twenty-Five Years of Data

Doug Degenstein [1] , *Adam Bourassa* [2] , *Kimberlee Dube* [3] , *Daniel Zawada* [4] , *Taran Warnock* [5] , *Chris McLinden* [6]

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Presented by / Présenté par: *Doug Degenstein*

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In early 2001 the Canadian led OSIRIS instrument was launched into orbit onboard the Swedish led Odin spacecraft. For almost a quarter of a century OSIRIS has made climate quality measurements of atmospheric constituents such as ozone, nitrogen dioxide, sulphate aerosol and bromine monoxide along with atmospheric parameters such as temperature. This has been done using the signatures contained within spectrally dispersed, vertically resolved, limb scattered sunlight profiles and has resulted in the longest data records inferred from a single space-based, limb looking optical instrument. The experience and knowledge gained from OSIRIS has greatly enhanced our understanding of the atmosphere and our ability to measure it. OSIRIS

measurements have contributed to international initiatives like the World Meteorological Organization's quadrennial ozone assessment and the instruments and data analysis techniques associated the new Canadian HAWC mission have been evolved from stat of the art OSIRIS technology. This talk will present the latest status of OSIRIS as it continues to age gracefully, detailing recent scientific and technological achievements. It will also outline how OSIRIS experience will be used to enhance the HAWC scientific return.

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ID: 12443 Contributed abstract

Analyses and comparisons of the ACE-FTS and MIPAS CFC-11, CFC-12 and HCFC-22 data

Jiansheng Zou [1] , *Kaley Walker* [2] , *Patrick Sheese* [3] , *Christopher Boone* [4] , *Gabriele Stiller* [5] , *Tobias Kerzenmacher* [6]

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Presented by / Présenté par: *Jiansheng Zou*

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The most recent ACE-FTS version 5.3 data for CFC-11, CFC-12 and HCFC-22 are compared with the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) version 8 data for these species, processed by the IMK/IAA (Institut für Meteorologie und

Klimaforschung/Instituto de Astrofísica de Andalucía) for 2005 - 2012. Comparisons of these two datasets are carried out for the time series of zonally averaged monthly means in nine latitude bands of 20° width from 90°S to 90°N. Four types of time series are used: two from the coincident subsampled datasets of both instruments and two from the entire datasets. Dynamical components are extracted from these time series. The mean annual cycles are derived by averaging over the data period, while the mean distributions, linear trends and quasi-biennial oscillations (QBOs) are derived from the de-seasonalized time series using multiple linear regression (MLR). A companion analysis is applied to the MIPAS tracer-derived residual velocity data. These velocity components largely explain the mean distribution of the atmospheric species, the annual variations linked to the Brewer-Dobson Circulation, the interhemispheric asymmetry in linear trends between the Southern and Northern Hemispheric stratosphere, and the QBOs in the equatorial region. In addition, the time series analyses of both the ACE-FTS and MIPAS data are enhanced using derived meteorological product (DMP) data, allowing comparisons between latitude/altitude and equivalent latitude/potential temperature space. Finally, 21 years of ACE-FTS data are used to derive time varying linear trends in the latitude/altitude bins, reflecting events related to compliance/non-compliance with the Montreal Protocol and its subsequent amendments.

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ID: 12309   Contributed abstract

MOPITT measurements of the 2023 and 2024 Canadian wildfires

Paul Jeffery [1] , *James R. Drummond* [2] , *Jiansheng Zou* [3] , *Heba S. Marey* [4] , *Kaley A. Walker* [5]

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Presented by / Présenté par: *Paul Jeffery*
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Launched aboard NASA's Terra satellite in December 1999, the Measurements Of Pollution In The Troposphere (MOPITT) instrument has been measuring upwelling thermal and near-infrared radiance in a nadir-viewing geometry for 25 years. The measurements made by MOPITT are used to retrieve profile and total column estimates of carbon monoxide (CO) concentration. Global coverage is achieved every 3 days, with an exact revisit cycle of 16 days. The MOPITT CO dataset constitutes the current longest satellite-based record of global CO measurements.

Atmospheric CO has two dominant sources, anthropogenically derived emissions from incomplete combustion and emissions from biomass-burning events. Current trend estimates for atmospheric CO show a global decrease in of approximately 1%/year, with this trend being attributed to decreasing anthropogenic emissions of CO. However, changing climate conditions have led to an increase in the frequency and severity of biomass burning events. In 2023, the wildfire season in Canada was the largest on record, with over 15 million ha of forest burned, and 2024 saw one of the largest recorded fire seasons, with approximately 5 million ha of burned area.

This study aims to examine the impact of these two severe fire seasons using the 25-year MOPITT data record. Measurements of these two fire seasons will be compared to the rest of the MOPITT data record to examine the representation and repercussions of these events. Specific focus within this work is on leveraging the vertical profile information contained in the MOPITT dataset to analyze global transport of CO from these events.

MOPITT was built in Canada by COMDEV of Cambridge, ON, data processing is performed at NCAR in Boulder, CO. The Terra satellite is funded and operated by NASA, and the MOPITT instrument and operations are funded by the Canadian Space Agency (CSA). This study is supported by contract number CSA 9F045-170863/001/MTB.

Session: 8042 Global Water Futures: Solutions to water threats in an era of global change - Part 3 L'avenir de l'eau dans le monde : Solutions aux menaces pesant sur l'eau à l'ère du changement planétaire - Partie 3

Convenors:
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Our water is at risk—in Canada and globally, we are facing unprecedented water-related challenges. Half of the world's population depend on water from cold regions, and while Canada is home to 20 per cent of the world's freshwater reserves, it has some of the highest warming rates which adversely affect infrastructure, ecosystems and human health. Facing these challenges, water scientists in Canada and globally are asking the question, "how can we best forecast, prepare for and manage water futures in the face of dramatically increasing risks?" Global Water Futures (GWF; 2016–2025) is a major Canadian research consortium that came together to address this grand challenge. Its overarching goal is to deliver risk management solutions—informed by leading-edge water science and supported by innovative decision-making tools—to manage water futures in Canada and other cold regions. With GWF coming to its conclusion, it is timely and important to share its scientific outcomes and synthesize the complete set of findings to ensure that these are useful and actionable to society. This effort is underway and the session brings together key thematic and regional components of the synthesis. Submissions on related GWF advances in cold regions water and climate science, utilization of GWF models or results, community and user engagement, and knowledge mobilization are encouraged.

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ID: 12534 Contributed abstract

Future transition of forest and tundra landscapes across Canada in response to climate change – advancements and findings from the Global Water Futures program

Chris DeBeer [1] , *Jennifer Baltzer* [2] , *Sean Carey* [3] , *Altaf Arain* [4] , *Alan Barr* [5] , *Rich Petrone* [6] , *Mike Waddington* [7] , *John Pomeroy* [8]

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Presented by / Présenté par: *Chris DeBeer*
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Forest and shrub tundra ecosystems cover over half of Canada's land surface area and play a major role in energy, water, and carbon cycling from global to local scales. These ecosystems are undergoing rapid change and transition in their structure, function, and biodiversity, driven by climate change and human disturbance. Northern forests are losing ecological resilience with very clear increasing trends in the extent and severity of wildfire, thawing permafrost and forest collapse, and pest infestations and disease. Treelines in montane and subarctic locations are shifting, while shrub tundra environments are showing greening trends, with more extensive growth of shrubs in some areas, and browning trends in other places. Taken together, this is one of the most rapid landcover changes changes since agricultural settlement of Canada with massive hydrological and water quality and hence water management implications. The Global Water Futures program (GWF; www.globalwaterfutures.ca) undertook extensive studies to improve understanding of how hydrological and terrestrial ecological processes will co-evolve under a changing climate, providing critical information on landscape and water futures. Work was guided by very specific questions posed by an extensive community of partners and knowledge users. This presentation briefly summarizes the GWF projects and work under its Hydrology and Terrestrial Ecosystems theme before reviewing the outcomes, contextualized by our user questions and concerns. Topics include the changing wildfire regime in Canada's northern and montane forests, thawing permafrost and other disturbance impacts to forest ecosystems, and shrub growth and expansion in northern and montane regions. The findings are presented in more detail in a GWF synthesis currently being developed as a major outcome of the program, to be completed in the spring–summer of 2025.

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ID: 12563 Contributed abstract

Advances in Ice-Jam Flood Hazard Assessment and Risk Mapping

Karl-Erich Lindenschmidt [1], *Apurba Das* [2], *Mohammad Ghoreishi* [3], *Sergio Gomez* [4], *Ananya Kowshal* [5], *Rasa Moeini* [6]

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Assessing flood hazards is crucial for determining the exceedance probabilities of floodwater levels and extents within floodplains and other flood-prone areas. By placing these threshold levels and extents within a probabilistic context, we can establish design

criteria for the development of residential areas, industrial complexes, commercial assets, and infrastructure. Extending the analyses to include flood risk, where the costs of damages caused by flooding are considered within such probabilistic frameworks, provides an outlook on the benefits of such developments and a means of evaluating the efficacy of measures implemented to protect these assets. For areas prone to ice jamming and ice-jam flooding, an additional level of complexity is introduced due to the chaotic nature of ice jams. Small shifts in a jam's hydraulic and ice regimes, such as changes in ice-jam morphology or slight alterations in lodgment locations, can yield different outcomes in floodwater levels and extents. This unpredictability necessitates more sophisticated assessment tools and methodologies to determine flood hazard and risk.

Significant progress has been made under the Global Water Futures research program to enhance current tools for the assessment of hazard and risk specific to ice-jam flooding. These advancements include (i) stochastic modelling, which incorporates randomness and variability in the modelling process, allowing for a more comprehensive understanding of potential flood scenarios and their probabilities; (ii) agent-based modelling, which simulates the actions and interactions of individuals within an area of flood risk, (iii) systems-dynamic modelling, which focuses on the feedback loops and time delays within the socio-economic flood-impacted system; and (iv) machine-learning approaches which leverage large datasets to identify patterns to make predictions about ice-jam formation and flood risk. These advancements can enhance our ability to assess and map the hazards and risks associated with ice-jam flooding, leading to more effective flood management and mitigation strategies.

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ID: 12310 Contributed abstract

Glacier melt contributions to a Canadian mountainous basin and the impact of climate change and deglaciation

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Presented by / Présenté par: *Ala Bahrami*
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The snow-dominated Fraser River Basin (FRB), one of the largest and most critical basins in western North America, is highly vulnerable to rapid climate change. Rising temperatures and shifting precipitation patterns have altered the FRB's seasonal snowpack, reducing its contribution to the hydrological regime, causing glaciers to retreat, and transitioning the basin from a nival system to a pluvio-nival hybrid. Adaptation strategies are essential to sustain the hydrological and ecological systems. Therefore, evaluating climate scenarios using well-established models for hydrological variables such as snow and glacier melt, streamflow, and water budget changes is very important for predicting future hydrology. The MESH hydrological land surface model was used to predict the effects of climate change on the hydrology of the FRB to the end of the century as part of the Global Water Futures core modelling research. A high-resolution hydrological-glaciological model was structured, parameterised and evaluated over the FRB using multiple datasets. The contribution of glacier melt to the basin hydrology and the sensitivity of the basin to changes in glacier coverage were quantified for differing climate trajectories. Model simulations were run for the current, mid-century, and late-century climate for current, mid and late 21st century glaciation by considering dynamic glacier coverage. Runs with no glacier coverage were made in order to assess the glacier melt contribution to streamflow. Mid-century and late-century simulations revealed earlier snowmelt and peak flows, increased winter flows, changes in the volume of snowmelt runoff, and reduced summer flows. The glacier retreat scenario shows that by the end of the century, only a few glaciers will remain in the Interior and Rockies regions of the Fraser River Basin and the glacier contribution to streamflow will become very small – this may degrade mountain ecosystems, water supply during droughts, and alpine tourism.

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ID: 12209 Contributed abstract

The impact of climate change and concomitant permafrost degradation and deglaciation on the hydrology of the Yukon River Basin

Mohamed Elshamy [1] , *John Pomeroy* [2] , *Alain Pietroniro* [3]

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Presented by / Présenté par: *Mohamed Elshamy*
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Earth system models predict that the current global warming trends will continue. Continental high latitudes have been heating at higher rates than the global average, resulting in deglaciation and permafrost thaw with implications for hydrology, water resources, and infrastructure. Feedbacks are generally complex and depend on a multitude of factors including changes to precipitation intensity, timing, and phase as well as soil composition and hydraulic and thermal properties. The Yukon River basin drains headwaters in glaciated mountains and is underlain by permafrost for much of its extent. Here, the MESH distributed hydrological-cryospheric land surface model was set up over the Canadian part of the basin (outlet at Eagle, Alaska) to solve for coupled water and energy budgets, forced with bias-corrected, downscaled RCM forcings, and parameterized with snow redistribution, organic terrain, and glaciers, to couple simulations of hydrological and cryospheric dynamics. The model was calibrated against selected river discharge observations and validated against discharge and available permafrost probability maps. The model was initializing via cycling the 1st 10 years of climate forcing for 40 times until changes to the thermal regime were minimal. The resulting high-fidelity model was used to simulate the changing hydrology over the 21st C under the RCP8.5 climate change scenario. The results show rapidly increasing rates of permafrost thaw, such that most of the basins will be permafrost-free by the 2080s. By the late century, river discharges shift to earlier and higher peaks in response to projected increases in precipitation, temperature, maximum snowpack, and snowmelt rates, despite increases in evapotranspiration from a longer snow-free season. Baseflow discharges increase in winter, due to both increased basin connectivity from permafrost thaw, more liquid subsurface water and increased precipitation. Deglaciation reduces summer flow significantly in the headwaters of the Yukon and its White River tributary and combined with the shift in the timing of peak flow, may have severe consequences for water resources management and aquatic ecosystems.

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ID: 12552 Contributed abstract

Surface Water Flows and Basin Budgets: Global Water Futures Advances in Integrated Management in a Changing Climate

Alain Pietroniro [1] , *John Pomeroy* [2] , *Ashleigh Duffy* [3] , *Karl-Erich Lindenschmidt* [4] , *Ala Bahrami* [5] , *Mohamed Elshamy* [6] , *Fuad Yassin* [7] , *Zelalem Tessema* [8] , *Darrell Corkal* [9] , *Chris DeBeer* [10]

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Presented by / Présenté par: *Mohamed Elshamy*
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Canada's surface water resources span seven major drainage basins, each uniquely influenced by natural and human factors such as climate change, resource extraction, and land development. Climate change is significantly altering hydrology, leading to earlier snowmelt, increased peak flows, and shifting seasonal patterns, creating challenges for water management across jurisdictions. Downstream users face consequences from upstream decisions, while upstream users recognize the need for interjurisdictional collaboration. Adaptive governance, supported by predictive modeling and real-time decision-support tools, is essential for sustainable water management. Global Water Futures (GWF) has developed advanced hydrological models, such as the Modélisation Environmentale Communautaire—Surface and Hydrology (MESH), to project future water supply scenarios. These models highlight trends like increased winter flows, earlier peak discharges, and permafrost degradation, particularly in the Mackenzie and Yukon basins. The Saskatchewan and Nelson-Churchill basins face heightened flood and drought risks, while the Fraser and Columbia basins contend with glacier retreat and water allocation pressures. Effective water governance requires integrating scenarios, climate-informed operations, and cross-jurisdictional management. As part of the GWF efforts, we engaged diverse stakeholders—including policymakers, researchers, industry leaders, and Indigenous communities—towards developing adaptive strategies. Collaborative decision-making processes that incorporate traditional knowledge and scientific expertise will enhance water security and resilience. As climate change accelerates, proactive adaptation and sustainable water strategies will be critical to safeguarding Canada’s freshwater future.

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ID: 12526 Contributed abstract

Outreach and Knowledge Mobilization: Lessons from Global Water Futures

Stacey Dumanski [1] , *Monica Morrison* [2]

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Presented by / Présenté par: *Stacey Dumanski*
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Outreach and knowledge mobilization (KM) are essential for bridging the gap between research and real-world impact, ensuring that scientific insights are accessible, actionable, and drive informed decision-making for communities, policymakers, and stakeholders. The Global Water Futures (GWF) pan-Canadian freshwater research program was designed to generate actionable scientific knowledge for forecasting, preparing for, and managing cold regions water futures. Guided by the needs of governments, industries, and the public, GWF emphasized co-creation of knowledge throughout the investigation, review, and research processes, and maintained

engagement with hundreds of user groups, communities, and researchers. The scope and reach of the GWF program posed both opportunities and challenges when strategizing and effectively sharing research outcomes from the program. GWF addressed these challenges through dedicated KM, outreach, and communications teams, employing diverse strategies to enhance relevance, accessibility and usability of scientific findings. This presentation will highlight key lessons learned, best practices, and the impact of GWF's approach, offering insights for future large-scale networked research programs seeking to maximize societal benefits.

Session: 3021 biogEosCiences peRspectives - Part 2 biogéosciences peRspectives - Partie 2

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This session aims to showcase science from early career researchers (ECRs) investigating ecosystem processes from a biogeosciences perspective. Research that demonstrates progress towards an improved understanding of biogeochemical processes and patterns, and/or advances in models are welcomed. In particular, we encourage presentations that seek to quantify biogeochemical functions of natural or managed environments; characterize measurement and modelling uncertainty in complex and heterogeneous landscapes; scale biophysical exchange processes; quantify the impacts of climate and land-use change on ecohydrological fluxes across ecosystems; or identify and evaluate the effects of extreme weather and disturbance phenomena on biogeochemical properties. Studies at local to landscape scales, with a focus on atmospheric, terrestrial, or aquatic systems will all be considered. Submissions from researchers at all career stages will be considered with presenting slots set aside for ECR (<7 years since terminal degree).

Session: 3021 biogEosCiences peRspectives - Part 2 biogéosciences peRspectives - Partie 2 **26/05/2025 15:30**

ID: 12327 Contributed abstract

Evaluating Carbon Sequestration in New Brunswick Mudflats: Insights from a New Multidisciplinary Research Program

M Graham Clark [1] , *Meriam Barbeau* [2] , *Christopher Wong* [3] , *Courtney Allen* [4] , *Naaman Omar* [5] , *Abigail Dickinson* [6] , *Jeff Ollerhead* [7] , *Amanda Loder* [8] , *Douglas Campbell* [9] , *Adrian Reyes-Prieto* [10] , *Damith Perera* [11] , *Diana*

Hamilton [12]

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Presented by / Présenté par: *M Graham Clark*
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Mudflats are soft-sediment intertidal ecosystems found oceanward of beaches and slat marshes in the intertidal zone. Only recently identified as significant “blue carbon” reservoirs, their role in the global carbon cycle is poorly understood. Mudflats gentle slopes promote carbon burial and sediment cores suggest significant carbon stocks. However, the rate of accumulation into these reservoirs is difficult to quantify and scale into regional carbon budgets. New Brunswick (NB) hosts some of the world’s largest mudflats, yet the processes governing carbon exchange, especially microalgae’s role in sequestration, remains unclear.
This talk presents findings from the first field season in NB of an ongoing multidisciplinary effort to measure and scale carbon dynamics in these ecosystems. Our approach integrates cutting-edge methods, including environmental DNA and RNA (eDNA/eRNA) analysis to characterize microbial communities, eddy covariance and gas flux chambers to quantify carbon fluxes, and sediment cores to assess carbon storage. Additionally, multispectral drone imagery is being used to link in situ measurements to satellite observations, enabling regional-scale assessments. By integrating these techniques, we refine our understanding of biological and physical controls of carbon sequestration in mudflats.
Preliminary results highlight spatial and temporal variability in microalgae biomass, particularly around the two annual algae blooms and the related grazing. This seasonality emphasizes the need for high-resolution monitoring to capture ecosystem-scale dynamics across the whole season. As expected, tidal stage also has a major role in vertical carbon dynamics, but isolating and quantifying its impact on carbon dynamics is ongoing. Lastly, mudflat sediment profiles, including particle size and sediment type, are variable and likely contribute to variation in carbon stocks and rates of carbon accumulation across New Brunswick mudflats. These insights will improve our ability to integrate mudflats into carbon budgets and inform conservation strategies in the face of climate change.

Session: 3021 biogEosCiences peRspectives - Part 2
biogéosciences peRspectives - Partie 2 **26/05/2025 16:00**

ID: 12493 Contributed abstract

Building Boreal Landscapes: Carbon Dynamics During the Initial Six Years of Ecosystem Evolution at a Reclaimed Upland

Natasa Popovic [1] , *Scott Ketcheson* [2] , *Richard Petrone* [3]

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Presented by / Présenté par: *Nataša Popović*
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Boreal uplands provide key ecosystem services such as water storage, carbon sequestration and biodiversity. As such, these landscapes have become the focus of reclamation efforts in the Athabasca Oil Sands Region (AOSR). The performance of reclaimed landscapes can be assessed through carbon dynamics as they incorporate key aspects of an ecosystem's ecohydrological functioning. This study provides a temporal snapshot of the carbon dynamics for a constructed upland part of the greater Lake Miwasin watershed – a pilot-scale end pit lake. Here, growing season observations were measured using the eddy covariance technique and paired with multispectral imagery to capture ecosystem evolution. The first six years following construction proved to be dynamic with the upland rapidly evolving from a barren, dry landscape to a robustly vegetated ecosystem. By year 3 understory vegetation was widespread and enhanced vegetative index (EVI) values were comparable to those measured at nearby, undisturbed landscapes (0.2-0.5). Carbon trends during ecosystem development mirrored the establishment of vegetation, and the upland rapidly shifted from a carbon source (Net Ecosystem Exchange (NEE): 225 g C m-2) to carbon sink (NEE: -52 g C m-2). Notably, plant establishment and net carbon assimilation occurred earlier at this constructed site compared to a nearby reclaimed upland (Nikanotee Upland). Differences in the timing of ecosystem evolution between the two constructed uplands is likely the result of variable hydrophysical properties and hydroclimatic conditions. Thus, results from this study provide vital insight to land managers on ecohydrological dynamics along reclamation trajectories – lessons which can be applied to future site designs to ensure long-term reclamation success.

Session: 3021 biogEosCiences peRspectives - Part 2
biogéosciences peRspectives - Partie 2 **26/05/2025 16:15**

ID: 12248 Contributed abstract

Evaluating the CBM-CFS Model Using Repeated Forest Ground Plot Measurements

Francis Durnin-Vermette [1] , *Oleksandra Hararuk* [2] , *Derek Sattler* [3]

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Presented by / Présenté par: *Francis Durnin-Vermette*
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Forests are the largest terrestrial carbon (C) sink and constitute around 40% of Canada’s land cover. Reliable estimates of forest C stocks and fluxes are crucial to Canada's national and international reporting as well as developing strategies for C sequestration. C stocks and fluxes in Canada’s managed forests are scaled and tracked using the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS), and it is important to calibrate and validate the model using the ground plot data to ensure accurate reporting. Recently, Bayesian inversion techniques have been successfully applied to optimize parameters within the CBM-CFS, however, these calibrations have relied on C stock measurements and stand histories taken at single points in time. In this study, we evaluated the calibrated CBM-CFS against repeated measurements taken at 641 ground plots established as a part of Canada's National Forest Inventory (NFI) program. Our results provide new insights into CBM-CFS3 model performance over time.

Session: 3021 biogEosCiences peRspectives - Part 2
biogéosciences peRspectives - Partie 2 **26/05/2025 16:30**

ID: 12487 Contributed abstract

Picture Not Perfect: High-resolution dendrochemical investigation reveals complex, non-uniform elemental distribution

Chloe Canning [1] , *Colin Laroque* [2] , *David Muir* [3]

[1] University of Saskatchewan
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Presented by / Présenté par: *Chloe Canning*
Contact: chloe.canning@usask.ca

Tree-ring science, or dendrochronology, is a common technique used to document past environmental and ecological conditions through variations in radial growth. Growth rings provide insights about past climate, insect populations, and extreme events (e.g., fires, storms, and ice jams). There is also increasing interest in using dendrochronological methods to document elemental changes in the environment. The subfield of dendrochemistry applies the same assumptions as dendrochronology, that elements present within a growth season are represented within individual tree-rings. However, methodological limitations and a lack of standard sampling procedures have resulted in variable, often conflicting, outcomes of elemental quantification in tree-rings. Furthermore, the current understanding of the natural elemental distribution in trees is

incomplete. Currently, there is minimal research to suggest where elements reside across ring boundaries and throughout the height of a tree at a high resolution. Synchrotron X-ray fluorescence imaging (SXRF) presents a unique opportunity to document how elements are distributed throughout a tree. SXRF is a non-destructive method capable of detecting a wide range of elements in low concentrations. In this study, six native boreal forest tree species were sampled and then scanned at the Canadian Light Source synchrotron. The SXRF images show the 2-dimensional relative elemental concentrations of naturally occurring elements in cross-sectional tree discs increasing in height along the tree stems. Results indicate that how and where samples are collected on a tree influences the elements present and that elemental distribution is not uniform within individual growth rings, between growth rings, or along the height of the stem. Internal physiological growth disrupts uniformity within the ring structures in a 3-dimensional pattern. These results show that the sampling protocol for dendrochemistry should be much more complex than previously considered and questions the ability to obtain meaningful insights into elemental changes in the environment over time from tree-rings.

Session: 3021 biogEosCiences peRspectives - Part 2
biogéosciences peRspectives - Partie 2 **26/05/2025 16:45**

ID: 12507 Contributed abstract

Seeing the Whole Picture: Improving Boreal Metal Mine Tailings Characterization With Synchrotron Speciation and Imaging

Levi Lundell [1] , *Katherine Stewart* [2] , *Derek Peak* [3]

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Presented by / Présenté par: *Levi Lundell*
Contact: levi.lundell@usask.ca

Tailings are widespread across the boreal forest at active and legacy metal mine sites. Tailings present a long-term risk if improperly managed because they often contain high concentrations of potentially toxic metal(loid)s that can become mobilized to the broader environment. Restoration and management of legacy and modern tailings impoundments can be improved by detailed chemical characterization of the tailings. While typical characterization methods rely on elemental quantification, elemental speciation yields information about chemical reactivity, mobility, and bioavailability which is especially useful for predicting elemental fate under future management scenarios. Sampling was conducted over two years across a gold mine tailings cell in northern Ontario with the aim of assessing spatial heterogeneity of environmentally toxic elements. Elemental quantification was performed on samples from multiple locations and along environmental gradients (i.e. proximity to water features). Metals were found to be heterogeneously distributed across the tailings cell, but no differences were found at various depths. The two elements of greatest environmental concern in the tailings were copper and chromium, and these elements' speciation was further studied through synchrotron X-ray absorption spectroscopy and X-ray fluorescence imaging. Chromium

was primarily observed in inorganic phases associated with iron. However, copper was present in multiple diverse species – primarily as chalcopyrite and adsorbed copper. Despite the low abundance of organic matter in the tailings (total carbon < 0.4%), up to 55% of all copper was associated with organic compounds. Results indicate significant spatial heterogeneity in both total concentrations and speciation of environmentally important metals in this tailings cell. These findings highlight the utility of chemical speciation in tailings management planning by providing novel insights into the bioavailability, mobility, and reactivity of key elements of environmental concern in tailings.

Day 2 – 27 May 2025

Dr. Catherine Robin
Canadian Geodetic Survey, Natural Resources Canada

BIO

Catherine Robin has been at the Canadian Geodetic Survey (CGS) since 2011, and is currently section chief (Geodetic Analysis and Development). She leads the implementation of the Canadian Spatial Reference System (CSRS) modernization project at CGS, and chairs the Unified Reference Frames Task Team of the Canadian Geodetic Reference System Committee (CGRSC).

Session: 1002 Plenary - Modernization of Heights Above Sea Level and other spatial references: Implications for geospatial and hydrospatial data Plénière - Modernisation des hauteurs au-dessus du niveau de la mer et d'autres références spatiales : Implications pour les données géospatiales et hydrospatiales	**27/05/2025 09:00**

ID: 12580 Invited plenary speaker

Modernization of Heights Above Sea Level and other spatial references: Implications for geospatial and hydrospatial data

Catherine Robin [1]

[1] **Canadian Geodetic Survey (CGS)**

Presented by / Présenté par: ***Catherine Robin***
Contact: catherine.robin@nrcan-rncan.gc.ca

NRCan's Canadian Geodetic Survey (CGS) is the federal agency responsible for providing the fundamental values defining latitude, longitude, height and gravity in Canada. In 2026, CGS plans to adopt new national spatial reference systems in parallel with the US. This includes a significant update to the Canadian Vertical Datum of 2013 (CGVD2013) realized by a new gravity equipotential surface (the geoid) approximating mean sea level around the North America; and a new geometric reference system replacing the North American Datum of 1983 (NAD83). Both new systems have been developed binationally as a collaboration between CGS and the US's National Geodetic Survey (NOAA).

Modernizations of this magnitude occur roughly every 50-100 years. In Canada, these transitions are coordinated with provincial governments, who are currently working toward the adoption of the new systems by 2030. If successful, this will mark the first time since the pre-GPS era that national spatial reference systems are uniformly adopted across all federal and provincial jurisdictions. It will also be the first time since then that Canada and the US share the same definition of heights above mean sea level.

This presentation will outline plans for federal modernization in 2026, with a focus on the update of CGVD2013, including the new geoid model's development and validation, as well as expected differences from the current version. The session will also explore the implications - both opportunities and challenges - for geospatial and hydrospatial professionals. Through this lecture, CGS aims to engage the broader geoscience and oceanographic communities to better understand their needs and interests regarding Canada's new spatial reference systems.

Session: 6020 Permafrost Hydrology and Hydrogeology Interactions Interactions entre l'hydrologie et l'hydrogéologie du pergélisol

Convenors:

Elise Devoie (Queen's University); Jeff McKenzie (McGill University); Mohamed Elshamy (University of Saskatchewan); Peter Morse (Natural Resoucres Canada); Brendan Mulligan (Yukon Government); Christopher Spence (Environment and Climate Change Canada); Stephanie Wright (Queen's University)

As climate changes continue to affect permafrost regions through changing meteorology and permafrost thaw, knowledge of permafrost hydrology and hydrogeology interactions is rising in importance as it is increasingly required to address Northern Canadian needs and issues. A relatively nascent, but growing field of research, a major gap is that no comprehensive view exists of the relationships between permafrost and hydrogeology across Canada's permafrost landscapes. Consequently, it is difficult to extrapolate documented responses of these systems to climate change and other stressors. In order to stimulate research concerning permafrost and hydrogeological interactions in Canada, the CGU Hydrology Section's Committee on Permafrost – Hydrogeology Interactions is inviting papers that summarize research of 1) permafrost hydrological and hydrogeological processes and how these processes manifest in different permafrost landscapes; 2) how hydrology and hydrogeology regimes across different permafrost regimes respond to climate change and other stressors; 3) how this may impact water quality and contaminant transport; 4) innovative approaches to model permafrost – hydrogeological interactions; and 5) the application of research to address issues caused by changing northern permafrost.

Session: 6020 Permafrost Hydrology and Hydrogeology Interactions
Interactions entre l'hydrologie et l'hydrogéologie du pergélisol **27/05/2025 10:30**

ID: 12215 Contributed abstract

Hydrological modeling of permafrost thaw in discontinuous permafrost

Abigail R. Baran [1] , *Élise Devoie* [2] , *Ryan F. Connon* [3] , *Stephanie N. Wright* [4]

[1] Queen's University
[2] Queen's University
[3] Department of Environment and Climate Change, Government of the Northwest Territories
[4] Queen's University

Presented by / Présenté par: *Abigail R. Baran*
Contact: abigail.baran@queensu.ca

Northern river systems undergo changes through various mechanisms, which can be represented and simulated using hydrological models. However, unique processes in cold permafrost regions, particularly structural changes such as permafrost thaw, present challenges for these models. This study aims to represent a discontinuous permafrost watershed and climate change-driven structural changes using a flexible hydrological model.

The La Martre River watershed, located in central Northwest Territories (NWT), was selected due to its significant annual and winter streamflow increases, driven by increasing precipitation, permafrost thaw and wildfire. The watershed drains 14,000 km² into Great Slave Lake, including nearly 1,000 km² burned by a 2014 wildfire. Field data from both burnt and unburnt regions were used to parameterize the model.

Raven, a flexible hydrological modeling framework, was chosen to model the system and the key driving factors of streamflow increases. Although precipitation data in the NWT are limited, ERA5 Land reanalysis data align with observed trends in Yellowknife, the nearest weather station, showing increased precipitation and shifts in timing and snow fraction. Permafrost thaw alters hydrologic connectivity. In the model, soil profiles of peat plateaus, bogs, and coniferous forests contain permafrost, with or without laterally continuous taliks. Permafrost thaw is modeled by increasing the percentage of talik-bearing hydrologic response units (HRUs) across these land covers. Thaw progression is also represented by changes in the proportion of peat plateau, bog, and fen HRUs. Wildfires are modeled by increasing talik depth, organic layer thickness, and altered vegetation parameters.

The next steps of this project will involve simulating the model with different combinations of these driving factors to assess their relative importance and cumulative

impact on streamflow. This approach will provide insights into future landscape changes and their implications for water availability in discontinuous permafrost watersheds.

Session: 6020 Permafrost Hydrology and Hydrogeology Interactions
Interactions entre l'hydrologie et l'hydrogéologie du pergélisol **27/05/2025 10:45**

ID: 12483 Contributed abstract

Application of the SHAW Model to Quantify Groundwater Recharge in an Andean Basin with Permafrost

Claudia Prehn [1] , *Jeffrey McKenzie* [2] , *Andres Meglioli* [3] , *Lauren Somers* [4]

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[2] McGill university
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Presented by / Présenté par: *Claudia Prehn*
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Mountain regions serve as critical water sources, sustaining ecosystems and human populations far beyond their geographical boundaries. However, climate variability and increasing anthropogenic pressures threaten the resilience of these systems, particularly through changes in groundwater recharge dynamics. In high-altitude basins where permafrost is present, freeze-thaw processes significantly influence hydrological fluxes by modulating infiltration, runoff, and subsurface water storage. Despite their importance, groundwater recharge processes in these environments remain poorly quantified, limiting the ability to develop adaptive water management strategies.
This study investigates groundwater recharge processes in the De Los Mogotes River basin in the Argentinian Andes (4,218–5,664 m asl). The research addresses the question: How does permafrost influence groundwater recharge in high-altitude Andean basins? Given the region's limited hydrogeological data, a physically-based modelling approach is applied to estimate recharge rates and their variability over space and time. The research uses the Simultaneous Heat and Water (SHAW) model that simulates water fluxes, heat transport, and soil-atmosphere interactions. The methodology incorporates digital elevation models, well reports, and meteorological observations, along with model parameterization and calibration using soil temperature data. The model explicitly simulates active layer development, seasonal infiltration restrictions, and thaw-driven groundwater recharge to account for freeze-thaw dynamics.
Thermistor observations indicate permafrost is present at considerable depths (>40 m) at higher elevations (>5100 m asl) and that the active layer is approximately 0.5 m thick. Initial data analysis and simulations highlight the dominance of snowmelt events in driving infiltration. Further refinements, including sensitivity analyses, enhance the model's predictive capacity and inform resilience-focused water management strategies. By improving groundwater recharge estimations in high-altitude basins, this study contributes to building resilient water futures for Andean communities and ecosystems.

Session: 6020 Permafrost Hydrology and Hydrogeology Interactions **27/05/2025**
Interactions entre l'hydrologie et l'hydrogéologie du pergélisol **11:00**

ID: 12180 Contributed abstract

Seasonal variability of ocean-aquifer connectivity in healthy and degraded permafrost coastal sites

H. Bay Berry [1] , *Barret Kurylyk* [2] , *Cansu Demir* [3] , *M. Bayani Cardenas* [4] , *Julia Guimond* [5]

[1] Dalhousie University
[2] Dalhousie University
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Presented by / Présenté par: *Barret Kurylyk*
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Roughly a third of the Earth's coastlines are underlain by permafrost, which can be more than one kilometre thick in the high Arctic. In these regions, shallow groundwater is only available in the supra-permafrost aquifer in the summer while the active layer is thawed. These shallow aquifers provide a conduit for seaward transport of nutrients and organic matter originating from thawing permafrost and landward saltwater intrusion. High solute concentrations due to subsurface saltwater intrusion or other processes such as burial of marine sediments can depress the ground freezing temperature and accelerate active layer progression. The thickness of unconfined supra-permafrost aquifers is defined by the difference between the water table elevation and thaw depth elevation. Ocean water level signals can be transmitted through coastal aquifers, with the propagation efficiency controlled by hydraulic diffusivity, the ratio of aquifer transmissivity to storativity. Diffusivity can be seasonally impacted by changes to the saturated thickness, hydraulic conductivity, and specific yield of flow zones exposed by active layer thickening and thawing pore ice. We use time and frequency domain techniques to investigate seasonal changes in high-latitude aquifer diffusivity and relationships between groundwater time series and meteorological data from the coast of Simpson Lagoon, Alaska. A multi-well approach to classic solutions for tidal signal propagation in groundwater showed a relatively constant inferred aquifer diffusivity throughout the summer, which is largely attributed to the water table drop in parallel with active layer thickening. However, locations that were contrasted by salinization, hydrogeology, and thermal properties, in turn showed disparate signal transfer efficiency and relationships with meteorological conditions. Under increasing water and ground temperatures and longer sea-ice free seasons, greater active layer development and permafrost degradation are expected, which could be exacerbated by increased saltwater intrusion associated with sea-level rise and intensifying storms. The resultant increase in aquifer-ocean interactions along northern coastlines could result in more biogeochemically active 'subterranean estuaries' that are common at lower latitudes.

Session: 6020 Permafrost Hydrology and Hydrogeology Interactions
Interactions entre l'hydrologie et l'hydrogéologie du pergélisol **27/05/2025 11:15**

ID: 12537 Contributed abstract

Stable water isotopes and major ions reveal temporal and spatial heterogeneity of flow pathways across seven subarctic watersheds

Amanda Harrison [1] , *Arsh Grewal* [2] , *Sean K. Carey* [3]

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Presented by / Présenté par: *Amanda Harrison*
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Permafrost environments are sensitive to climate change as ground thermal status controls runoff pathways and mediates stream chemistry. In addition, precipitation phase, timing and magnitude affect streamflow response, yet are changing rapidly as conditions warm. Where permafrost exists, seasonal thaw controls vertical and lateral connectivity of the catchment to the stream, yet there is considerable variability across watersheds based on permafrost status, geology, and other biophysical factors. To better understand runoff processes in headwater catchments and their potential response to climate change, this study integrates six years of isotopic and hydrochemical data collected from seven catchments in the Tombstone Waters Observatory in Yukon Territory. The objective of this work is to assess how catchment characteristics, seasonality and inter-annual variability affect coupled runoff and stream chemistry response. Data collected includes grab samples several times per month at each stream during the open water season combined with high frequency salinity and flow data and concomitant climate information. Results show strong seasonal patterns in isotopic and chemical composition. Concentration-discharge relationships show widespread dilution of weathering ions, with major ion concentrations increasing throughout the season as the active layer thickens, facilitating deeper subsurface flow. Isotopic composition of stream samples became more enriched as the season progressed. While all sites exhibit similar seasonal trends, variability in isotopic and chemical composition differs among catchments. Sites with lower permafrost extent had reduced isotopic variability, particularly in summer and fall, and more constrained ion concentrations compared to sites with greater permafrost coverage. The tighter clustering of isotope values and narrower distribution of major ions suggest greater storage, as reduced permafrost extent promotes increased subsurface mixing and longer transit times. In contrast, more variable ion and isotope signatures indicate stronger seasonal controls driven by limited subsurface storage and shorter transit times.

Session: 6020 Permafrost Hydrology and Hydrogeology Interactions
Interactions entre l'hydrologie et l'hydrogéologie du pergélisol **27/05/2025 11:30**

ID: 12490 Contributed abstract

Sudden and emergent changes in in water quality from permafrost underlain catchments in the Tombstone Waters Observatory, Yukon

Sean Carey [1] , *Elliott Skierszkan* [2] , *Andras Szeitz* [3] , *Arsh Grewal* [4] , *Calvin Newbery* [5] , *Amanda Harrison* [6] , *Erin Nicholls* [7] , *Matthew Lindsay* [8]

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Presented by / Présenté par: *Sean Carey*
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Resource and logistical constraints have led to a consolidation and decline of circumpolar observations over the last several decades despite rapid environmental change. To address concerns related to northern water security, the Tombstone Waters Observatory was established in 2018 in partnership with the Tr’ondëk Hwëch’in First Nation and other Yukon stakeholders. Multiple headwater streams along the Dempster Highway between Km 44 and Km 185 that cover representative ecozones and variable geology and permafrost cover have been established since 2018 with comprehensive hydrometeorological and water chemistry data. In 2024, field observations at one of our sites revealed a 1900 m2 area of tundra vegetation that had been killed by emergent acid seepages and coated the stream with ocherous precipitates. Satellite imagery shows an average increase of 200 m2 yr-1 in acid burn area. This seepage, with a pH<4, sulfate ~4.7 g/L and metal concentrations reaching tens to hundreds of mg/L has notably impacted water quality since 2023; decreasing stream clarity, lowering pH, increasing specific conductance and inter-annual concentrations and fluxes of dissolved sulfate and metals. The same year, Yukon Parks received reports from hikers of 'rusty' streams and lakes in popular routes that had previously pristine water. Our water chemistry records reveal subtle increases in sulfate and metal concentrations and fluxes and declines in pH in several catchments, with metal concentrations routinely exceeding federal guidelines for the protection of aquatic life and drinking water quality. Here we presented integrated hydrological, water quality and d18O/d2H data to highlight the links between surface-groundwater interactions, inter-annual climate variability and complex coupled geochemical and hydrological processes. While results suggest sulfide-mineral oxidation in an expanding active layer is degrading water quality, ongoing efforts are aimed to understand the spatial and temporal extent of these changes, specific mechanisms, and long-term implications for water quality and ecosystem health.

Convenor: Julie Thériault

Related to scientific studies and/or information sharing about the atmosphere, including weather, meteorology, clouds and precipitation, air quality, atmospheric dynamic and extreme events, using various approaches.

This session covers many topics, including, but not limited to, theoretical research, model development, observation techniques, real-time monitoring, databases, diagnostic methods, data analysis and artificial intelligence.

Session: 2031 Atmosphere - Theoretical to applied science - Part 2
Atmosphère - De la théorie à la science appliquée - Partie 2 **27/05/2025 10:30**

ID: 12290 Contributed abstract

Virtual

Blocking identification using kinematic methods and point vortex theory

Lisa Schielicke [1]

[1] The University of Western Ontario

Presented by / Présenté par: *Lisa Schielicke*
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Atmospheric blocking is a synoptic-scale, quasi-stationary phenomenon that disrupts the typical westerly flow in the midlatitudes, often persisting for several days to weeks. These large-scale structures, typically composed of a high-pressure systems poleward of one or two low-pressure counterparts, are associated with extreme weather events such as heatwaves and heavy precipitation. Two primary blocking configurations, high-over-low (Rex block) and Omega block, differ in their vortex arrangement, yet both exhibit complex dynamical evolution within a single blocking period. While numerous methods exist for detecting blocking events, an automated and publicly available approach to classify them into high-over-low or Omega types remains absent.

This study presents a novel Python-based methodology for identifying and classifying blocking patterns using kinematic principles and point vortex theory. The approach models the synoptic-scale vortices with characteristic length scale of 1000 km as a point vortex ensemble, allowing for an efficient and dynamically consistent representation of blocking structures. The algorithm provides key diagnostics, including the temporal evolution, spatial characteristics, vortex circulation, and blocking type. Additionally, this method facilitates the identification of regions prone to high-impact weather associated with blocking. By advancing the classification of blocking configurations, this work contributes to improved understanding and prediction of their role in extreme weather events.

Session: 2031 Atmosphere - Theoretical to applied science - Part 2
Atmosphère - De la théorie à la science appliquée - Partie 2 **27/05/2025 10:45**

ID: 12388 Contributed abstract

Comparison the GEM model and ERA5 reanalysis data with observations in severe thunderstorm inflow regions in western Canada

Daniel Brown [1] , *John Hanesiak* [2] , *David Walker* [3] , *Clinton Macadam* [4] , *Eric Ayitah* [5] , *Joanne Kunkel* [6]

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[2] University of Manitoba
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Presented by / Présenté par: *Daniel Brown*
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Improving the accuracy of severe thunderstorm and tornado forecasts and warnings is important because severe weather events can be dangerous to people and damaging to property. The tropospheric wind profile can strongly influence the organization and evolution of severe thunderstorms. The boundary layer wind profile, in the lower part of the troposphere influenced by ground-based friction, is sometimes poorly represented in numerical weather models. Poorly represented boundary layer winds can be a significant source of error in forecasting storm mode, storm motion, and the associated severe hazards. The most dramatic hazard may be the distinction between tornadic and non-tornadic supercells, which depends heavily on the wind profile from the ground to 1km above. Model and reanalysis verification in thunderstorm inflow environments may not get as much attention because the relatively weak winds (often 10-20 knots) in the inflow region may be assessed as low impact. However, their influence on storm mode is high impact if it is the difference between a tornadic and non-tornadic supercell. Several high-impact thunderstorm cases were analyzed to see how often forecast model output and reanalysis data poorly estimate the low-level winds in the inflow of these thunderstorms. The low-level winds are assessed by comparing surface winds and low-level wind profiles from weather radar velocity data with wind data from numerical weather models and reanalysis. In at least three cases, the low-level winds were significantly underestimated by both numerical weather model and reanalysis data, which can drastically affect the severe thunderstorm and tornado indices that depend on them. In some cases, the measured 0-1km helicity was almost double that of the model and reanalysis values. The errors in low-level wind cascade from the kinematic indices through many of the composite indices like the significant tornado parameter.

Session: 2031 Atmosphere - Theoretical to applied science - Part 2
Atmosphère - De la théorie à la science appliquée - Partie 2 **27/05/2025 11:00**

ID: 12338 Contributed abstract

Virtual

The Canadian Severe Storms Laboratory: A New Era in Severe Storms Research

Connell Miller [1] , *David Sills* [2] , *Julian Brimelow* [3] , *Gregory Kopp* [4]

[1] Canadian Severe Storms Laboratory
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Presented by / Présenté par: *Connell Miller*
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The Canadian Severe Storms Laboratory (CSSL) was launched at Western University in October of 2024 with the aim of being the authority for severe thunderstorm data and research in Canada. The CSSL will advance the detection, documentation and understanding of severe convective storms and their impacts across Canada.

CSSL’s mission is driven by three key projects: the Northern Tornadoes Project, the

Northern Hail Project, and the Northern Mesonet Project. The Northern Tornadoes Project aims to improve tornado, downburst and derecho detection and documentation across Canada, utilizing aerial and ground surveys, satellite imagery, and advanced research methods to improve Canadian climatologies.

The Northern Hail Project focuses on understanding hailstorm frequency, intensity, and impacts, leveraging radar observations, storm chasing, and damage assessments to better characterize hail hazards.

The Northern Mesonet Project supports these initiatives by increasing the spatial density of real-time advanced weather observations, enhancing data availability and quality for severe weather analysis and prediction.

CSSL also provides unique training opportunities through its internship programs. These programs aim to cultivate the next generation of severe weather researchers by offering hands-on experience in data collection, storm chasing, and severe storms research.

This presentation will outline the strategic framework and technological advancements that underpin CSSL's operations and research. It will also showcase initial findings from each project and explore future directions.

Session: 2031 Atmosphere - Theoretical to applied science - Part 2
Atmosphère - De la théorie à la science appliquée - Partie 2 **27/05/2025 11:15**

ID: 12184 Contributed abstract

A Canadian Hail Climatology Based on Elevation and the Hail-Thunderstorm Ratio

Scott Kehler [1] , *Matt Desorcy* [2]

[1] Weatherlogics
[2] Weatherlogics

Presented by / Présenté par: *Scott Kehler*
Contact: scott@weatherlogics.com

This paper examines the relationship between elevation and the hail-thunderstorm ratio. Hail data from the Weatherlogics Hail Database (WHD) was used to calculate the average annual hail hours in urban areas. The hail-thunderstorm ratio was then calculated as the quotient of average annual hail hours and average annual thunderstorm hours. The hail-thunderstorm ratio was calculated for all hail (diameter >= 5 mm) and severe hail (diameter >= 20 mm). The relationship between elevation and the hail-thunderstorm ratio was then examined, with coefficients of determination (r2) of 0.78 and 0.65 found for all hail and severe hail, respectively. Using this relationship, the root-mean-square error between actual hail hours and predicted hail hours was found to be 0.6 and 0.2 hours, for all hail and severe hail, respectively. The relationships were then used to construct national hail climatologies for Canada using gridded elevation data and a thunderstorm hours climatology. A strong correlation of 0.98 was also found between annual hail hours and annual hail days, allowing for a national hail days climatology to be produced. A maximum in all hail hours and hail days was found along the Alberta

foothills, with secondary maxima in the British Columbia interior and southern Prairies.

Session: 2031 Atmosphere - Theoretical to applied science - Part 2
Atmosphère - De la théorie à la science appliquée - Partie 2 **27/05/2025 11:30**

ID: 12289 Contributed abstract

Virtual

Exploring cloud dynamics with Cloud Model 1 – insights from a university modeling workshop

Lisa Schielicke [1] , *Yidan Li* [2] , *Jerome Schyns* [3] , *Sperschneider Aaron* [4] , *Jose Pablo Solano Marchini* [5] , *Christoph Peter Gatzen* [6]

[1] The University of Western Ontario
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Presented by / Présenté par: *Lisa Schielicke*
Contact: lschieli@uwo.ca

We present a two-week educational block course, first conducted at the University of Bonn during the 2023 winter semester, that introduced students to Cloud Model 1 (CM1) and its convection-resolving capabilities. The course provides training in configuring and running CM1 simulations on a high-performance computing cluster, offering participants practical experience in numerical modeling of moist convection. Additionally, an introduction to three-dimensional visualization software enabled the transformation of simulation data into graphical representations, facilitating the interpretation of cloud dynamics. Pre- and post-course surveys indicate its effectiveness in enhancing participants' understanding of the subject matter and showing their steep learning curve. While the first part of the course covers the essentials, participants applied the acquired knowledge to independent research projects in the second part. Building on this experience, the course is now being adapted to develop learning materials at Western University and will be used to study severe convective events in Canada together with students.

Session: 5021 Climate Variability and Predictability - Part 2 Variabilité et prévisibilité du climat - Partie 2

Convenors:

Hai Lin, Environment and Climate Change Canada
Bin Yu, Environment and Climate Change Canada

This session invites contributions that deal with climate variability and predictions on subseasonal, seasonal, interannual and decadal-interdecadal time scales. Contributions are solicited on topics including studies of the Madden-Julian Oscillation (MJO) and tropical waves, El Nino/Southern Oscillation (ENSO), atmospheric circulation patterns, tropical-extratropical-polar interactions and teleconnections, and impacts of these processes on predictability and predictions. Equally welcome are contributions on extended- and long-range weather forecasts, and predictions of climate variability on various time scales, including ensemble and initialization techniques, model development, forecast skill assessment, downscaling and calibration, and end-user value and applications. Results from diagnostic, modelling, model inter-comparison, and theoretical approaches are all welcome.

Session: 5021 Climate Variability and Predictability - Part 2
Variabilité et prévisibilité du climat - Partie 2 **27/05/2025 10:30**

ID: 12477 Contributed abstract

Leveraging the CanESM5-LE to produce robust estimates of GEV return-periods for extremely rare heat events

Matthew Pereira Wilson [1] , *Adam Monahan* [2] , *Nathan Gillett* [3]

[1] University of Victoria
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[3] CCCma

Presented by / Présenté par: *Matthew Pereira Wilson*
Contact: mhpereir@gmail.com

The accumulation of anthropogenic emissions of greenhouse gases has led to a measurable increase in the average global temperature and a higher incidence of extreme weather events. Among them, heatwaves pose significant dangers to human societies and the ecosystems they depend on, and are increasing in severity. Such events have spurred interest in quantifying the impact of anthropogenic climate change on the frequency of extreme events, and propelled significant research efforts into estimating the expected return-period of extremely rare events, such as the Pacific Northwest heatwave of July 2021. However, the limited historical record of atmospheric data seriously restricts our present-day ability to estimate return periods for 1:>100-year events, and thus the impact of anthropogenic climate change on their frequency.

Our work focuses on the Generalized Extreme Value (GEV) distribution of extreme heat events occurring in the Pacific Northwest (PNW) region of North America. We are working with the CanESM5-Large Ensemble, which allows us to leverage nearly 30,000 years of historical + multiple SSP scenarios for a robust analysis of high return-period events. We examine the GEV distribution parameters, including the role of block-length, and the non-stationary nature of the location and scale parameters with co-variates such as the Global Mean Surface Temperature. We will also examine the frequency of extreme heat events like the PNW 2021 event in historical and present-day climate in a bias-corrected version of the CanESM5 dataset (CanDCS).

Session: 5021 Climate Variability and Predictability - Part 2
Variabilité et prévisibilité du climat - Partie 2 **27/05/2025 10:45**

ID: 12415 Contributed abstract

The Climate/CO2 Debate: Should Worldwide (CO2) emissions be reduced or allowed to increase

Ray Garnett [1] , *Madhav Khandekar* [2]

[1] Agro-Climatic Consulting
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Presented by / Présenté par: *Ray Garnett*
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The current debate on climate change emphasizes need to curb CO2 emissions so as to reduce possible harmful impacts of weather extremes in particular. However, very little has been discussed concerning the benefits of higher CO2 levels on grain yields and enrichment of world forestry

"This talk will highlight benefits of more CO2 on agriculture and forestry by providing selected examples from various regions in Canada and elsewhere. In particular, it will be shown that worldwide grain yields have increased threefold or more in last 25 years. Canada's grain yields have increased twice or more and has withstood deleterious impacts of few severe droughts like last three years. Elsewhere world grain yields have increased substantially as documented by the UN Agency FAO (Food & Agriculture Org)."

"The enrichment of world forestry is another significant benefit of higher levels of CO2 in the environment. These beneficial impacts of higher levels outweigh any possible harmful impacts of higher levels of CO2: this will be shown by specific examples from various regions including Canada "

Session: 5021 Climate Variability and Predictability - Part 2
Variabilité et prévisibilité du climat - Partie 2 **27/05/2025 11:00**

ID: 12263 Contributed abstract

A Full-Column View of the Radiative Adjustment of Stratospheric Water Vapor

Ruogu He [1] , *Yi Huang* [2]

[1] McGill University
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Presented by / Présenté par: *Ruogu He*
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Stratospheric water vapor (SWV) was considered a potentially important contributor to global warming, with an effect comparable to or even greater than cloud and surface albedo. However, recent studies challenged the significance of SWV by identifying a compensation between the tropospheric and stratospheric adjustments, which limits the overall effects of SWV on the top-of-atmosphere radiation budget and thus global warming. What remains unclear is the robustness of this compensation as well as its underlying physical mechanisms. To address these questions, we quantify the SWV radiative feedback by accounting for the radiatively driven full-column atmospheric temperature adjustment in 12 CMIP6 global climate models. Our results show that stratospheric cooling leads to an SWV feedback of 0.25±0.06 Wm^(-2) K^(-1), which is substantially reduced to 0.020±0.007 Wm^(-2) K^(-1) due to tropospheric warming. This suggests that the radiation process is an intrinsic and robust mechanism that mitigates the impact of SWV on surface warming. Our findings highlight the need for further investigation into atmospheric adjustment processes to improve the accuracy of climate change projections.

Session: 5021 Climate Variability and Predictability - Part 2
Variabilité et prévisibilité du climat - Partie 2 **27/05/2025 11:15**

ID: 12326 Contributed abstract

Quantifying the future evolution of internal climate variability for northern Quebec and Labrador

Léandre Houde-Labrecque [1] , *Martin Leduc* [2] , *Alejandro Di Luca* [3] , *Robert G. Way* [4] , *Émilie Bresson* [5]

[1] Centre ESCER, Université du Québec à Montréal
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[5] Ouranos

Presented by / Présenté par: *Alejandro Di Luca*
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This study investigates projected changes in the interannual variability of near-surface temperature and snow water equivalent in northern Quebec and Labrador using the ClimEx ensemble, a dynamically downscaled CanESM2-based 50-member single model initial conditions large ensemble. We compare near-surface air temperature and snow water equivalent between 2000-2019 and 2080-2099 to understand the impacts of climate change on their interannual variability. Our results suggest a future overall decrease in near-surface temperature variability (-30% to -90%) over both land and sea, which appears to be partly associated with the weakening of the pole-to-equator near-surface temperature gradient. The largest decrease occurs over oceans in winter, suggesting that sea ice loss plays a compounding role. Over land, near-surface

temperature variability increases in April (up to +30%) and in May (up to +90%), a process linked with the northward shift of the spring snow line and the resulting changes in snow-albedo feedback during the spring. Snow water equivalent variability also exhibits significant future changes, with a slight decrease in winter (up to -30 kg m-2) likely caused by the increase of mean near-surface temperature, and a mixed pattern of increase/decrease in spring (from -40 kg m-2 to +40 kg m-2 in March to -90 kg m-2 to +80 kg m-2 in May) likely caused by the northward migration of the spring snow line expected in a future warmer climate. These findings underscore the complex interplay between climate drivers and their influence on near-surface temperature and snow variability in northern Quebec and Labrador, highlighting the importance of understanding climate variability for future climate projections and adaptation strategies.

Session: 5021 Climate Variability and Predictability - Part 2
Variabilité et prévisibilité du climat - Partie 2 **27/05/2025 11:30**

ID: 12268 Contributed abstract

The Impact of Springtime Taklamakan Dust Aerosols on the Coordinated Variations of the Northern and Southern Branches of the Tibetan Plateau Jet Stream

Qian Huang [1] , *Tong Guo* [2] , *Xiaofeng Xu* [3] , *Suxiang Yao* [4]

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Presented by / Présenté par: *Qian Huang*
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The Asian subtropical westerly jet splits into northern and southern branches over the Tibetan Plateau, exhibiting pronounced synergistic variability. During spring, frequent dust weather events occur in the Taklimakan Desert, situated between the two jet branches. Dust aerosols significantly influence weather and climate by modifying local thermal conditions, highlighting the importance of investigating their physical mechanisms in driving the synergistic variation of the jet branches. This study employs the ERA5 reanalysis dataset from the European Centre for Medium-Range Weather Forecasts (ECMWF) and NASA’s MERRA-2 reanalysis dataset to analyze the thermal effects of Taklimakan dust aerosols and their synergistic impacts on the jet branches.Results reveal that intensified dust activity over the Taklimakan Desert induces a northward displacement of the northern branch jet, weakens the southern branch intensity, and triggers spatial divergence with a "north-strong, south-weak" pattern. Dust aerosols modulate this synergistic variation through “direct” and “indirect” thermal pathways. The "direct" effect stems from dust radiative forcing, which warms the mid-to-lower troposphere, enhancing (reducing) the meridional temperature gradient north (south) of the desert, thereby driving jet divergence and intensity asymmetry. The "indirect" effect involves jet-induced circulation adjustments: anomalous high pressure over the dust source region and its northern periphery promotes adiabatic subsidence

and mid-to-upper tropospheric warming. Concurrently, southerly anomalies west of the key region transport warm advection, synergizing with diabatic heating to amplify warming both zonally and meridionally. This vertically consistent warming further reinforces jet divergence and the "north-strong, south-weak" configuration.

Session: 5021 Climate Variability and Predictability - Part 2
Variabilité et prévisibilité du climat - Partie 2 **27/05/2025 11:45**

ID: 12316 Contributed abstract

Multi-Hazard Hurricane Projections for Atlantic Canada: Wind, Coastal Flooding, and Storm Duration Under Climate Change

Saeed Saviz Naeini [1] , *Reda Snaiki* [2]

[1] École de technologie supérieure (ÉTS)
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Presented by / Présenté par: *Saeed Saviz Naeini*
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The intensity and frequency of hurricanes are expected to change significantly, with disproportionate impacts across different locations and other factors such as climate change. In this study, both wind and coastal flooding hazards are assessed, along with the role of storm duration in exacerbating damage. A physics-based tropical cyclone downscaling model is employed to generate synthetic storm tracks over the Canadian Atlantic region under both historical conditions and future climate scenarios. To capture the evolving nature of the hazards, two projection periods are investigated - a near-future scenario (2024–2059) and a far-future scenario (2060–2095) - allowing for an examination of unstationarity within the generated data and a comparison with the historical scenario (1979–2014). Multiple Global Climate Models (GCMs) are utilized to derive future scenarios, enabling a comparative analysis of projected hazards and their variabilities. A total of 10,000 years of hurricane activity is generated for each simulation scenario. The synthetic tracks are then coupled with an analytical wind model and a simplified empirical flooding model (Bathtub). Return period maps are generated under both historical and projected climate scenarios, providing a comprehensive view of risk. The effects of storm duration are subsequently investigated by generating joint distributions between duration and both wind intensity and coastal flooding. This approach evaluates how prolonged exposure can compound risks and structural damage. These analyses enhance the understanding of hurricane-induced risks and support the development of adaptive resilience strategies and flood-resistant design codes, ultimately improving the preparedness of communities and infrastructure in a changing climate.

Session: 4060 Canadian Climate Services, Impact Assessment, and Actionable Climate Information - Part 1 Services climatologiques canadiens, évaluation des incidences et informations climatiques exploitables - Partie 1

Convenors:

Michael Morris, ECCC (contact: Michael.Morris@ec.gc.ca)
Eva Gnegy, ECCC (contact: Eva.Gnegy@ec.gc.ca)
Elaine Barrow, ECCC (contact: Elaine.Barrow@ec.gc.ca)

Demand is at an all-time high for reliable and usable climate data, information and guidance in ways that are relevant and usable to potential users. This is driven an increase in the explicit consideration of future climate in many activities such as climate risk disclosures; assessments of climate impacts, vulnerabilities, and risks; adaptation plans; and consideration of future climate in disaster risk reduction. This uptake is occurring simultaneously across a wide range of disciplines such as human health, buildings, agriculture, transportation, forestry, and many others.

Climate services operate at the interface between climate science and this real-world decision making. To ensure the usefulness of climate information and its uptake by stakeholders, there must be communication between climate scientists, climate service providers and practitioners. Collaboration between these parties is necessary for building resilience through informed climate change adaptation.

Although coverage, availability and accessibility of climate data have greatly improved, barriers associated with developing and tailoring information remain. The goal of this session is to encourage those in the climate field to share their experiences in creating robust, tailored climate information, data products, and guidance, for delivery to practitioners, researchers, and local communities. We also welcome users of climate information and climate data to share their experiences and findings, highlight how climate service providers have met or not met their needs, and identify ways in which climate services offerings could be expanded to improve their ability to build resilience to a changing climate.

Relevant topics for this session could include:

- Climate information development

- User needs engagement and analysis

- Deployment of platforms providing climate information

- Co-production of datasets and tools with practitioners and climate scientists

- Translation of technical climate information into a usable format

- Examples of successful application of climate information, particularly for climate change adaptation

ID: 12232 Contributed abstract

Bridging Canadian climate indices to hazards for use in adaptation planning

Teah Lizee [1] , *Elaine Barrow* [2]

[1] Canadian Centre for Climate Services

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Presented by / Présenté par: *Elaine Barrow*

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In Canada, the use of climate data in decision-making is progressing from recommendation to requirement. As a result, there is an influx of new users of climate projections. Incorporating future climate data presents a challenge and these users can be overwhelmed by too much choice, data, uncertainty, and complexity at the same time as too little guidance. One solution to this problem is to make climate information available in more accessible ways.

User uptake of climate information can be improved by translating and framing climate data using a familiar framework. The current practice is for climate data to be presented by dataset names such as CMIP6 and CanDCS-M6, and then by climate variables such as temperature and precipitation. While this categorization is intuitive to the experts developing these datasets, this type of technical jargon can seem like nonsense to new users.

Climate data can be presented in a manner that resonates more with users and how they experience climate change – through the lens of climate hazards such as extreme heat, floods, and wildfires. This approach is more intuitive because users are already familiar with hazards from contexts such as disaster risk reduction, public safety, and emergency preparedness. The involvement of climate experts in the simplification of climate information can also help prevent errors that would otherwise occur from users attempting to do this on their own. This presentation will explore this framing of climate data, where we can make direct and nuanced connections for users between climate hazards and specific climate proxies to guide them through the overwhelming amount of climate data.

The Canadian Centre for Climate Services (CCCS) aims to make climate science more actionable. This talk will provide an overview of recent approaches at CCCS to make use of a hazards approach in our work.

Session: 4060 Canadian Climate Services, Impact Assessment, and Actionable Climate Information - Part 1 Services climatologiques canadiens, évaluation des incidences et informations climatiques exploitables - Partie 1 **27/05/2025 10:45**

ID: 12433 Contributed abstract

Virtual

Developing User-Informed Web Apps for Accessible and Actionable Climate Data

Eva Gnegy [1] , *Sonya Nakoneczny* [2] , *Jeremy Fyke* [3]

[1] Canadian Centre for Climate Services, Environment and Climate Change Canada

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Presented by / Présenté par: *Eva Gnegy*

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The growing demand for actionable climate data has spurred the development of innovative tools that bridge the gap between climate science and real-world decision-making. One such tool is web applications hosted within climate portals, such as ClimateData.ca, developed to make climate information more accessible, interactive, and user-friendly. We will discuss the development of these apps by showcasing the first tool of this kind on ClimateData.ca: The Fire Weather Projections App. Built using the open-source Python package Panel, these web apps enable researcher and practitioner users to engage with climate data in an interactive format, supported by contextual guidance to facilitate accurate interpretation. Apps enable users to explore a wide range of climate variables and select and compare various regions, time periods, emissions scenarios, and more for tailored analysis. Data can be displayed using various components, such as spatial maps, time series, and tables, offering versatile ways to visualize and interact with complex information. Additionally, users can download relevant graphics and datasets, empowering them to efficiently incorporate the data into their analyses and decision-making processes. The Python framework allows researchers and climate service providers to develop robust tools and dashboards without extensive web design expertise (e.g., JavaScript, HTML, CSS). Further, by leveraging version control platforms, such as GitHub, climate apps can evolve through collaborative, incremental updates and be easily adapted into new tools. We will highlight the flexibility, scalability, and

importance of co-producing an application adapted for diverse user needs in collaboration with practitioners, ensuring that the climate services delivered are relevant, accessible, and actionable.

Session: 4060 Canadian Climate Services, Impact Assessment, and Actionable Climate Information - Part 1 Services climatologiques canadiens, évaluation des incidences et informations climatiques exploitables - Partie 1

27/05/2025 11:00

ID: 12419 Contributed abstract

Global Warming Levels: Supporting the Design of Climate-Resilient Infrastructure

Elaine Barrow [1] , *Trevor Murdock* [2] , *Pouriya Jafarpur* [3]

[1] Canadian Centre for Climate Services

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Presented by / Présenté par: *Elaine Barrow*

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The recent Climate-Resilient Buildings and Core Public Infrastructure report provided an assessment of how climatic design data relevant to users of the National Building Code of Canada and the Canadian Highway Bridge Design Code might change as the climate continues to warm. Both historical climatic design variables and projected future changes in these variables are accessible through PCIC’s Design Value Explorer (DVE). To increase the usability of this information and uptake by stakeholders, Future Building Design Value Summaries were developed and disseminated using ClimateData.ca.

These one-page, location-specific summaries provide historical and future projected values of design variables in the same format as Table C-2 of the building code, supplemented with relevant guidance and supporting information. A fundamental difference between these summaries and projections for other climate variables available on ClimateData.ca is that they are provided by levels of global warming (GWLs) and not by emissions scenarios. To support their adoption, a number of guidance materials were developed, including articles on levels of global warming and best practices for choosing and using future climatic design data.

Although GWLs are independent of emissions scenarios, the user is required to select appropriate GWLs which is not necessarily straightforward. While this choice can be aligned with climate policy (e.g., the 1.5°C target of the Paris Agreement), different GWLs may be relevant to infrastructure with differing design service lives. This presentation explores how simple climate models (e.g., FaIR) can be used to inform GWL selection in a robust manner. Additionally, it will provide an overview of the Future Building Design Value Summaries available on ClimateData.ca, and how future climate data is expected to be integrated into the building codes and design standards.

Session: 4060 Canadian Climate Services, Impact Assessment, and Actionable Climate Information - Part 1 Services climatologiques canadiens, évaluation des incidences et informations climatiques exploitables - Partie 1 **27/05/2025 11:15**

ID: 12429 Contributed abstract
Virtual

CMIP6 Marine Variables Assessment for Ocean Regions Around Canada

Housseyni Sankaré [1] , *Dhouha Ouali* [2] , *Hayley Dosser* [3]

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Presented by / Présenté par: *Hayley Dosser*
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Climate change significantly impacts ocean ecosystems, influencing both the physical environment and biogeochemical cycles. These changes necessitate adaptation strategies for coastal communities and marine ecosystems. One of the key consequences of climate change is the alteration of critical marine variables, including sea surface temperature (SST), sea ice concentration, and sea ice thickness. Accurately estimating future values of these variables is essential for developing effective mitigation and adaptation strategies within a sustainable development framework.

In this presentation, we will share the results of an evaluation of CMIP6 model data for these key marine variables. Sea ice concentration was compared against HadISST and OSTIA observational datasets, while sea ice thickness was evaluated using PIOMAS and C3S data. Additionally, we assessed the performance of SST bias-corrected data using the Quantile Delta Mapping (QDM) method, applied to the outputs of 28 CMIP6 global climate models (GCMs). SST data were evaluated against OSTIA

observations at a resolution of 0.05°.

Our findings reveal systematic biases in the sea ice variables and demonstrate that the QDM method effectively reduces SST biases by up to 50% in certain Canadian ocean regions. This improved dataset enhances the reliability of future SST projections, providing a more robust foundation for climate impact assessments. By reducing uncertainties in climate projections, these refined datasets support better decision-making for policymakers, researchers, and coastal communities adapting to climate change.

Ultimately, our work highlights the importance of continuous model evaluation and bias correction in producing high-quality climate data. These efforts are crucial for understanding oceanic responses to climate change and ensuring informed adaptation strategies for Canadian marine and coastal environments.

Session: 4060 Canadian Climate Services, Impact Assessment, and Actionable Climate Information - Part 1 Services climatologiques canadiens, évaluation des incidences et informations climatiques exploitables - Partie 1 **27/05/2025 11:30**

ID: 12427 Contributed abstract

Virtual

Marine heatwave forecasts - at the intersection of climate science and climate services

Hayley Dosser [1] , *Elise Olson* [2] , *Bill Merryfield* [3] , *Jacinthe Racine* [4]

[1] Environment and Climate Change Canada
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Presented by / Présenté par: *Hayley Dosser*
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As climate change progresses, marine heatwaves (MHWs) are increasing in frequency and intensity, threatening marine ecosystems, coastal communities, fisheries and aquaculture. Accurate representation of MHWs is a challenge for both climate science and climate services, requiring models to successfully capture not just the mean state of ocean temperature but also the tails of the distribution and requiring public-facing data products that clearly communicate complex information around forecast interpretation and model skill. Though forecasts of MHWs are a

relatively new development, advance warning of these extreme events is at the forefront of user needs.

Monthly forecasts for MHW occurrence based on Canadian Seasonal to Interannual Prediction System version 3 (CanSIPSv3) sea surface temperature predictions are now in development at Environment and Climate Change Canada (ECCC). Over large areas of the global ocean and for a range of lead times, CanSIPSv3 outperforms the full North American Multimodel Ensemble (NMME), including for MHWs in the Northeast Pacific off Canada's west coast due to skillful representation of ENSO events.

These forecasts have the potential to meet user needs, however important considerations remain, including prioritizing space and time scales that provide both predictive capability and information relevant to decision makers. Options being explored include daily forecasts, which show a comparable level of skill to monthly forecasts in many regions, and pairing forecasts with MHW monitoring using satellite and buoy data to provide more detailed information in coastal waters. Collaboration within ECCC, with Fisheries and Oceans Canada (DFO) and regional partners, and with coastal communities is key to developing tailored MHW products that meet user needs.

Session: 4060 Canadian Climate Services, Impact Assessment, and Actionable Climate Information - Part 1 Services climatologiques canadiens, évaluation des incidences et informations climatiques exploitables - Partie 1	**27/05/2025 11:45**

ID: 12509 Contributed abstract

Climate Prediction as a Force Multiplier: A User Needs Analysis for the Canadian Armed Forces

Joseph Martin [1]

[1] Royal Canadian Navy

Presented by / Présenté par: *Joseph Martin*
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The mandate of the Canadian Armed Forces (CAF) is the defence of Canadian interests at home and abroad. Climate change has increased the effects of climate on military operations and altered the threat environment as it pertains to Canadian interests. This assessment will consider the broad range of operations the CAF is currently engaged in and the climate prediction gaps they face. Operation LENTUS is the CAF response to natural disasters inside Canada. Multiple activations occur every year in

response to fires, floods, hurricanes, and snowstorms. While Operation LENTUS is front-of-mind when most Canadians think of climate change and the CAF, the weather and climate intelligence which supports it is largely inorganic and relies on the federal and provincial emergency management programs supported by the CAF during these contingency operations. As exercising our Northern sovereignty is an increasing priority for Canada, understanding the battlespace in our own territory continues to be a CAF priority. While nations are increasing the icebreaking capabilities of their naval vessels and climate change is reducing Arctic sea ice, no country possesses sufficient arctic climate prediction capability to plan and execute a campaign-level military operation in the Arctic Ocean. Finally, the original impetus for the field of “military oceanography” is the effect of sea water characteristics on the effectiveness of the active and passive acoustics sensors used to prosecute underwater warfare. As the underwater battlespace continues to be of major operational and strategic importance both abroad (Operations HORIZON and REASSURANCE) and at home (Operation SCYLLA), adapting CAF doctrine and tactics to today’s ocean sensing and prediction capabilities will be key to establishing superiority in this domain. The substantial effect of climate on the weather and terrain of the CAF’s battlespaces makes filling the current gaps in military climate prediction a potentially significant force multiplier.

Session: 6010 Observation and modelling of snow and glacier processes - Part 1 Observation et modélisation des processus liés à la neige et aux glaciers - Partie 1

Convenors:

Christopher Marsh 1 , Phillip Harder 2 , Vincent Vionnet 3 , Caroline Aubry-Wake 4 , Libo Wang 1
1 Climate Research Division, Environment and Climate Change Canada, Canada
2 Croptimistic Technology Inc, Canada
3 Meteorological Research Division, Environment and Climate Change Canada, Canada
4 University of Lethbridge, Canada

Unprecedented anthropogenic climate and land use change are dramatically impacting the cold region processes that shape seasonal snowcovers and glaciers worldwide. Billions of people depend on the seasonal snowcovers and glaciers to provide essential freshwater flows for local and downstream communities and ecosystems. There are therefore significant incentives to provide better estimates of these changing physical processes through improved observations, analysis, and modelling. In this session, we invite contributions on all aspects of snow, ice, and glaciers including impacts on cold-regions meteorology, hydrology, surface-atmosphere-energy exchanges, frozen soil dynamics, glacier dynamics, and groundwater coupling. Contributors are encouraged to share their experiences, insights, and advances in utilizing existing and next-generation tools for observations, analysis, and/or modelling spanning all climate zones.

Contributions that span the traditional CMOS and CGU boundaries are particularly encouraged.

Session: 6010 Observation and modelling of snow and glacier processes - Part 1 Observation et modélisation des processus liés à la neige et aux glaciers - Partie 1 **27/05/2025 10:30**

ID: 12245 Contributed abstract

Modelling the Impacts of Extreme Precipitation Events on Surface Mass Balance in the Eastern Canadian Arctic and Greenland

Nicole Loeb [1] , *Alex Crawford* [2] , *Brice Noël* [3] , *Julienne Stroeve* [4]

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Presented by / Présenté par: *Nicole Loeb*
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The accelerating loss of Arctic land ice is contributing to global sea level rise. While this loss is largely driven by melt induced by rising temperatures, precipitation can alter the rate at which loss may occur depending on its intensity and phase. Case studies have illustrated varied potential impacts of extreme precipitation events on the surface mass balance (SMB) of land ice. A summer snowfall event may increase albedo and reduce mass loss, whereas heavy rainfall can lead to additional melt. However, the importance of extreme precipitation to seasonal SMB has not been investigated. The Greenland Ice Sheet and glaciers and ice caps of the eastern Canadian Arctic are of particular interest due to their accelerated ice loss in recent decades and evident changes in extreme precipitation events.

In this study, the Regional Atmospheric Model (RACMO) and Variable-Resolution Community Earth System Model (VR-CESM) are used to investigate the impacts of daily extreme precipitation events on the SMB of the region's land ice in the historical (1980-1998) and future (2080-2098, SSP5-8.5) periods in the warm season (June-September) and cold season (December-March). Comparisons of SMB on extreme and non-extreme precipitation are performed, and anomalies are explored to understand event impacts. To understand the overall importance of these events to seasonal SMB, daily SMB is split into positive and negative components and the relative importance of extreme precipitation days to each is investigated. In general, the impacts of cold season extreme precipitation show little change in the future, but during summer their impact grows. Historically, extreme precipitation led to mass gain almost everywhere in the domain, but projections indicate a shift towards more mass loss in the future, particularly in SW Greenland and Baffin Island, illustrating a shift in their role in seasonal SMB.

Session: 6010 Observation and modelling of snow and glacier processes - Part 1 Observation et modélisation des processus liés à la **27/05/2025 10:45**

neige et aux glaciers - Partie 1

ID: 12349 Contributed abstract

Understanding the tidal response of Helheim Glacier, Greenland, using Terrestrial Radar Interferometry

Jae Hun Kim [1] , *Eric Rignot* [2] , *Hanning Chen* [3] , *David Holland* [4] , *Denise Holland* [5]

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Presented by / Présenté par: *Jae Hun Kim*
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Helheim Glacier, a major outlet in East Greenland, discharges around 33 Gigatons of ice annually and has been retreating since 2003. Studying calving is challenging due to the short timescales of deformation and calving events, which occur over hours, while satellite observations are limited to days or weeks. To address this, we use portable terrestrial radar interferometry to track the glacier's grounding line migration and tidal flexure in near real time (in minute-scale). The data reveals a central bed ridge acting as a pivot, causing differential movement of the glacier: one side moves in sync with the tide, while the other moves out of sync with a reduced amplitude. We also detect seawater intrusions beneath the glacier front, reaching the full ice thickness at high tide. After major calving events, most of the ice flexing stops, indicating the glacier front becomes grounded and the ice blocks are already floating. These findings emphasize the crucial role of tidal seawater intrusions in the glacier dynamics.

Session: 6010 Observation and modelling of snow and glacier processes - Part 1 Observation et modélisation des processus liés à la neige et aux glaciers - Partie 1 **27/05/2025 11:15**

ID: 12331 Contributed abstract

Coupled response of the WRF-Hydro and Crocus models to simulate mass balance and meltwater in the glacier-fed watersheds of northwestern British Columbia

Shanaka Weththasinghe [1] , *Siraj ul Islam* [2]

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Presented by / Présenté par: *Shanaka Weththasinghe*
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Glaciers and seasonal snowpacks act as vital natural water reservoirs that strongly control the streamflow generation in the glacier-fed watersheds of western Canada. These watersheds are highly sensitive to climate change due to their strong atmosphere–cryosphere interaction and can, therefore, serve as model systems for investigating the impacts of climate change on mass balance and streamflow generation. This talk will showcase the application of the Weather Research and Forecast Hydrological (WRF-Hydro) model on the Iskut River, a glacier-fed watershed in coast mountainous regions of northwestern British Columbia (BC). The WRF-Hydro model is coupled with the Glacier/Crocus model, and the simulations are performed at 2 km horizontal resolution using ERA5 reanalysis forcings and three different glacier masks representing glacier areas in the years 1985, 2005, and 2021. We will first discuss the WRF-Hydro/Crocus modeling system's accuracy and reliability and then quantify the changing contributions of ice and snowmelt to Iskut River flows. This research contributes to enhancing knowledge of glacial-fed hydrological systems and their responses to climate variability and change, providing crucial information for water resources managers and decision-makers to inform sustainable water use and adaptation planning in the western region of northern BC.

Session: 6010 Observation and modelling of snow and glacier processes - Part 1 Observation et modélisation des processus liés à la neige et aux glaciers - Partie 1 **27/05/2025 11:30**

ID: 12213 Contributed abstract

Deciphering Groundwater Dynamics in a Glacierized Himalayan Basin Under Changing Climates

Caroline Aubry-Wake [1] , *Walter Immerzeel* [2] , *Lauren Somers* [3]

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Presented by / Présenté par: *Caroline Aubry-Wake*
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Mountain groundwater in glacierized regions is increasingly recognized for its importance, yet the contributions of glacier melt to groundwater recharge and its subsequent resurfacing remain poorly understood. In this study, we integrate a cryosphere-surface hydrology model with numerical groundwater simulations to investigate these processes in the high-altitude Langshisha basin of the Langtang Himalaya (elevation 4094–6049 m). We quantify the extent to which glacier melt recharges groundwater and how this groundwater contributes to surface streamflow under current and projected climatic conditions. Using in-situ weather data and field measurements for model evaluation, our findings reveal that glacier melt accounted for up to 58% of groundwater recharge in the Langshisha basin during 2012–2024. This significant contribution is driven by the basin's extensive glacier cover (40%) and high elevation. In areas above 5300 m, cold temperatures limit melt, and underlying permafrost restricts recharge. Groundwater simulations based on these recharge rates indicate a combination of shallow, short flow paths near the glacier toe and longer flow paths originating from higher elevations, which extend toward the broader downstream

valley. Under current conditions, approximately 15% of the basin's yield is sourced from glacier melt-fed groundwater. We apply future climate scenarios to assess the impacts of warming and glacier retreat on surface water-groundwater dynamics. While glacier-sourced groundwater is expected to decline with reduced glacier cover, this may be offset by increased precipitation-driven recharge in some scenarios.

Session: 8020 Changing Chemical Loads in Evolving Watershed - Part 1 Modification des charges chimiques dans un bassin versant en évolution - Partie 1

Convenors:

Xiaochuang Bu (University of Waterloo)
Serghei Bocaniov (University of Waterloo)
Noelle Starling (University of Waterloo)
Raoul-Marie Couture (Université Laval)
Helen Baulch (University of Saskatchewan)

Global environmental changes—driven by accelerated climate shifts and intensified human activities—are reshaping water systems worldwide. Canada, endowed with vast and diverse water systems including the Great Lakes, extensive river networks, expansive wetlands, coastal and estuarine systems, provides a unique and critical context for investigating these changes. As sentinels of environmental disturbance, water bodies reflect changes in climate, land use, and pollutant transport through measurable variations in chemical loads of key elements (e.g., C, N, P, Cl) and contaminants. Faced with challenges such as permafrost thaw, cultural eutrophication, increasing salinization and aquatic pollution, it is imperative to understand the factors that contribute to and shape chemical loads, discharge and biogeochemical fluxes across waterbodies is imperative.
This session aims to advance the systematic study of chemical loads, discharge and biogeochemical fluxes in changing water systems. It also focuses on quantitative and qualitative characterization of these processes not only under past and present climates but also their predictions under future climatic conditions or extreme events. We invite abstracts utilizing field experiments, observations, and modeling to characterize the transport and biogeochemical transformations of carbon, nutrients, metals, major ions, and contaminants in inland waters, estuaries, and coastal environments. We welcome contributions related to existing databases, diagnostic methods, data analysis, and applications of artificial intelligence.

Session: 8020 Changing Chemical Loads in Evolving Watershed - Part 1 Modification des charges chimiques dans un bassin versant en évolution - Partie 1

27/05/2025 10:30

ID: 12468 Contributed abstract

Patterns and Trajectories of Organic Carbon Loads in Arctic Rivers Under Climate Warming

Xiaochuang Bu [1] , *Chris Parsons* [2] , *Philippe van Cappellen* [3]

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Presented by / Présenté par: *Xiaochuang Bu*
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Climate warming is significantly amplified in the Arctic, driving permafrost thaw and altering the carbon cycle in its river systems. Of particular concern are the regional to global scale impacts arising from changes in organic carbon (OC) transport to the Arctic Ocean. This study examines dissolved organic carbon (DOC), particulate organic carbon (POC), and dissolved inorganic carbon (DIC) loads from 2000 to 2024 across eleven Arctic rivers (Mackenzie, Yukon, Ob, Yenisei, Lena, Kolyma, Thelon, Peel, Coppermine, Firth, and Brown) and fifteen tributaries with watershed sizes ranging from 2,000 to 2,990,000 km². We applied Gated Recurrent Unit with Decay (GRU-D) and Weighted Regressions on Time, Discharge, and Season with Kalman filtering (WRTDS-K) to generate continuous OC load records based on extensive monitoring data. Our results indicate that DOC yields range from 0.9 to 9.5, POC from 0.09 to 4.6, and DIC from 8.2 to 120 ton d^{-1} km^{-2}. While the six major rivers (Mackenzie, Yukon, Ob, Yenisei, Lena, and Kolyma) contribute higher OC loads (DOC and DIC: ~106 ton C yr-1, POC: ~105 ton C yr-1), smaller rivers display higher yields and greater variability across different rivers. In contrast, rivers regulated by large lakes show more stable monthly distributions but at notably lower yields. Over the past 25 years, POC and DIC loads have generally increased, whereas DOC exhibits no clear directional trend. These changes stem not only from rising river discharge but also from shifts in concentration–discharge (C–Q) relationships, most rivers show anticlockwise C–Q rotations, especially in high-latitude regions. These results highlight how the combined effects of permafrost thaw, changing hydrology, and watershed biogeochemical processes regulate river OC loads, thus advancing our understanding of present and future carbon budgets in a rapidly warming Arctic environment.

Session: 8020 Changing Chemical Loads in Evolving Watershed - Part 1 Modification des charges chimiques dans un bassin versant en évolution - Partie 1

27/05/2025 10:45

ID: 12228 Contributed abstract

Distribution of rare earth elements and their signatures from the Mackenzie River delta to the Abyssal Arctic Ocean

Thomas Bossé-Demers [1] , *Charles Gobeil* [2] , *Bennet Juhls* [3] , *Martine Lizotte* [4] , *Michael Fritz* [5] , *Lisa Bröder* [6] , *Atsushi Matsuoka* [7] , *Santiago Mareque* [8] , *Raoul-Marie Couture* [9]

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Presented by / Présenté par: *Thomas Bossé-Demers*
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The Mackenzie River is North America's largest contributor of freshwater and sediment to the Arctic Ocean. Permafrost thaw and erosion in its vast catchment and along the coasts increases sediment export to the coastal ocean and beyond. In this context, we aimed to evaluate the potential of rare earth elements (REE) as tracers of sediment sources and fate, from the river mouth to the deep Arctic Ocean. We collected sediment cores from 21 sites, from the delta to the marine shelves, slopes and basins. We measured the spatial and down-core distribution of total, leached and residual REE concentrations. Our results show that the proportion of leached REE is highest in the delta, reaching up to 60% for gadolinium. This proportion decreases with distance from the river, suggesting mixing with other sediment sources, REE loss to the residual phase, or REE scavenging via adsorption and complexation in coastal waters. Normalized REE concentrations plotted against their atomic number provide regional signatures. The leached REE signatures indicate medium REE enrichment in the Mackenzie Delta, which diminishes with distance from the delta. We used a similarity index (SI) to evaluate the divergence amongst REE signatures, using riverine and deep marine basin values as endmembers for the calculation. Our results highlight the influence of the Mackenzie Region sediments on the Beaufort Sea margin. Further from the delta, a distinctive cerium (Ce) anomaly increasingly shapes the signature. Comparison with previously published manganese profiles at those sites suggests that Ce responds to deep oxygen penetration [1]. Overall, our findings demonstrate that REE are relevant tracers for identifying sediment sources and tracking their distribution from the delta to the deep Arctic Ocean, thereby offering additional insights into sediment transport mechanisms.

[1] R. W. Macdonald, C. Gobeil, Aquatic Geochemistry 2011, 18, 565-591 10.1007/s10498-011-9149-9.

Session: 8020 Changing Chemical Loads in Evolving Watershed - Part 1 Modification des charges chimiques dans un bassin versant en évolution - Partie 1

27/05/2025 11:00

ID: 12366 Contributed abstract

Understanding the Longevity of Impacts on Nitrogen Cycling Caused by Active Layer Detachments in the Canadian High Arctic

Samuel Poirier [1] , *Melissa Lafreniere* [2]

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Presented by / Présenté par: *Samuel Poirier*
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Warming air temperatures and deepening active layers in the Canadian High Arctic have led to a considerable increase in the number of active layer detachments (ALDs). Typically triggered by deep thaw and late season rainfall, these disturbances redistribute active layer soils on slopes, exposing the top of the permafrost, allowing for subsequent mobilization of previously buried and frozen sediments, carbon, nutrients and other biochemically relevant components. Abrupt thaw events like ALDs, are expected to have relatively short-lived, but very significant impacts on the global C, however, little is known about the duration of downstream impacts, making modelling of impacts a challenge. At the Cape Bounty Arctic Watershed Observatory (CBAWO), previous work found that a watershed subject to ALDs saw a significant increase in the export of nitrogen (N). Nitrogen is often a limiting nutrient in Arctic ecosystems, hence increases in N availability has significant implications for watershed ecosystems. This study seeks to better understand the nature and timescale of the impacts of ALDs on N dynamics by revisiting two previously studied watersheds 17 years post disturbance. In each catchment, Goose (undisturbed) and Ptarmigan (disturbed in 2007), discharge was monitored and snow, rain, and water samples were collected during the summer of 2024. Samples were analyzed for pH, EC, dissolved nitrogen, major ions, and stable isotopes of water and nitrate. Preliminary results show concentrations and speciation of N between catchments are more similar to each other than in a study conducted 5 years post-disturbance. Average fluxes of NO3 were very similar between catchments at 7.73±11.6 mg/min in Ptarmigan and 7.10±10.5 mg/min in Goose. Understanding the temporal scale of the impacts of ALDs on N is crucial for proper modelling of climate warming on local ecosystems and food sources, as well as on the global carbon cycle.

Session: 8020 Changing Chemical Loads in Evolving Watershed - Part 1 Modification des charges chimiques dans un bassin versant en évolution - Partie 1

27/05/2025 11:15

ID: 12261 Contributed abstract

Dammed Nutrients: Reservoir impacts on Nitrogen and Phosphorus export, creating an opportunity for nutrient management in the Lake Winnipeg Basin

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Presented by / Présenté par: *Noelle Starling*
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Lake Winnipeg experiences severe seasonal algae blooms driven by elevated nitrogen (N) and phosphorus (P) loads from the watershed. Spanning four provinces and four states, the basin covers a large geographic area, much of which is dominated by a snowmelt-driven hydrological regime. Extreme flow variability has resulted in extensive water management within the watershed, including construction of 156 large (>10ha) dammed reservoirs. Previous research has shown that reservoirs typically reduce N and P export, making these reservoirs a significant variable to examine when looking at nutrient loading across the Lake Winnipeg Basin.

Here we investigate N and P removal in 12 case study reservoirs using a mass balance approach, leveraging existing flow and water chemistry data from upstream and downstream locations. We applied Weighted Regressions on Time, Discharge and Season (WRTDS) to generate load and concentration estimates, investigate the relationships between concentration and discharge and evaluate changes to nutrient stoichiometry. Across the twelve sites, P retention efficiency was 51.4%, while average N removal efficiency was 7.67%, demonstrating clear decoupling of the cycles of N and P. Furthermore, while upstream concentrations of N and P were positively correlated with discharge, these relationships were suppressed downstream of reservoirs, leading to less variable concentrations. This work investigates the reservoir characteristics controlling N and P removal efficiency and seeks to leverage knowledge obtained from the case study sites to estimate total N and P removal by reservoirs across the Lake Winnipeg Basin.

Session: 8020 Changing Chemical Loads in Evolving Watershed - Part 1 Modification des charges chimiques dans un bassin versant en évolution - Partie 1

27/05/2025 11:30

ID: 12409 Contributed abstract

Chloride load modeling with key predictors and machine learning

Mir Jafar Sadegh Safari [1] , *Claire Oswald* [2] , *Bill Thompson* [3] , *Christopher Wellen* [4]

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Presented by / Présenté par: *Mir Jafar Sadegh Safari*
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Chloride contamination in freshwater ecosystems is an emerging environmental concern in cold climates due to extensive road salt applications. This study advances the understanding of chloride transport through addressing the challenges arising from missing data, the complexities of non-linear relationships and the necessity of accurate chloride load modeling. A Hybrid Random Forest-Harmony Search algorithm is implemented to address the critical gap of data imputation for stations with significant

missing data. This study integrates predictors to represent seasonality and time to capture temporal trends and also base flow fraction to account for the contribution of groundwater flow as key variables for daily chloride load modeling. This study also examined trends across 18 subwatersheds that span a gradient of land use in the Lake Simcoe drainage basin in Southern Ontario. The importance of individual variables and their interactions through variable importance analysis, and the interaction effect of streamflow and seasonality on chloride load are examined. Results confirm that land use changes, especially urban expansion and increased road density significantly influence chloride pollution trends, while Cl concentrations and loads have been increasing through time. These findings highlight the critical need for including sustainable winter road maintenance practices and long-term monitoring to mitigate chloride pollution in vulnerable freshwater ecosystems.

Session: 8020 Changing Chemical Loads in Evolving Watershed - Part 1 Modification des charges chimiques dans un bassin versant en évolution - Partie 1

27/05/2025 11:45

ID: 12476 Contributed abstract

RENEWED LAKE ERIE PHOSPHORUS BUDGET SUGGESTS MAJOR INPUT FROM COASTAL EROSION

Serghei A. Bocaniov [1] , *Chris A. Houser* [2] , *Philippe Van Cappellen* [3]

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Presented by / Présenté par: *Serghei A. Bocaniov*
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Phosphorus (P) input from coastal erosion, including the P fraction that can be incorporated in the aquatic food web (AFW), is difficult to characterize from in-situ field observations alone. In large lakes, the spatial size and high temporal variability, and the associated logistical challenges and high costs, hinder the acquisition of comprehensive datasets. Alternatively, lake P budgets that explicitly account for AFW can be used to estimate the magnitude of P input loads. In this study, we build on a recently revised lake budget of total P (TP) for Lake Erie averaged over the period 2003-2016, and expand it to include the amount of TP incorporated in phytoplankton, zooplankton, fish, and zoobenthos. The budget is based on known inputs of TP and known outputs of TP via lake outflow and sediment burial. The results reveal that these known inputs and outputs are significantly unbalanced. To support AWF, an additional amount of 3,400-4,000 metric tonnes per year of P must be entering Lake Erie, thus highlighting the existence of a previously unaccounted for source of bioavailable P. We propose that this additional P input is caused by coastal erosion. Mapping of coastline retreat rates combined with preliminary P concentration data for soil samples from eroding bluffs in Lake Erie shows that the magnitude of the P input related to coastal erosion is of the same order of magnitude as that derived from the TP budget calculations.

Session: 3040 Methane Emissions and Measurement Techniques Across Canada Émissions de méthane et techniques de mesure au Canada

Convenors:

Rayden Laliberte, University of Waterloo
Akshara Withanage, University of Waterloo
Sandani Buddhima, University of Waterloo

Methane is a powerful greenhouse gas with a global warming potential that is 28 times greater than carbon dioxide over a 100-year period, making it a key contributor to climate change. Despite this importance, there is a lack of data on methane emissions in comparison to other greenhouse gases, such as carbon dioxide. Additional measurements of methane, with a focus on environmental controls, and spatial and temporal variation, will be essential for updating national greenhouse gas budgets, understanding the benefits and trade-offs of mitigation efforts, and predicting how emissions are altered under a changing climate. We welcome research conducted at both natural and disturbed ecosystems and other natural and anthropogenic sources in Canada, including lakes, wetlands, artificial water bodies (e.g., reservoirs, stormwater ponds, farm ponds), agriculture, landfills and industrial facilities.

There are multiple established approaches to the quantification of methane emissions across temporal and spatial scales, including flux chambers, eddy covariance, remote sensing and modelling. We also welcome studies on new approaches and technologies of quantifying methane emissions. We hope the discussions will improve our knowledge of methane dynamics across Canada and provide a greater understanding of our mitigation efforts.

Session: 3040 Methane Emissions and Measurement Techniques Across Canada Émissions de méthane et techniques de mesure au Canada **27/05/2025 13:30**

ID: 12505 Contributed abstract

Monitoring Methane Dynamics Across Canadian Wetlands

Sara Knox [1] , *Rosie Howard* [2] , *Zoran Nesic* [3] , *Tzu-Yi Lu* [4] , *Oliver Sonnentag* [5] , *Daniel Nadeau* [6] , *Ian Strachan* [7] , *David Olefeldt* [8] , *Pascal Badiou* [9] , *Irena Creed* [10] , *Larry Flanagan* [11] , *Graham Clark* [12]

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Presented by / Présenté par: *Sara Knox*
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Wetlands are the largest and most uncertain natural source of global methane (CH4) emissions, with fluxes closely linked to temperature. Canada has been warming at approximately twice the global average, with even more pronounced warming-nearly three times the global rate-occurring in Northern Canada (>60°N). A recent study reported a robust increasing trend in CH4 emissions (+8.9%) across the Boreal–Arctic region, predominantly driven by rising temperatures (Yuan et al., 2024). This underscores the vulnerability of wetland CH4 emissions across both temperate and high-latitude regions of Canada to climate change, while their long-term dynamics remain poorly understood.

Here, we provide a comprehensive overview of wetland CH4 monitoring sites across Canada that utilize the eddy covariance (EC) method. EC towers provide continuous, high-resolution flux measurements over large spatial scales (~100 to >1,000 m), making them invaluable for capturing the complex spatial and temporal variability of wetland CH4 fluxes. We summarize new and ongoing wetland CH4 flux monitoring efforts, including Can-Peat, CARBONIQUE, CANO, Blue Carbon Canada, and an expanding network of EC sites across freshwater mineral soil wetlands. We discuss the spatial coverage of these sites, the wetland ecosystems represented, and the evolution of this monitoring network over time. Finally, we synthesize key findings from a subset of sites, offering insights into the drivers and patterns of wetland CH4 emissions across Canada.

Reference: Yuan, K., Li, F., McNicol, G., Chen, M., Hoyt, A., Knox, S., Riley, W. J., Jackson, R., & Zhu, Q. (2024). Boreal–Arctic wetland methane emissions modulated by warming and vegetation activity. Nature Climate Change 2024 14:3, 14(3), 282–288. https://doi.org/10.1038/s41558-024-01933-3

Session: 3040 Methane Emissions and Measurement Techniques Across Canada Émissions de méthane et techniques de mesure au Canada

27/05/2025 13:45

ID: 12271 Contributed abstract

Balancing the Benefits: Quantifying Methane Emissions from Restored Wetlands

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Presented by / Présenté par: *Shayna Meinzinger*
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Wetlands offer a range of valuable ecosystem services, including natural water filtration, flood mitigation, and opportunities for recreation. However, they are the most significant natural sources of methane emissions. Ongoing research is vital for understanding the pathways and environmental factors that influence their contribution to greenhouse gases (GHG), particularly methane.

This study aims to quantify methane emissions from restored agricultural wetland systems in Southern Ontario and identify potential environmental factors driving these emissions. We examine the spatial and temporal variability of methane emissions from seven restored wetlands in the Lake Erie Basin, adjacent to agricultural land, focusing on diffusive and ebullitive pathways. Data has been collected over nine months, including summer, fall, and winter, with one final sampling scheduled for spring.

To measure diffusive methane emissions, we use floating chambers connected to gas analyzers. In cases where chamber measurements were unsuccessful, we employed a gas exchange model to estimate methane flux. For ebullitive emissions, we employ floating bubble traps to collect gas over 24 hours. Ebullitive methane emissions are particularly important, as they bypass oxidation, a process that consumes methane before it reaches the atmosphere.

We conduct detailed wetland profiling by collecting dissolved gas samples and measuring hydrophysical and hydrochemical parameters (oxygen, temperature, pH) from the wetland surface to its deepest point. Water samples from four key locations are analyzed for nutrients, carbon species, and the isotopic signatures of water, as well as dissolved methane and carbon dioxide concentrations, to explore the chemical and physical factors driving methane emissions in restored wetlands.

Our findings will address the trade-offs between wetland ecosystem services and GHG emissions, contributing to knowledge gaps that can inform policy and restoration practices. This research aims to enhance understanding of wetlands' roles in sustainable water management and climate mitigation.

Session: 3040 Methane Emissions and Measurement Techniques Across Canada Émissions de méthane et techniques de mesure au Canada

27/05/2025 14:00

ID: 12394 Contributed abstract

Driving mechanisms and unknowns for methane behaviour in small prairie waterbodies

Anthony Baron [1] , *Richard Helmle* [2] , *Lauren Miranda* [3]

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Presented by / Présenté par: *Colin Whitfield*
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The Prairie region of southern Alberta, Manitoba, and Saskatchewan is unique to other parts of Canada. This landscape is heavily managed for agricultural production, is relatively dry, and features ubiquitous small wetland ponds and reservoirs. These features are often geographically isolated with hydrologic connections via surface paths occurring only intermittently, leading to wide ranging biogeochemical character and behaviour. In this presentation, we will contrast different modes of measurement and consider multiple pathways (diffusive, ebullitive and vegetation-mediated) for methane exchange between waterbodies and the atmosphere. We will highlight the importance of methane release from these aquatic systems, showing that at regional scales fluxes range from negligible to being high enough to negate much of the role of these systems for carbon storage (with respect to climate forcing). We will demonstrate the role of sulphate as the key predictor of this regional variability in methane release among water bodies. We will also use novel high-resolution sensor-based measurements of ebullitive methane release to the atmosphere to illustrate how temperature and dissolved oxygen can contribute to contrasting temporal patterns of release for similar waterbodies. Finally, we will consider the role of current management practices and some important unknowns for methane dynamics in these systems.

Session: 3040 Methane Emissions and Measurement Techniques Across Canada Émissions de méthane et techniques de mesure au Canada

27/05/2025 14:15

ID: 12280 Contributed abstract

Comparing Multiple Methods of Quantifying Methane Emissions from Atmospheric Measurements at the Twin Creeks Landfill

Lawson Gillespie [1] , *Sébastien Ars* [2] , *Felix Vogel* [3] , *Debra Wunch* [4]

[1]

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Presented by / Présenté par: *Lawson Gillespie*

Contact: lgillespie@physics.utoronto.ca

While landfills are significant sources of methane emissions in Canada, facility self-reported and inventoried emissions values have significant limitations for understanding landfill emissions. Atmospheric measurements can be used to improve our understanding of these emissions by estimating facility-level emissions rates. However landfills’ large spatial extent, diffuse and variable emissions, dynamic operational status and cover variations make them challenging sources to quantify. In this work, we investigate different emissions quantification strategies at a large, active landfill in Southern Ontario. We compare measurements spanning three and a half years from ground, aircraft, and satellite-based remote sensing methodologies, in addition to mobile aircraft and vehicle based in situ measurements, and 28 months of continuous in situ measurements from a stationary low precision sensor network. We develop a Gaussian plume inversion framework to interpret the low precision sensor network measurements, and demonstrate that facility-level emissions rates determined with each method agree within their statistical uncertainties. We find that remote sensing measurements, on

average, have slightly higher estimated emissions rates and explore possible causes for this discrepancy. We also evaluate the advantages and drawbacks of each of these observational strategies, and discuss the implications for monitoring landfill emissions across Canada.

Session: 3040 Methane Emissions and Measurement Techniques Across Canada Émissions de méthane et techniques de mesure au Canada **27/05/2025 14:30**

ID: 12337 Contributed abstract

Effects of Seismic Lines and Mounding Restoration on Methane Emissions in Peatlands

Maria Strack [1]

[1]

Presented by / Présenté par: *Nazia Tabassum*
Contact: n7tabass@uwaterloo.ca

Boreal peatlands are vital carbon (C) sinks but also emit methane (CH_4), a potent greenhouse gas. Seismic lines, created for resource exploration, disrupt peatland hydrology and microtopography, leading to warmer, wetter conditions and shifts in plant communities that enhance CH_4 emissions. However, the impact of mounding as a restoration strategy remains unclear. This study examines CH_4 flux variations across untreated seismic lines, mounded sites, and natural reference plots. Chamber measurements indicate that untreated seismic lines release more CH_4 than natural sites, with both hummocks and hollows contributing to elevated flux. Mounding further amplifies CH_4 emissions in hollows/pools due to flooded conditions, whereas fluxes from mounded hummocks remain comparable to natural hummocks. Mounded sites exhibit the highest variation in water table depth, highlighting the hydrological impact of restoration, while untreated lines show moderate fluctuations and natural plots maintain stable conditions. Linear Mixed Model (LMM) analysis confirms that CH_4 flux is primarily controlled by water table depth, with shallow water tables (<15 cm) driving higher emissions, whereas deeper water tables significantly suppress CH_4 release. A transition from pools to deep-water tables reduces CH_4 emissions by 2.3%. Soil temperature alone does not strongly influence flux but interacts with water table depth—higher temperatures intensify CH_4 emissions under shallow water table conditions but have minimal impact at drier plots. A 1 °C increase in soil temperature results in an 18% rise in CH_4 flux when the water table is shallow. These findings underscore the role of hydrological restoration in regulating CH_4 emissions. Mounding creates distinct emission zones, where wetter hollows enhance CH_4 production, while drier hummocks experience elevated temperatures but lower emissions. Understanding these methane-soil-water interactions can guide peatland restoration strategies to balance C storage with greenhouse gas mitigation.

Session: 3040 Methane Emissions and Measurement Techniques Across Canada Émissions de méthane et techniques de mesure au Canada **27/05/2025 14:45**

ID: 12496 Contributed abstract

You wood-n't believe it: measuring methane flux from tree stems in southern Ontario swamps

Megan Schmidt [1] , *Maria Strack* [2]

[1] University of Waterloo
[2] University of Waterloo

Presented by / Présenté par: *Megan Schmidt*
Contact: meg.schmidt@uwaterloo.ca

Trees are known for their incredible ability to take up and store carbon dioxide (CO2) from the atmosphere, but recent research has shown they also release methane (CH4) from their stems, although the exact mechanisms are still largely unknown. Two main theories are suspected: methanogenic production within bark and/or tissues and transport from the soil through transpiration pathways; regardless, CH4 diffuses through the bark to the atmosphere. We selected three genera prominent in swamps across southern Ontario – Acer (maple), Betula (birch), and Thuja (cedar) – to measure in three swamps where we concurrently measured soil fluxes of CO2 and CH4. Using a custom-made chamber and potable greenhouse gas analyzer, fluxes were assessed by hydrogeomorphic setting (position in landscape) of sites, canopy composition, hydrologic conditions (VWC, water table position), environmental conditions, species, and more. Fluxes were higher from tree stems during the growing season and consistently lower from cedar than birch and maple regardless of time of year; fluxes from all species were near zero through the non-growing season. CH4 efflux increased with deciduous presence in canopy composition. Fluxes from all species were highest in basin sites and linked with water table changes, increasing with higher water levels. Trees showed a rapid response to precipitation events, immediately and rapidly increasing CH4 efflux while the response by soils lagged. Results can be used to better predict ecosystem CH4 emissions from swamps by including emissions from tree stems in addition to soil fluxes.

Session: 13020 Multidisciplinary- Community, Service and Education
Multidisciplinaire- Communauté, Services et Éducation

Convenor: Serge Desjardins

Related to multidisciplinary environmental studies and/or information sharing , which includes, but not limited to Arctic studies, wildfire fires, hydrology, and cryology using various approaches.
This session covers many topics, including but not limited to education, community science and data collection, data dissemination, and other activities as well as all environmental topics that are not addressed in the atmosphere, ocean, and climate sessions.

Multidisciplinaire- Communauté, Services et Éducation

13:30

ID: 12264 Contributed abstract

Meteorological Service of Canada update

Doris Fortin [1] , *Cecile Siewe* [2]

[1] Meteorological Service of Canada
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Presented by / Présenté par: *Doris Fortin*
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The Meteorological Service of Canada (MSC) is the authoritative source of hydro-meteorological information in Canada, providing weather, water, ice, air quality, climate and environmental services. These include accurate and timely weather and environmental information, early notifications, and impact-based warnings to support Government of Canada departments, public authorities, emergency management organizations and many others in making decisions that protect the health, safety, and economic well-being of Canadians. This presentation will highlight the strong foundation of scientific research and development supporting the MSC, advances related to artificial intelligence and machine learning, transformation initiatives, and continuous improvements of the MSC's weather and environmental services to meet the evolving needs of users and stakeholders.

Session: 13020 Multidisciplinary- Community, Service and Education Multidisciplinaire- Communauté, Services et Éducation

27/05/2025 14:15

ID: 12387 Contributed abstract

Updates on the use of the VIIRS derived Normalized Difference Vegetation Index (NDVI) in Crop Yield Forecasting in Canada

Aston Chipanshi [1] , *Yinsou Zhang* [2] , *Dongzhi Qi* [3] , *Catherine Champagne* [4] , *Andrew Davidson* [5] , *Alexander Trishchenko* [6] , *Calin Ungureanu* [7] , *Shaheen Ghayourmanesh* [8] , *Alexandre Cyr* [9] , *Gordon Reichert* [10]

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Presented by / Présenté par: *Aston Chipanshi*

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The onstream Normalized Difference Vegetation Index (NDVI) derived from the Visible Infrared Imaging Radiometer (VIIRS) was evaluated as a substitute for the near defunct NDVI derived from the MODerate-resolution Imaging Spectroradiometer (MODIS) in the prediction of crop yields across Canada. The NDVI is a key input amongst others to the operational model: Canadian Crop Yield Forecasting (CCYF) used by both Agriculture and Agri-Food Canada and Statistics Canada. VIIRS NDVI data sets differed in terms of source, sensors used and quality control levels. VIIRs NDVI suppliers were NOAA and NASA with the JPPS-1/NOAA-20 and S-NPP sensors respectively. Quality control levels included Best Quality Clear Sky (BQCS), All Quality Clear Sky (AQCS) and the Blended NDVI Index gap filled missing pixels with lower quality data to ensure complete coverage. Throughout the growing season, the VIIRS Blended NDVI replicated the MODIS NDVI accurately with Coefficient of Determination values of above 0.95. Hindcast and near real time predictions of spring wheat, canola, barley soybean and corn for grain compared favourably between VIIRS NDVI and MODIS NDVI inputs with very small Mean Absolute Percentage Differences (MAD) between the two. Although the results from 2023 and 2024 are encouraging, there is room for improvement by extending the analysis beyond two years.

Session: 13020 Multidisciplinary- Community, Service and Education
Multidisciplinaire- Communauté, Services et Éducation **27/05/2025 14:30**

ID: 12560 Contributed abstract

A new Environmental Science focus area for airborne research at NRC to increase engagement with universities

Leonid Nichman [1]

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Presented by / Présenté par: *Leonid Nichman*
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The Flight Research Laboratory of the National Research Council of Canada (NRC) operates a fleet of fixed wing and rotary aircraft, frequently for environmental research applications. The Convair-580, Twin Otter, and UAVs are often used by researchers to study wildfires, severe weather, cloud physics, pollution, GHGs, lightning and other areas, advancing science and technologies for satellite earth observation (SEO). The flights are also instrumental in the development and testing of new in-situ measurement technologies. The facilities are world-class and include tens of instruments integrated onboard.
Last year, the Aerospace Research Center of the NRC has launched a new Environmental Science focus area (ESFA). The focus area is keen to enable engagements between university scholars and NRC scientists on research topics that align with NRC and GoC objectives on climate, quality of life, and well being of

Canadians in the environmental context. In its first year, the ESFA provided in-kind contributions for 9 projects, enabling collaboration with 5 Canadian universities contributing to training of their HQP.
The academic researchers are encouraged to seek partnership/collaboration with NRC researchers in developing research proposals to funding agencies (e.g., CSA-FAST, Horizon Europe pillar II, NSERC Alliance). Such proposals can be supplemented with ESFA support of in-kind contributions and operational funds.
The mutual benefit of reduced cost for facilities, in kind research labour, and University students working on NRC datasets, producing tangible outcomes, will benefit Canada and Canadians.

Session: 13020 Multidisciplinary- Community, Service and Education Multidisciplinaire- Communauté, Services et Éducation **27/05/2025 14:45**

ID: 12194 Contributed abstract

Filling critical data gaps in High-Altitude Environments of the Himalayan Region

Michael Crowe [1] , *Jamie Smith* [2] , *Dhiraj Pradhananga* [3] , *Dinka Karkayastha* [4] , *Luna Bharati* [5] , *Binod Paraj* [6]

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Presented by / Présenté par: *Michael Crowe*
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This presentation describes a project to address the critical need for high altitude environmental monitoring in the Nepal Himalayas, where the impacts of climate change such as water and food insecurity, biodiversity loss, and increased extreme events, are increasingly felt. Despite the region’s vulnerability, existing climate monitoring infrastructure remains inadequate, and past efforts to install Automated Weather Stations (AWS) have often failed due to sustainability challenges related to maintenance and upkeep. The proposed solution leverages the strategic location of monasteries in remote, high-altitude regions, which serve as centers of teacher-student traditions and many of which are occupied year-round and can provide secure sites for AWS installation. By training monks, nuns, and lamas to maintain these stations, this approach aims to fill critical data gaps and strengthen adaptation strategies for local communities with the monastic practice of spreading wisdom by fostering community awareness about climate change. Furthermore, this approach addresses potential logistical and bureaucratic barriers, such as permissions within national parks, by using private monastery properties with established accessibility. The project includes equipment installation, volunteer training, and collaborative research to create a robust, sustainable monitoring network while contributing to the global understanding of high-altitude climate dynamics.

Session: 10040 Ocean - Theoretical to applied science - Part 1 Océan - De la théorie à la science appliquée - Partie 1

Convenor: Nancy Soontiens

Related to scientific studies and/or information sharing about the ocean, including studies in physical, chemical, and biological oceanography, ocean waves and storm surge using various approaches.

This session covers many topics, including, but not limited to, theoretical research, model development, observation techniques, real-time monitoring, databases, diagnostic methods, data analysis and artificial intelligence.

Session: 10040 Ocean - Theoretical to applied science - Part 1 Océan - De la théorie à la science appliquée - Partie 1

27/05/2025 13:30

ID: 12471 Contributed abstract

Virtual

CIOOS at 5 years: A look back, a look ahead

Jonathan Kellogg [1] , *Brad de Young* [2] , *Anne-Sophie Ste Marie* [3] , *Shayla Fitzsimmons* [4]

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[2] CIOOS Pacific
[3] St Lawrence Global Observatory
[4] CIOOS Atlantic

Presented by / Présenté par: *Brad de Young*
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CIOOS works with regional and national partners to enhance access to ocean data. The ambition is to be THE home for ocean data in Canada. Significant progress has been made in five short years, as CIOOS now supports over 15 TB of ocean data, from more than 100 data providers, in one open access website. These data come from more than 2600 datasets, spanning more than one hundred years, and from all three of Canada's ocean basins. CIOOS adds considerable value to these data by enabling enhanced access and by ensuring their preservation for future reuse. CIOOS is constantly working to expand the available data, to develop new partnerships, and to improve the tools that support data discovery and exploration online. From academic researchers to larger programs like Transforming Climate Action or the expanding activities at the Bamfield Marine Sciences Centre, CIOOS is looking to partner with individuals, organizations, and Indigenous groups who are working to observe and monitor ocean conditions. Another focal area is to improve data support services to modellers who need ocean data for both model initialization and verification. CIOOS is reaching out to the modelling community to explore new approaches which will improve support. This presentation will be a chance for a brief reflection on CIOOS' history, highlight recent advances and tools (including discussion of the Building Bridges project on the use artificial intelligence in

ocean sciences), outline future objectives, and provide an opportunity to hear user suggestions for additional features and data that should be targeted for integration.

Session: 10040 Ocean - Theoretical to applied science - Part 1 Océan - De la théorie à la science appliquée - Partie 1 **27/05/2025 13:45**

ID: 12381 Contributed abstract

Virtual

Characterizing reliability of ocean model surface currents for end user applications

Nancy Soontiens [1] , *Kuo-Hsien Chang* [2] , *Michael Dunphy* [3] , *Andy Lin* [4] , *Rabab Mashayekhi* [5] , *Jean-Philippe Paquin* [6] , *Andrew Peterson* [7] , *Gregory Smith* [8] , *Graigory Sutherland* [9]

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Presented by / Présenté par: *Nancy Soontiens*
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Surface currents from hydrodynamic and ocean circulation models are increasingly used in support of operational activities in the marine environment such as oil spill response, search and rescue, and e-navigation. Under the Canadian Operational Network of Coupled Environmental Predictions Systems (CONCEPTS) and the Drift Prediction and Near-Shore Modelling (DPNM) programs within the Government of Canada, these models undergo extensive validation against available observations and are subject to expert review prior to being made available operationally. Yet, with limited observational data available, particularly observational data that spans the wide variety of marine environments over which the operational models cover and for which operational activities require, the suitability of these models to support drift prediction is not completely characterized. In this study, we discuss an ongoing effort to communicate our best understanding of the reliability and accuracy of the surface currents generated from ocean circulation models. The idea is to produce an “Uncertainty Heat Map”, where the ocean model domain is divided into three categories: Red zone (Do not use), Yellow zone (Use with caution), Green zone (Use) and these categories are displayed on a static map. The technique for identifying the red zone involves comparing the ocean model coastline to high resolution and accurate coastline observations. This technique is applied to the CONCEPTS Coastal Ice-Ocean Prediction System for the East Coast of Canada (CIOPS-E), and the identified red zones are compared to observed discrepancies in drift trajectories. A potential benefit of this approach is that it can be applied to evaluate the impact of hydrodynamic model uncertainty on Lagrangian trajectory simulations, providing a score to quantify uncertainty level in emergency

incident response modeling. Recommendations for future research to characterize uncertainty in areas away from coastlines (i.e., yellow and green zones) are also discussed with potential methods and approaches highlighted.

Session: 10040 Ocean - Theoretical to applied science - Part 1 Océan - De la théorie à la science appliquée - Partie 1 **27/05/2025 14:00**

ID: 12473 Contributed abstract

Mercury Levels in Northern Crayfish: Influence of Reservoirs and Coal Power Plants in Saskatchewan

Yuliya Shtymburska [1] , *Britt Hall* [2] , *Chris Somers* [3]

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Presented by / Présenté par: *Yuliya Shtymburska*
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The northern crayfish (Orconectes virilis) is an important species in freshwater bodies on the northern Great Plains. Crayfish play an important role in nutrient cycling and are both predators and prey across multiple trophic levels. In many instances, crayfish are a critical food resource for sport fish such as bass, walleye, northern pike, and burbot. Mercury bioaccumulation is a naturally occurring process where mercury levels increase with each trophic step. Crayfish can accumulate mercury in several ways, and accumulation can be increased by pollution through the combustion of fossil fuels. For my M.Sc. research, (n = 488) crayfish were collected from five lakes and reservoirs, two rivers, and one creek all located in southern Saskatchewan, Canada. I used a direct mercury analyzer to measure total mercury concentrations in tail muscle tissue. Mercury levels ranged more than 4-fold across sampling locations but were generally low (0.02 - 0.09 mg/kg). The sites with the highest levels were Grant Devine Reservoir (0.09 mg/kg) with Rafferty Reservoir (0.08 mg/kg) and Boundary Reservoir (0.08 mg/kg) being close second. In general, crayfish from small reservoirs had higher mercury levels than those from natural lakes. In addition, crayfish in close proximity to, or downwind from, coal power plants had the highest mercury levels. Our research shows that multiple factors contribute to mercury levels and suggests that changes to coal use may benefit some aquatic ecosystems in the near future.

Session: 10040 Ocean - Theoretical to applied science - Part 1 Océan - De la théorie à la science appliquée - Partie 1 **27/05/2025 14:15**

ID: 12502 Contributed abstract

Virtual

Climate Change Impacts on Arctic Sea Ice and Future Year-Round Shipping in the Mackenzie Delta

Matthew Asplin [1] , *David Fissel* [2] , *Keath Borg* [3] , *Alex Graham* [4]

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Presented by / Présenté par: *Matthew Asplin*
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With year-round shipping through Russia's Northern Sea Route becoming feasible, understanding Arctic sea ice challenges is critical to potential future operations in the Mackenzie Delta. A potential year-round route in the Western Arctic Ocean is under consideration to support natural resource transport from Canada's Beaufort Sea. The Mackenzie Delta Liquefied Natural Gas (MDLNG) concept envisions a pipeline connecting to an offshore gravity-based structure (GBS) that would load Arc7 ice-class LNG carriers for transport via the Bering Strait. Sea ice presents hazards, including seasonal and long-term variability in concentration, thickness, and deformation. A key risk is ships becoming immobilized, or "beset", by ice pressure from wind-driven ice drifting toward shore.

This paper presents results from a pre-feasibility study on how historical and projected sea ice conditions would impact year-round shipping logistics and infrastructure. The study has two parts: (1) a regional sea ice analysis for an LNG export route from the Mackenzie Delta to the Bering Sea, and (2) an in-depth review of sea ice conditions for MDLNG's nearshore facilities. The first part examines historical (1991-2000) and forecasted ice conditions (2030–2060) along a proposed route from Tuktoyaktuk to the northern Bering Sea. It recommends an optimal corridor, integrating input from government and indigenous organizations to mitigate challenges from multiyear sea ice and avoid culturally sensitive waters. The second part analyzes nearshore ice conditions 30 km offshore in 15–16 meters of water, with comparisons between 1991–2000 and 2011–2020.
Findings indicate declining sea ice concentrations in October and May–August, with a delayed autumn freeze-up extending the shipping season to year-round by 2030–2060. Break-up timing remains unchanged through 2045 but may shift by 2060. While ice thickness and extent will further decline, risks and unpredictable impediments to shipping will persist.

Session: 10040 Ocean - Theoretical to applied science - Part 1 Océan - De la théorie à la science appliquée - Partie 1 **27/05/2025 14:30**

ID: 12545 Contributed abstract

Virtual

Lockup and Breakout Events: Wind-driven Winter Sea Ice Motion over the South-East Beaufort Sea Shelf

David Fissel [1] , *Matthew Asplin* [2] , *Keath Borg* [3] , *Humfrey Melling* [4]

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Presented by / Présenté par: *David Fissel*
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Year-round sub-hourly sea-ice velocity measurements of nearly 30 years of duration at locations seaward of the floe edge in the south-eastern Beaufort Sea were analyzed. During December through April, when ice concentrations are nearly 100%, this analysis shows the general westward ice drift in this area is punctuated by intervals of both no motion and prolonged rapid westward movement. We refer to these as lockup and breakout events, respectively.

The magnitude of the dominant wind-driven motion under north-westerly (viz. shoreward) winds is reduced due to the development of internal ice stress that impedes motion, leading to lockup conditions. Once established, lockup conditions have sometimes persisted during periods of strong easterly (viz. offshore) winds, while in other instances, the pack ice “breaks out” and then drifts rapidly westward. During the first hours-to-days of a breakout, ice speed sometimes approached free-drift values (>1.5% of the wind speed) more commonly characteristic of late spring and early fall, when the concentration of thick, strong sea ice is much lower.
Pack ice over the middle to outer continental shelf has been immobile 30% of the time during December through April over the last three decades. Lockups usually occur simultaneously at the mid- and outer-shelf sites. Events have often been brief, with 71% lasting 3 days or less and only 14% extending over 5 days. The three longest lockouts lasted 47, 39, and 34 days.

Breakout events, as defined for our present purpose, are intervals of westward ice motion lasting 3 days or more at an average drift speed of 10 km/d or more, with total westward displacements exceeding 75 km. Breakout events have typically occurred a few times each year which usually account for the majority of net westward ice movement observed during the winter through early spring period.

Session: 10040 Ocean - Theoretical to applied science - Part 1 Océan - De la théorie à la science appliquée - Partie 1 **27/05/2025 14:45**

ID: 12270 Contributed abstract

Multifrequency Radar Remote Sensing of Diesel Contaminated Sea Ice at the Churchill Marine Observatory

Dustin Isleifson [1] , *Mahdi Zabihi Mayvan* [2] , *Durell Desmond* [3] , *Gary Stern* [4]

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Presented by / Présenté par: *Dustin Isleifson*
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Climate change has profoundly impacted Arctic sea ice by reducing its extent and thickness. Consequently, Arctic marine shipping traffic has increased substantially, increasing the risk of oil spills in this region. An effective response to an oil spill requires early detection and monitoring, and radar has been shown to be a useful way to track oil spills in the marine environment. However, the presence of sea ice confounds the detection capability, and the complexity requires more information to uniquely determine if, and where, a spill has occurred. To address this need, we are performing research into detecting and monitoring oil spills in an Arctic marine environment.
Herein, we present our first results from a diesel spill experiment conducted at the Churchill Marine Observatory (CMO) in December 2024 as part of the GENICE II program. Natural seawater was used to fill the pools within the Ocean Sea Ice Mesocosm (OSIM) where sea ice grew under ambient conditions. Once the sea ice thickness reached 13 cm, ~120 L of diesel were introduced beneath the ice cover. Physical sampling and meteorological observations were performed to characterize the ice growth and the progression of the diesel spill in a time series. Throughout the experiment, we monitored the surface of the ice using polarimetric radars operating in three frequency bands: L-band (1.26 GHz), C-band (5.5 GHz), and Ku-band (17.2 GHz). These frequencies correspond to conventional satellite-based sensors that are used to monitor the cryosphere.
The results of this experiment enhance our understanding of the interconnections between the physical, chemical, and thermodynamic states of clean and diesel-contaminated sea ice. Simultaneous multi-frequency radar results from mesocosm experiments can provide critical information for developing future drone or satellite-based sensors that can be used to operationally monitor sensitive regions, such as those in the Hudson Bay.

Session: 4061 Canadian Climate Services, Impact Assessment, and Actionable Climate Information - Part 2 Services climatologiques canadiens, évaluation des incidences et informations climatiques exploitables - Partie 2

Convenors:

Michael Morris, ECCC (contact: Michael.Morris@ec.gc.ca)
Eva Gnegy, ECCC (contact: Eva.Gnegy@ec.gc.ca)
Elaine Barrow, ECCC (contact: Elaine.Barrow@ec.gc.ca)

Demand is at an all-time high for reliable and usable climate data, information and guidance in ways that are relevant and usable to potential users. This is driven an increase in the explicit consideration of future climate in many activities such as climate risk disclosures; assessments of climate impacts, vulnerabilities, and risks; adaptation plans; and consideration of future climate in disaster risk reduction. This uptake is occurring simultaneously across a wide range of disciplines such as human health, buildings, agriculture, transportation, forestry, and many others.

Climate services operate at the interface between climate science and this real-world decision making. To ensure the usefulness of climate information and its uptake by stakeholders, there must be communication between climate scientists, climate service providers and practitioners. Collaboration between these parties is necessary for building resilience through informed climate change adaptation.

Although coverage, availability and accessibility of climate data have greatly improved, barriers associated with developing and tailoring information remain. The goal of this session is to encourage those in the climate field to share their experiences in creating robust, tailored climate information, data products, and guidance, for delivery to practitioners, researchers, and local communities. We also welcome users of climate information and climate data to share their experiences and findings, highlight how climate service providers have met or not met their needs, and identify ways in which climate services offerings could be expanded to improve their ability to build resilience to a changing climate.

Relevant topics for this session could include:

- Climate information development

- User needs engagement and analysis

- Deployment of platforms providing climate information

- Co-production of datasets and tools with practitioners and climate scientists

- Translation of technical climate information into a usable format

- Examples of successful application of climate information, particularly for climate change adaptation

Session: 4061 Canadian Climate Services, Impact Assessment, and Actionable Climate Information - Part 2 Services climatologiques canadiens, évaluation des incidences et informations climatiques exploitables - Partie 2 **27/05/2025 13:30**

ID: 12423 Contributed abstract

Virtual

1991-2020 Canadian Climate Normals

Chantale Cerny [1] , *Diana Nguyen* [2]

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Presented by / Présenté par: *Chantale Cerny*
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The Meteorological Service of Canada (MSC) operates an extensive national meteorological network that monitors, collects, and disseminates millions of environmental, weather, and climate observations to service both Canadians and institutions alike. Observational data from surface weather stations operated by the MSC and its partners are processed and archived for long-term access, in which climate data products such as the Canadian Climate Normals are tabulated from.

“Climate Normals” or “climate averages” are used to summarize or describe the average climatic conditions of a particular location. They refer to arithmetic calculations based on

observed climate values over a specified time period. Climate normals are often used to classify a region's climate and help make decisions for a wide variety of purposes involving habitability, agriculture, forestry, energy use, transportation, infrastructure, and research spanning across different fields. These are also used as a reference for seasonal weather monitoring for public interest, drought or forest fires risk management, and climate change adaptation planning.

In December 2024, the MSC completed its publication of the 1991-2020 Climate Normals, making normals data available on the Historical Climate Data website for 450 locations across the country. This set comprises of 30-year averages, normal-period extremes and long-term extremes. With this latest edition, many production changes had to be made to account for the evolving observation networks, data availability, and adherence to the product’s completeness rules. For the first time, normals and extremes are calculated using composite stations, where data from individual stations are joined to create a 30-year data series, by element, for a given location.

Session: 4061 Canadian Climate Services, Impact Assessment, and Actionable Climate Information - Part 2 Services climatologiques canadiens, évaluation des incidences et informations climatiques exploitables - Partie 2 **27/05/2025 13:45**

ID: 12431 Contributed abstract

Comparing climate data in northern Canada to aid in climate change adaptation

Nicole Loeb [1] , *Ruth Moore* [2] , *Teah Lizee* [3] , *Hayley Dosser* [4]

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Presented by / Présenté par: *Nicole Loeb*
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The Canadian Centre for Climate Services (CCCS) supports climate change adaptation in Canada by providing high-quality climate data and tools. Given that northern Canada's is warming three times faster than the global average [1], there is a critical need for tailored data to aid decision-making in these regions. However, sparse station data and regional challenges complicate this effort. This project aims to enhance CCCS’s ability to provide constructive, quantitative guidance on the fitness-for-purpose of climate datasets for users in Canada’s North.

This is a comparative study of historical data and future climate projections at the local level in northern Canada to provide guidance about the various datasets available that could be used for climate change adaptation. Approximately 15 communities (locations) with different environmental conditions and varying levels of data availability have been selected in collaboration with CCCS’s northern partners for analysis. Datasets used in this study include stations (within the ECCC network and independent community stations), adjusted historical datasets (AHCCD, PCIC-Blend etc.), reanalysis (ERA5-Land & RDRS), reanalysis driven RCMs (CORDEX NA), ClimateNA, GCMs (CMIP6)

and downscaled GCMs (CanDCS-U6 & CanDCS-M6). Temperature and precipitation-based climate variables and indices are analyzed, assessing each dataset results at a local level. This study also analyzes how different datasets can be used for adaptation purposes, advising on which datasets to use in the absence of station observations, and the limitations of any suggested data or methodologies.

Most of the output of this project will be available in plain language to ensure accessibility for a wide audience. This work will support the CCCS' Service Delivery's Northern and Indigenous team and the CCCS's northern partners in their work. This talk will give an overview of this project with preliminary results and expected outcomes of this project.

[1] Chapter 4 — Canada's Changing Climate Report

Session: 4061 Canadian Climate Services, Impact Assessment, and Actionable Climate Information - Part 2 Services climatologiques canadiens, évaluation des incidences et informations climatiques exploitables - Partie 2 **27/05/2025 14:00**

ID: 12242 Contributed abstract

Bias-adjusted projections of snow cover indices over the Quebec Province using an ensemble of regional climate simulations

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Presented by / Présenté par: *Émilie Bresson*
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Access to climate scenarios of snow cover and the resulting indices has long been of interest to many users. In the climate change context, stakeholders and decision-makers are in demand for an easily accessible projected portrait of snow cover to develop adaptation plans.

To meet this need, we produced an ensemble of climate scenarios of snow water equivalent (SWE) indices over the Quebec Province which is available upon request and will be publicly released soon. We applied a statistical bias adjustment to an ensemble of regional climate simulations of SWE. This bias adjustment required some fine tuning to operational methods, mainly due to the seasonality of SWE. We calculated SWE indices of interest for several sectors based on the bias-adjusted SWE. These indices include, but are not limited to, snow season duration, start and end and maximum of SWE.

A thorough analysis was conducted to document the snow cover changes and assess the climate data we produced. First, an overview of changes over the Quebec Province was studied. Then to understand the evolution in the snow cover behaviour more precisely, the changes in the timing of the beginning and end of the snow season, in large SWE accumulations in 24 hours, and in the days without snow on the ground

during the snow season were investigated over smaller regions.

Session: 4061 Canadian Climate Services, Impact Assessment, and Actionable Climate Information - Part 2 Services climatologiques canadiens, évaluation des incidences et informations climatiques exploitables - Partie 2 **27/05/2025 14:15**

ID: 12369 Contributed abstract

Assessing the use of the Canadian Surface Reanalysis (CaSR) for Drought Prediction in Canada

Marilee Pregitzer [1] , *Catherine Champagne* [2] , *Richard Warren* [3] , *Tyler Black* [4]

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Presented by / Présenté par: *Marilee Pregitzer*
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Drought prediction in Canada is essential for minimizing the impacts of water shortages on agriculture, ecosystems, and the economy. With extensive agricultural regions across the country, early warning systems play a critical role in reducing economic losses and assisting farmers in decision-making. Assessing drought and other climate related risk requires both historical and current climate conditions. Agriculture and Agri-Food Canada (AAFC) has traditionally developed drought indicators, such as Palmer Drought Severity Index (PDSI), Standardized Precipitation Index (SPI) and Standardized Precipitation Evapotranspiration Index (SPEI) using station based data where current conditions can be normalized against a 30 year baseline. These provide good estimates at point locations but lack the spatial density to assess droughts at a national scale.
This research explores the combined use of Canadian Surface Reanalysis (CaSR) and Regional Deterministic Prediction System (RDPS) data from Environment and Climate Change Canada (ECCC) to generate key drought indices in real time, which are then applied in machine learning models for drought forecasting. CaSR datasets provide high-resolution, continuous climate variables such as precipitation, temperature, and soil moisture, making them valuable for calculating drought indices relevant to agricultural conditions. These were compared against existing indices calculated from climate stations and assessed for their value in analyzing drought events.
These indices serve as essential input features for machine learning models, enabling them to identify patterns and trends associated with drought occurrences. With droughts becoming more frequent and severe across various regions, the approach of integrating CaSR with machine learning will help strengthen early warning systems, enhance prediction accuracy, and extend lead times for proactive drought management.

Session: 4061 Canadian Climate Services, Impact Assessment, and Actionable Climate Information - Part 2 Services climatologiques canadiens, évaluation des incidences et informations climatiques exploitables - Partie 2 **27/05/2025 14:30**

ID: 12278 Contributed abstract

Optimal cropping patterns securing agricultural benefits on potential arable land in northern high latitudes under climate change

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Presented by / Présenté par: *Lina Wu*
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Agricultural expansion made possible from warming climate conditions in Arctic and sub-Arctic regions is being promoted as a means to mitigate food insecurity while enhancing economic development. We first conducted comprehensive counterfactual analyses of potential agricultural production in Northwest Territories (NWT), Canada under baseline (2010-2019) and the latest CMIP6 climate change scenarios in both the near (2040-2059) and far (2080-2099) future based on an optimization model. Findings indicate that Shared Socioeconomic Pathways (SSPs) in the 2090s intensify water deficit and reduce the yields of crop varieties with shorter growing periods while increasing the average yields of crop varieties with longer growing periods by reducing the risk of crop failure from fall frost. Shifting cropping patterns can achieve stable average economic benefits of $0.5 billion from large-scale agricultural expansion. Canola and oats are the two most profitable crops, each accounting for 35% of the total allocated land. Although the spatial distribution of crops changes in response to climate change, the land share of canola at the territorial level is robust. Global sensitivity analysis shows that the optimal cropping patterns and total net benefits are sensitive to the price of lentils. Moreover, the cropping pattern shift aiming to maximize territorial net profits redistributes regional economic benefits. Additionally, climate change possibly increases regional crop diversity within NWT in the near future, while this diversity likely decrease further in the far future. These findings are relevant to other high-latitude areas where agricultural expansion is being considered.

Session: 6011 Observation and modelling of snow and glacier processes - Part 2 Observation et modélisation des processus liés à la neige et aux glaciers - Partie 2

Convenors:

Christopher Marsh 1 , Phillip Harder 2 , Vincent Vionnet 3 , Caroline Aubry-Wake 4 , Libo Wang 1
1 Climate Research Division, Environment and Climate Change Canada, Canada
2 Croptimistic Technology Inc, Canada
3 Meteorological Research Division, Environment and Climate Change Canada, Canada
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Unprecedented anthropogenic climate and land use change are dramatically impacting the cold region processes that shape seasonal snowcovers and glaciers worldwide. Billions of people depend on the seasonal snowcovers and glaciers to provide essential freshwater flows for local and downstream communities and ecosystems. There are therefore significant incentives to provide better estimates of these changing physical processes through improved observations, analysis, and modelling. In this session, we invite contributions on all aspects of snow, ice, and glaciers including impacts on cold-regions meteorology, hydrology, surface-atmosphere-energy exchanges, frozen soil dynamics, glacier dynamics, and groundwater coupling. Contributors are encouraged to share their experiences, insights, and advances in utilizing existing and next-generation tools for observations, analysis, and/or modelling spanning all climate zones. Contributions that span the traditional CMOS and CGU boundaries are particularly encouraged.

Session: 6011 Observation and modelling of snow and glacier processes - Part 2 Observation et modélisation des processus liés à la neige et aux glaciers - Partie 2

27/05/2025 13:30

ID: 12298 Contributed abstract

Snow persistence mapping in the Yukon River Headwaters using Google Earth Engine

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Presented by / Présenté par: *Stephanie Saal*
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The headwaters of the Yukon River begin at the Juneau Icefields at the border of Alaska and British Columbia at above 2000m, leading into a system of large lakes, the Southern Lakes, which are the start of the Yukon River. The stratification of and the snow water equivalent (SWE) contained in the snowpack in this area have major impacts on ecology and water supply. In 2021, record amounts of snow in conjunction with a heat wave that melted the available snow quickly across several elevation bands, caused major flooding in Southern Lakes communities. Runoff in the region further contributes to hydro power generation. Despite the significant role snow plays in the lives of local people, animals, and plants, our understanding of the snowpack, particularly in mountains, is poor.
This paper tackles the problem using remote sensing. By classifying snow covered area (SCA) throughout the year and subsequently calculating snow persistence, we can grow our understanding of snowpack availability and changes over the years. We built off the work from Wayand et al (2018) and perform updated SCA and snow persistence calculations in Google Earth Engine (GEE). The web-based nature of GEE makes it an accessible tool for many users and code can be easily shared and applied to wider areas. This study focuses on a subset of the Yukon Headwaters that covers a wide range of elevation bands, aspects, and land covers. The algorithm is then to be expanded to the entire subwatershed, yielding valuable insights into the mountain snowpack.

Session: 6011 Observation and modelling of snow and glacier processes - Part 2 Observation et modélisation des processus liés à la neige et aux glaciers - Partie 2 **27/05/2025 13:45**

ID: 12293 Contributed abstract

Accumulated SWE Days: A New Metric to Quantify Snowpack Changes?

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Presented by / Présenté par: *Joseph Shea*
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Mountain snowpack changes are commonly measured using observations of snow water equivalence (SWE) at discrete points in time (e.g. April 1). However, the seasonal/daily variability in SWE in mountainous regions may limit the usefulness of this approach, and the choice of a single point in time limits transferability of such approaches between regions and elevations. We develop a new metric (accumulated SWE days; ASWE) that integrates daily SWE observations from snow-on to snow-off dates to quantify both the duration of snow cover and the magnitude of the snowpack, and apply it to 11, 071 stations from the Northern Hemisphere reconstructed SWE dataset (Collados-Lara et al., 2023). Mean peak SWE and median ASWE are highly correlated, but the ASWE metric contains additional information, and examples from low and high ASWE seasons at individual stations are used to assess the utility of the metric in different snow climatologies. Cluster analyses of ASWE reveals distinct regional and global snowpack signatures, and trends in ASWE are assessed for sites with greater than 20 years of data. Overall, 69% of sites in the Northern Hemisphere show significant decreasing trends in ASWE, with the most negative trends observed in the Alps, southern Norway, and the Pacific Northwest. Conversely, significant positive trends in ASWE are found across most of Eurasia, suggesting different regional snowpack responses to ongoing climate change.

Session: 6011 Observation and modelling of snow and glacier processes - Part 2 Observation et modélisation des processus liés à la neige et aux glaciers - Partie 2 **27/05/2025 14:00**

ID: 12402 Contributed abstract

Virtual

State of Canadian Snow Observations (Draft) Report

Chantale Cerny [1] , *Frank Weber* [2] , *Sean McLeod* [3]

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Presented by / Présenté par: *Chantale Cerny*
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Snow plays an important part in Canadian life. It affects a broad range of industrial activities, recreation, environmental processes, and is a component of the water cycle. As snow monitoring practices and technology evolve, data collection should align with user needs and applications. Snow data and its monitoring practices must be well documented, accessible and discoverable to improve user awareness and comparability of existing snow data resources.

The Canadian Council for Weather and Climate Monitoring (CWAC), a governance mechanism between Environment and Climate Change Canada and its provincial and territorial counterparts, has assembled a working group that was tasked with developing a comprehensive assessment of the state of snow monitoring in Canada. The working group is comprised of representatives from snow monitoring network operators from territorial, provincial and national agencies, the avalanche sector, municipal utilities, and hydroelectric utilities.

The report under development will contain summarised information gathered through a survey of 50+ snow monitoring network operators and data users, conducted in the November to December 2023 period. The report seeks to characterize the major operational snow monitoring networks in Canada, including their technologies, instrumentation, network densities, and processes. The information can be used to raise awareness of the differences in current methods and to potentially improve standardization. The observational practices described are presented by element, such as total snow depth, water equivalent of snow cover, and precipitation. Regional analysis is accompanied by maps that show a snapshot of current distribution of surface-based monitoring stations. The report contains information on data production, dissemination and usage. Strengths and weaknesses of Canadian snow observation systems are summarized, and recommendations are provided.

Session: 6011 Observation and modelling of snow and glacier processes - Part 2 Observation et modélisation des processus liés à la neige et aux glaciers - Partie 2 **27/05/2025 14:15**

ID: 12252 Contributed abstract

Virtual

Assimilation of synthetic radar backscatters at Ku-band to improve SWE estimates

Nicolas Leroux [1] , *Vincent Vionnet* [2] , *Courtney Bayer* [3] , *Julien Meloche* [4] , *Marco Carrera* [5] , *Bernard Bilodeau* [6] , *Maria Abrahamowicz* [7] , *Franck Lespinas* [8]

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Presented by / Présenté par: *Nicolas Leroux*
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In cold regions, snow serves as the primary water source for downstream rivers and lakes. Accurate snow water equivalent (SWE) estimation is hindered by the sparse ground observation network and the low resolution of satellite passive microwave products. To address this, Environment and Climate Change Canada and the Canadian Space Agency are developing the Terrestrial Snow Mass Mission (TSMM), a dual Ku-band satellite mission designed to measure backscatter at 13.5 GHz and 17.25 GHz across Canada at a 500-m resolution with a weekly temporal resolution. This study assesses the feasibility of assimilating TSMM-measured backscatter to enhance SWE estimates in a synthetic experiment, where 'observational' data are generated using a model that is also employed in the assimilation process. We used the Soil, Vegetation, and Snow land surface model (SVS-2), which incorporates the snowpack model Crocus, coupled with the Snow Microwave Radiative Transfer (SMRT) model. Observations extracted at weekly intervals from the synthetic truth (SWE, snow depth, and backscatter) were assimilated with a particle filter at point-scale at Powassan, Ontario, during the 2022/23 winter. Meteorological forcing derived from the high-resolution Canadian meteorological model was perturbed to generate an open-loop ensemble of snow simulations for assimilation. Results indicate that assimilating backscatters reduced the root mean square error of SWE estimates by a factor of 2.5 compared to the open-loop ensemble, performing similarly to snow depth assimilation. When SWE observations were assimilated with a low uncertainty typical of manual measurements, they outperformed backscatter assimilation in SWE estimation. However, if the uncertainty was typical of SWE retrieved from space, SWE and backscatter assimilations showed similar performances for SWE estimation, but backscatter assimilation better captured internal snow properties (density and specific surface area). These findings demonstrate the potential of direct Ku-band backscatter assimilation to enhance both bulk SWE and vertical snow property estimates.

Session: 6011 Observation and modelling of snow and glacier processes - Part 2 Observation et modélisation des processus liés à la neige et aux glaciers - Partie 2 **27/05/2025 14:30**

ID: 12426 Contributed abstract

Assessing the Impact of Vegetation Factors influencing the Premelt Distribution of Snow Water Equivalent in Sub-alpine Mountain Environments

Marc Pons [1] , *Alex Cebulski* [2] , *Madison Harasyn* [3] , *John Pomeroy* [4]

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Presented by / Présenté par: *Marc Pons*
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Vegetation structure significantly influences the spatial variability of snow accumulation within forested areas due to snow redistribution by wind transport and canopy interception, and due to variability in snow ablation energetics. However, the detailed mechanisms by which topography, canopy density and canopy structure affect snow interception and distribution in mountains remain incompletely understood. This study investigates how various forest structural characteristics influence the spatial distribution of snow across diverse forest stands at Fortress Mountain Research Basin, Canadian Rockies, Alberta, Canada. The focus is on understanding how spatial distributions of snow water equivalent (SWE) are modulated by varying forest structural characteristics, from dense coniferous stands to open canopy areas, whilst accounting for terrain features and wind conditions during different snowfall events. Analysis of multiple forest types revealed distinct patterns of snow accumulation related to canopy architecture, stem density, and crown closure. High-resolution observations combining drone-borne lidar and spatially distributed snow surveys enabled detailed analysis of forest structure and its relationship to snow distribution patterns across different forest compositions and densities. Findings indicate that a significant portion of the spatial variance in SWE can be attributed to variations in local forest structure as well as forest density, with marked differences between forest structural types. Dense coniferous stands showed different snow accumulation patterns compared to mixed or more open forest areas, highlighting the importance of forest structure in snow distribution. These insights will help to refine and extend to other terrain conditions and forests the integration of fine-scale vegetation metrics into models predicting snow distribution under forest canopies and improve the accuracy of snow hydrology models.

Session: 8021 Changing Chemical Loads in Evolving Watershed - Part 2
Modification des charges chimiques dans un bassin versant en évolution - Partie 2

Convenors:

Xiaochuang Bu (University of Waterloo)
Serghei Bocaniov (University of Waterloo)
Noelle Starling (University of Waterloo)
Raoul-Marie Couture (Université Laval)
Helen Baulch (University of Saskatchewan)

Global environmental changes—driven by accelerated climate shifts and intensified human activities—are reshaping water systems worldwide. Canada, endowed with vast and diverse water systems including the Great Lakes, extensive river networks, expansive wetlands, coastal and estuarine systems, provides a unique and critical context for investigating these changes. As sentinels of environmental disturbance, water bodies reflect changes in climate, land use, and pollutant transport through measurable variations in chemical loads of key elements (e.g., C, N, P, Cl) and contaminants. Faced with challenges such as permafrost thaw, cultural eutrophication, increasing salinization and aquatic pollution, it is imperative to understand the factors that contribute to and shape chemical loads, discharge and biogeochemical fluxes across waterbodies is imperative.
This session aims to advance the systematic study of chemical loads, discharge and biogeochemical fluxes in changing water systems. It also focuses on quantitative and qualitative characterization of these processes not only under past and present climates but also their predictions under future climatic conditions or extreme events. We invite

abstracts utilizing field experiments, observations, and modeling to characterize the transport and biogeochemical transformations of carbon, nutrients, metals, major ions, and contaminants in inland waters, estuaries, and coastal environments. We welcome contributions related to existing databases, diagnostic methods, data analysis, and applications of artificial intelligence.

Session: 8021 Changing Chemical Loads in Evolving Watershed - Part 2 Modification des charges chimiques dans un bassin versant en évolution - Partie 2 **27/05/2025 13:30**

ID: 12301 Contributed abstract

Modeling regional hydrology, crop yields, and soil phosphorus dynamics in Nelson River Basin

Yinlong Huang [1] , *Monireh Faramarzi* [2] , *Miles Dyck* [3] , *Symon Mezbahuddin* [4]

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Presented by / Présenté par: *Yinlong Huang*
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With a growing global population, increasing food production while protecting water and environmental health is essential. Mid-to-high latitude agricultural watersheds, such as Canada’s Nelson River Basin (NRB), are key global breadbaskets but face challenges such as soil nutrient loss, water pollution, and reduced crop yields under extreme climate events such as droughts and water loggings.
Soil phosphorus (P), a crucial soil nutrient, is depleting faster than it is replenished, affecting crop yields and water quality through runoff, leaching, and mobilization. A critical question arises: how can these regions sustain food production while protecting water resources and adapting to climate extremes?
This study develops watershed-scale models to assess farming practices, soil nutrients, and water processes under changing climates. Using an improved Soil Water Assessment Tool (SWAT-C) with 37 years of hydroclimate and agricultural data, it simulates soil and watershed hydrology, crop productivity, and soil nutrient dynamics under various management options (fertilizer, planting, harvesting, and tillage) and climate change scenarios. Preliminary calibration metrics for an example agricultural catchment within NRB are 0.52 (bR^2) for streamflow and 0.0155 (Mean Square Error) for crop yield. The calibrated model can accurately simulate solution P in the soil for the 1998-2006 period, representing mechanism driving its mineralization, absorption, decomposition, and mobilization from soil layers. Scenario analysis investigates soil P relations with soil temperature, and links between extreme climate events, soil hydrology, and crop production. This research provides insights into processes and mechanism driving soil P dynamics in agricultural watersheds and the effects of changing climate. The model will expand to cover entire NRB and the results can inform water-food managers for balancing crop productivity, Soil P retention, and water quality

conservation in NRB and similar agricultural watersheds in cold regions.

Session: 8021 Changing Chemical Loads in Evolving Watershed - Part 2 Modification des charges chimiques dans un bassin versant en évolution - Partie 2

27/05/2025 13:45

ID: 12302 Contributed abstract

Modelling the sensitivity of plant carbon inputs and soil carbon export to hydro-climatic changes in temperate grasslands of Nelson River Basin

Krushil Modi [1] , *Monireh Faramarzi* [2] , *Cameron Carlyle* [3]

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Presented by / Présenté par: *Krushil Modi*
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Grassland ecosystems are among the most important carbon sinks, globally. While grasslands sequester organic carbon, decomposition of plant residual and the rate of plant carbon input and export, as well as microbial processes can be accelerated under global warming effects, releasing higher rates of dissolved organic carbon (DOC) into water bodies. Moreover, future droughts can reduce aboveground biomass, increasing erosion and the transport of sediment and their particulate organic carbon (POC). The POC and DOC loss from soils can contribute to downstream water bodies endangering water quality and ecosystem health.
In cold climate regions such as temperate grasslands of Canadian Prairies, the spatiotemporal variability of plant carbon input are affected by shifts in numerous biogeochemical and physical processes, such as changes in soil freeze-thaw cycles, snowmelt, and evapotranspiration, vegetation growth, soil microbial processes among others. While the impacts of changes in precipitation and atmospheric temperature on grassland biomass and carbon input to the soil are generally well documented, a systematic assessment of such mechanism at a large watershed scale is poorly characterized in northern temperate grasslands such as those in Nelson River Basin in western Canada. Further, compound and lagged effects of climate warming and moisture depletion on plant carbon inputs remain unclear. Using empirical knowledge the study improves a process-based Soil and water Assessment Tool (SWAT-C) to simulate biogeochemical processes linking climate, above-and-below-ground biomass, SOC dynamics and its export under historical (1990-2021) and future (2030-2070) climate change scenarios. The calibrated model results show that during dry years of historical period, plant carbon inputs to the soil decrease by 10% to 40%, while soil carbon export to atmosphere increases by 5% to 15%. Further analysis elaborates on the potential impacts under global warming scenarios.
This study develops an improved understanding of the processes driving plant carbon inputs in northern temperate grasslands and their vulnerabilities to climate change. It lays the basis for improved understanding of SOC exports and their loads to downstream water bodies in NRB, highlighting challenges in similar watersheds in the mid-to-high latitudes.

Session: 8021 Changing Chemical Loads in Evolving Watershed - Part 2 Modification des charges chimiques dans un bassin versant en évolution - Partie 2

27/05/2025 14:00

ID: 12407   Contributed abstract

Understanding the impact of continuous cover on phosphorus export at the watershed scale in agricultural watersheds on the Canadian side of Lake Erie

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[1] Toronto Metropolitan University
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Presented by / Présenté par: *Laya Ahmadi*
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Eutrophication is a continuing water quality hindrance in the Laurentian Great Lakes, and is driven largely by excess phosphorus inputs to the Lakes. There is significant interest in reducing phosphorus losses to downstream ecosystems from multiple sources, including agricultural nonpoint sources. Experimental edge of the field research has highlighted the importance of continuous cover in reducing nutrient export to water bodies downstream. Many mechanistic modelling studies have quantified a watershed scale reduction of phosphorus loading as a result of cover crops. However, empirical evidence at the watershed scale for decreased loading of nutrients due to the adoption of continuous cover remains elusive. This is due to the paucity of approaches to empirically link land management with water quality. This research applies generalized additive models (GAMs) to integrate information from a pair of well monitored streams from Southern Ontario with a land management survey administered there. By representing both the effects of in-stream variability and land management in the same statistical model, we are able to account for the effects of continuous cover on phosphorus losses using a statistical approach at the watershed scale. The results will inform watershed policy by leading to a parsimonious, quantitative estimate of the effects of continuous winter cover on stream phosphorus loading.

Session: 8021 Changing Chemical Loads in Evolving Watershed - Part 2 Modification des charges chimiques dans un bassin versant en évolution - Partie 2

27/05/2025 14:15

ID: 12442   Contributed abstract

Constructing a fine-grained sediment budget for a major salmon spawning tributary in the Quesnel watershed

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Presented by / Présenté par: *James Rankin*
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Constructing a fine-grained sediment budget for a major salmon spawning tributary in the Quesnel watershed

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Keywords: Fine sediments, sediment erosion, sediment budget
Abstract
The Horsefly River, located in the Cariboo region of British Columbia, is a major tributary of the Quesnel River watershed and provides critical spawning habitat to three populations of anadromous salmon of the Fraser River. Within the watershed, biophysical processes and anthropogenic land uses at the landscape level have created conditions where sediment erosion and deposition have degraded critical spawning reaches of the Horsefly River. Within the research undertaken, sediments have been collected, processed, and analyzed to establish a sediment budget in an effort to understand the inputs and fluxes of fine-grained sediment moving throughout the system. Automatic water and sediment samplers were installed at several existing discharge monitoring stations operated by Water Survey of Canada. The water samples were used to determine suspended sediment concentration, which, when paired with the discharge data, enabled us to estimate suspended sediment loads. In addition, time-integrated samplers were used to collect bulk samples which were analyzed for particle size composition, and the concentrations of nutrients and metals to estimate the flux of fine-grained sediment and associated chemicals, and their delivery to downstream spawning habitat, including the watershed outlet to Quesnel Lake, an important salmon nursery lake. Other components of the sediment budget (e.g., floodplain sedimentation, channel bank erosion and channel bed storage) were also evaluated. This research bridges knowledge gaps between biophysical processes at the landscape level and ecosystem services and functions, including productive fisheries and healthy watershed features that can support resilient futures.

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27/05/2025 14:30

ID: 12529 Contributed abstract

Mapping and Modelling the Cumulative Impacts of Surface Disturbances on Water Quality in the Stewart River Watershed, Yukon

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Presented by / Présenté par: *John Foster*

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The Stewart River watershed in the Traditional Territory of the First Nation of Na-Cho Nyäk Dun (FNNND) in Yukon, Canada, has experienced significant landscape disturbance from wildfires, permafrost thaw, and anthropogenic land use. These disturbances can impact a variety of chemical and physical water quality parameters known to influence aquatic ecosystems and watershed health.

To support FNNND in land-use and conservation planning, this ongoing research seeks to quantify the relationship between landscape disturbance and water quality in the Stewart River watershed. The specific objective is to develop spatially-explicit empirical models that relate observed water quality parameters to a) mapped surface disturbances, b) landscape characteristics (e.g. land cover and topography), and c) disturbance proximity to the stream network. These models will provide insight into how watershed composition and configuration influence water quality, either amplifying or mitigating the effects of disturbance.

This presentation will outline the broader objectives of this project alongside water quality results from sampling campaigns conducted in 2023 and 2024. From late spring to the end of summer, a total of 40 stream sites representing a gradient of watershed impacts were sampled, including reference sites with minimal to no disturbance. Water quality varied significantly among sites, driven in part by disturbance location and type, but also shaped by broader landscape characteristics. Predictive mapping, based on the empirical models, identifies areas across the study area at risk of elevated disturbance impacts. Findings from this work will support evidence-based decision-making in the upcoming land-use planning process for the FNNND Traditional Territory, inform long-term water quality monitoring, and contribute methods for regionally specific cumulative effects assessments.

Day 3 – 28 May 2025

Session: 1003 Plenary - How marine emissions contribute to atmospheric particles, with implications for climate Plénière - Comment les émissions marines contribuent aux particules atmosphériques, avec des implications pour le climat **28/05/2025 09:00**

ID: 12573 Invited plenary speaker

How marine emissions contribute to atmospheric particles, with implications for climate

Rachel Chang [1]

[1] **Dalhousie University**

Presented by / Présenté par: ***Rachel Chang***
Contact: rachel.chang@dal.ca

Dr. Rachel Chang
Department of Physics and Atmospheric Science, Dalhousie University

BIO

Dr. Rachel Chang is an associate professor in the Department of Physics Atmospheric Science at Dalhousie University and a Tier 2 Canada Research Chair in Atmospheric Science. Her research uses a combination of ambient measurements, laboratory experiments, and modelling studies to explore air-sea interactions and the climate impacts of these processes through the formation of liquid fog and cloud droplets. Past studies have focussed on marine and coastal atmospheres such as the North Atlantic, the summer Arctic, and the East Pacific. Before starting at Dalhousie, Dr. Chang obtained degrees from the University of Toronto in Engineering Science, Chemical Engineering, and Environmental Chemistry, and completed a post-doctoral fellowship at Harvard University.

The exchange of energy and mass between the ocean and atmosphere occurs over many scales and in both directions, with implications for the physical and chemical state of both the atmosphere and ocean. This talk focuses on the how gases and particles emitted from the ocean can affect the aerosol particle population observed in the marine atmosphere, and the potential climate effects based on their impact on clouds, which can be quite extensive over the oceans. One region of the world that is extremely sensitive to cloud cover is the summer time Arctic, when sea-ice has retreated and the radiation is at its maximum. These conditions lead to ocean biological activity, which likely results in volatile organic compounds (VOC gases) being emitted into the atmosphere. Using atmospheric aerosol particle measurements from the Polar Environment Atmospheric Research Laboratory at Eureka, NU (80N, 86W) as well as the NETCARE (Network on Climate and Aerosols) cruises on board the CCGS Amundsen, we infer that these VOCs contribute to the frequent new particle formation and growth events observed in the Canadian Arctic Archipelago and that they can grow to sizes relevant for cloud droplet formation. Supporting model simulations show that this new source of aerosol particles can lead to 0.4 W/m2 of cooling in the Arctic summer through cloud-albedo radiative effects. Aerosol particles can also be emitted directly from the ocean into the atmosphere through sea spray, although the impact of ocean conditions on this flux remains uncertain. Recent results from laboratory experiments of sea spray aerosol generated from water sampled from the Halifax harbour show a distinct annual cycle. By linking this variability to the biological, chemical and physical properties of the harbour water, we highlight the potential impact of ocean properties on sea spray aerosols as well as their ability to impact climate through cloud formation. Together, this work shows that the emissions of marine gases and particles vary depending on the physical, chemical, and biological conditions of the ocean, impacting aerosol and cloud

properties, and therefore climate.

Session: 1004 Plenary (Woo Lecture) - From hydrological process studies to watershed management: can we bridge the scale gap?
Plénière - De l'étude des processus hydrologiques à la gestion des bassins versants : peut-on combler l'écart d'échelle ? 28/05/2025 09:00

ID: 12572 Invited plenary speaker

From hydrological process studies to watershed management: can we bridge the scale gap?

Genevieve Ali [1]

[1] McGill University

Dr. Genevieve Ali
Department of Earth & Planetary Sciences, McGill University

BIO

Genevieve Ali is an Associate Professor at McGill University, cross-appointed in Earth & Planetary Sciences and in Geography. She specializes in catchment hydrology, with a dual focus on forested and agricultural systems. Her research group uses both field data and remotely sensed data to study runoff generation processes, contaminant export dynamics, and ecohydrological connectivity, from small experimental plots (e.g., 1 m2) to large transboundary basins (e.g., Lake Winnipeg and Lake Erie Basins). Her recent focus has been on ‘engineered’ landscapes where dominant runoff sources and flow paths are significantly altered by surface drains, tile drains, storage ponds, wetland loss, soil compaction, cover crops, and other agricultural practices.

Presented by / Présenté par: *Genevieve Ali*
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Recent water-related extreme events in Canada and elsewhere, be it floods, droughts, or algal bloom episodes, have underlined the importance of process studies in hydrology. While process knowledge is key to developing effective mitigation and preparation strategies, most hydrological and biogeochemical process studies rely on high-frequency and high-resolution data collected at small plot to small watershed scales. This small-scale approach to process studies is at odds with the much larger spatial scales at which water, nutrient, and land management policies are devised. Significant variability in climate drivers, physiographic factors, runoff generation processes, and chemical export patterns

makes the transfer of research results from small to larger scales difficult. However, increasingly easier access to regional or national datasets, from flow timeseries to reanalysis climate data and satellite-derived surface water presence, provides new opportunities for assessing the transferability of hydrological research methodologies from small to larger scales.

This Woo Lecture will examine runoff generation and water quality dynamics in hydrological systems ranging in size from one square meter to one million square kilometers. Special attention will be given to the characterization of thresholds, concentration-discharge relations, and connectivity, as they help with process understanding but could also serve as management tools. While this lecture will build on a variety of research projects conducted with students and collaborators at the University of Montreal, University of Manitoba, University of Guelph, and McGill University, its general topic originates from my past foray into Prairie Hydrology. The lecture will therefore make references to how past research on the Lake Winnipeg Watershed influenced a shift from small-scale hydrology research to multi-scale hydrology research.

Session: 7050 The Polar Night Experiment (PONEX) Aircraft Campaign in Inuvik - Part 1 Campagne aérienne de Polar Night Experiment (PONEX) à Inuvik - Partie 1

Convenors:

1. Zen Mariani, ECCC
2. Kaley Walker, University of Toronto
3. Natalia Bliankinshtein, NRC Canada

ESA’s Earth Cloud, Aerosol, Radiation Explorer (EarthCARE; launched in May 2024), NASA’s Atmosphere Observing System (AOS; launches in 2029+), and the CSA’s High-altitude Aerosols, Water vapour and Clouds (HAWC; launch in ~2031) will conduct meteorological, climate, and air quality observations over the Poles. A coordinated month-long ground-based and aircraft field campaign will be conducted from Inuvik, NWT, in January 2026 as part of the sub-orbital component of these missions.

This session will highlight the unique set of observations that will be conducted and invite presentations from the PONEX campaign team, including scientists from ECCC, NRC, CSA, and Canadian and American Universities. The campaign’s objectives, observations, flights, activities, and opportunities for collaboration and coordination will be described. Members of the CMOS research community are encouraged to submit presentations on existing or potential complementary investigations for this region and opportunities for synergies with the campaign.

Session: 7050 The Polar Night Experiment (PONEX) Aircraft Campaign in Inuvik - Part 1 Campagne aérienne de Polar Night Experiment (PONEX) à Inuvik - Partie 1

28/05/2025 10:30

ID: 12231 Contributed abstract

The Polar Night Experiment (PONEX) Aircraft Campaign: Overview

Zen Mariani [1] , *Alexei Korolev* [2]

[1] Environment and Climate Change Canada
[2] Environment and Climate Change Canada

Presented by / Présenté par: *Zen Mariani*
Contact: zen.mariani@ec.gc.ca

The Polar Night Experiment (PONEX) is a Canadian Space Agency (CSA) funded aircraft campaign to perform calibration and validation of the NASA-CSA Atmospheric Observing System (AOS) satellite mission. In addition, the European Space Agency (ESA) is also contributing to the campaign to support the EarthCARE satellite mission. PONEX consists of a three-week long coordinated ground-based and aircraft field campaign in Inuvik, NWT, in January 2026 as part of the sub-orbital component of both satellite missions. AOS requires pre-launch calibration/validation ("cal/val") of its instruments, particularly the Aerosol Limb Imager (ALI) and far infrared (FIR) imaging radiometer TICFIRE, both of which are of novel design. Synergistically, the EarthCARE satellite requires post-launch cal/val of its observations and retrieval algorithms.

PONEX will be the first to employ aircraft during Polar night where unique atmospheric conditions will provide unprecedented opportunities to fill potential verification/validation gaps and support other scientific research on cloud microphysics, aerosol chemistry, and numerical weather prediction modelling. PONEX aims to address the cal/val science objectives for both satellite missions' sub-orbital components, leveraging the two opportunities into a single field campaign. This presentation will provide an overview of the campaign, including the participating partners, science objectives, ground-based operations, and will discuss current and future opportunities for collaboration with the CMOS/CGU community.

Session: 7050 The Polar Night Experiment (PONEX) Aircraft Campaign in Inuvik - Part 1 Campagne aérienne de Polar Night Experiment (PONEX) à Inuvik - Partie 1

28/05/2025
10:45

ID: 12447 Contributed abstract

Virtual

The Polar Night Experiment (PONEX) Aircraft Campaign: overview, instrumentation, flight operations

Alexei Korolev [1] , *Zen Mariani* [2] , *Natalia Bliankinshtein* [3] , *Cuong Nguyen* [4] , *Leonid Nichman* [5] , *Mengistu Wolde* [6]

[1] Environment and Climate Change Canada
[2] Environment and Climate Change Canada
[3] National Research Council Canada
[4] National Research Council Canada
[5] National Research Council Canada
[6] National Research Council Canada

Presented by / Présenté par: *Alexei Korolev*
Contact: alexei.korolev@ec.gc.ca

The Polar Night Experiment (PONEX) is a Canadian Space Agency (CSA) funded aircraft campaign designed to perform calibration and validation of the NASA-CSA Atmospheric Observing System (AOS) satellite mission and to obtain new knowledge on the Arctic environment during polar night. Despite increasing interest in the mechanisms of Arctic amplification, previous research flights in the Arctic have been conducted exclusively during the polar day, leaving significant gaps in knowledge regarding dynamics, atmospheric chemistry, aerosol load, and cloud formation during the polar night. PONEX is the first research flight campaign to be conducted during the Polar night, aiming to acquire new knowledge to improve weather and climate forecasts in the polar regions. This will be achieved through a better understanding of key physical processes and an advanced representation of these processes within numerical weather and climate prediction models. PONEX will utilize the National Research Council (NRC) Convair-580 research aircraft for data collection. This presentation will provide a brief overview of the PONEX scientific objectives, with a subsequent focus on the instrumentation integrated into the NRC Convair-580, the data sampling strategies, and flight planning designed to meet the project's goals.

Session: 7050 The Polar Night Experiment (PONEX) Aircraft Campaign in Inuvik - Part 1 Campagne aérienne de Polar Night Experiment (PONEX) à Inuvik - Partie 1 **28/05/2025 11:00**

ID: 12501 Contributed abstract

Airborne studies onboard the NRC Convair-580 aircraft for advancement of atmospheric satellite missions

Natalia Bliankinshtein [1] , *Cuong Nguyen* [2] , *Leonid Nichman* [3] , *Keyvan Ranjbar* [4] , *Paloma Borque* [5] , *Kenny Bala* [6] , *Anthony Brown* [7] , *Mengistu Wolde* [8]

[1] National Research Council Canada
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Presented by / Présenté par: *Natalia Bliankinshtein*
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National Research Council of Canada’s Convair-580 is a twin-engine pressurized turbo-prop aircraft with flight ceiling of 24,000 feet and endurance of 5 hours. This research aircraft is capable of carrying over 5000 lbs of project payload, and up to 10 research personnel. It has participated in numerous impactful airborne studies since mid 1970s in Canada and internationally. The Convair-580 is customarily instrumented with 40+ sensor for in-situ and remote sensing of atmosphere, making it a unique facility in Canada, with a substantial track record of Arctic research.

In January 2026, the Convair-580 will deploy to Inuvik, Northwest Territories, to conduct the Polar Night Experiment (PONEX) field campaign for suborbital pre-launch calibration and validation of Canadian Space Agency's High-altitude Aerosols, Water vapour and Clouds (HAWC) mission. Responsible for the airborne component of the PONEX campaign, NRC is integrating prototypes of two of the HAWC sensors onboard the aircraft. Environment and Climate Change Canada's Far-InfraRed Radiometer (FIRR-2) has been placed in the fuselage for nadir view of the atmospheric column and optically thin ice clouds, and University of Saskatchewan's Aerosol Limb Imager (ALI) is being installed in the cabin, for aft limb view via a periscope.
NRC Convair-580 has participated in pre-launch and post-launch suborbital campaign for several notable satellite missions, such as CloudSat, Wind Velocity Radar Nephoscope (WIVERN), Earth Cloud Aerosol and Radiation Explorer (EarthCARE), Far-infrared Outgoing Radiation Understanding and Monitoring (FORUM) and others. NRC-led research and development projects also advanced remote sensing techniques of clouds and water vapour, in particular via NRC Airborne W- and X- band (NAWX) radar and High Spectral Resolution Airborne Microwave Sounder (HiSRAMS). This presentation summarizes lessons learned from recent campaigns in application for the upcoming PONEX deployment.

Session: 7050 The Polar Night Experiment (PONEX) Aircraft Campaign in Inuvik - Part 1 Campagne aérienne de Polar Night Experiment (PONEX) à Inuvik - Partie 1 **28/05/2025 11:15**

ID: 12346 Contributed abstract

Preliminary Results from the WHAFFFERS Campaign: Investigating Thin Ice Clouds during the Canadian Winter Using FIRR-2

Raphaël Peroni [1] , *Jean-Pierre Blanchet* [2] , *Zen Mariani* [3] , *Liviu Ivanescu* [4] , *Yann Blanchard* [5] , *Natalia Bliankinshtein* [6] , *Kenny Bala* [7] , *Paloma Borque* [8] , *Leonid Nichman* [9] , *Cuong Nguyen* [10] , *Keyvan Ranjbar* [11] , *Yi Huang* [12]

[1] Université du Québec À Montréal
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[3] Meteorological Research Division, Environment and Climate Change Canada, Toronto
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Presented by / Présenté par: *Raphaël Peroni*
Contact: peroni.raphael@uqam.ca

The WHAFFFERS (W-band, HiSRAMS, AERI, FIRR-2, FINESSE, and FIRMOS Experiment on Remote Sensing) airborne campaign was conducted from January 7 to February 14, 2025, covering an area extending from Ottawa, ON, to Mont-Saint-Hilaire, QC, between two instrumented ground stations. This campaign focused on investigating the radiative and microphysical properties of Thin Ice Clouds (TIC) using advanced remote sensing instruments onboard the National Research Council Canada's Convair-580 aircraft and ground-based instruments at Gault and Flight Research Laboratory at Ottawa. A key instrument in WHAFFFERS was the Far InfraRed Radiometer model 2 (FIRR-2), developed as a technological precursor for the upcoming Thin Ice Clouds and Far InfraRed Emissions (TICFIRE) satellite mission, supported by the Canadian Space Agency (CSA). FIRR-2 measures atmospheric radiation across eight spectral bands ranging from 7.9 μm to 27.5 μm, with a particular emphasis on the largely unexplored far-infrared region (λ > 15 μm). This spectral range provides valuable information on water vapor content and cloud microphysical properties, especially in cold and dry conditions. By leveraging this sensitivity, FIRR-2 enhances our understanding of the radiative budget and the water cycle in the cold regions of the atmosphere, including the polar regions, particularly during Arctic winters. This presentation will highlight preliminary results from the analysis of FIRR-2 data collected during the six WHAFFFERS flights. Using complementary measurements from other airborne instruments (in-situ clouds physics, radar and lidar) along with ground-based observations (weather balloons and microwave radiometer), we aim to assess the impact of ice and liquid water clouds on the measured radiances and brightness temperatures across FIRR-2's various spectral bands. The data collected during WHAFFFERS play a crucial role in preparing for the upcoming PONEX (POlar Night EXperiment) campaign, scheduled for January 2026 in Inuvik, NT. The insights gained will help optimize future observational strategies and enhance the scientific return of forthcoming Arctic measurement campaigns.

Session: 7050 The Polar Night Experiment (PONEX) Aircraft Campaign in Inuvik - Part 1 Campagne aérienne de Polar Night Experiment (PONEX) à Inuvik - Partie 1 **28/05/2025 11:30**

ID: 12345 Contributed abstract

Aerosol Limb Imager: ER-2 Updates and the new PONEX campaign

Landon Rieger [1] , *Paul Loewen* [2] , *Daniel Letros* [3] , *Adam Bourassa* [4]

[1] Environment and Climate Change Canada
[2] University of Saskatchewan
[3] University of Saskatchewan
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Presented by / Présenté par: *Paul Loewen*
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The Aerosol Limb Imager (ALI) is a Canadian instrument scheduled to fly on the High-altitude Aerosol Water vapour and Cloud (HAWC) mission in 2032. ALI will make radiance and polarization measurements of the limb in the visible and near infrared, providing unique information on aerosol scattering not previously obtained from limb instruments. For development of this mission, the Aerosol Limb Imager participated in an

ER-2 aircraft campaign making two flights over Southern California and along the West coast of the US. Observations from this campaign are used to test the ALI design and operation and validate the retrieval algorithms and updated results from this campaign are presented. Further testing of the ALI measurement concept will be done during the PONEX campaign, which will take place in January/February, 2026 over Canada's arctic, providing a unique set of conditions to test ALI operations and science. PONEX will also include the FIRR-2 instrument (similar to TICFIRE), providing the first opportunity to test the coordinated measurement and science goals of ALI and TICFIRE on the same platform.

Session: 7050 The Polar Night Experiment (PONEX) Aircraft Campaign in Inuvik - Part 1 Campagne aérienne de Polar Night Experiment (PONEX) à Inuvik - Partie 1

28/05/2025 11:45

ID: 12347 Contributed abstract

Measurements of light precipitation at the Trail Valley Creek research stations located in the Canadian Arctic

Julie Thériault [1] , *Hadleigh Thompson* [2] , *Joseph Durat* [3] , *Phil Marsh* [4]

[1] UQAM
[2] UQAM
[3] UQAM
[4] Wilfrid Laurier University

Presented by / Présenté par: *Julie Thériault*
Contact: theriault.julie@uqam.ca

Frequent yet sporadic periods of light precipitation in the Arctic environments are difficult to measure with the existing precipitation gauge networks across the Canadian north. While the underestimation of the total snowfall is still not well understood, it could be explained by a combination of gauge undercatch due to wind, and from missing information about light precipitation (0.01-0.2 mm h-1) that is not detected at all by current systems. During the 2023-2024 Arctic winter at Trail Valley Creek (TVC) research station, Northwest Territories, a micro rain radar and laser-optical disdrometer were installed to improve solid precipitation measurements. These instruments, along with manual observations performed during March 2024, confirmed the presence of low-rate snowfall that was not detected by the standard measurement gauges such as the Geonor precipitation gauge installed in a single Alter shield. Analysis of the micro rain radar data indicates that light precipitation contributes to 15-20% of the total annual snowfall in trail valley creek watershed. Here, we present an overview of these observations and measurements collected at TVC to highlight the relationship between the observed light precipitation and current instrumentation methods. Finally, we propose methods for the use of micro rain radars to detect low-rate snowfall while examining the potential for this instrument to become an integral part of Arctic meteorological observations.

Session: 2020 Collaborative Earth System Modelling in Canada Modélisation collaborative du système terrestre au Canada

Convenors:
Matthew Toohey (University of Saskatchewan)
Clint Seinen (Environment and Climate Change Canada)

Earth System Models (ESMs) are the principal tools used to understand and attribute past climate changes, to make projections of future climate, and to carry out near-term environmental predictions. The Canadian research community pursues collaborative research with ESMs across many domains, from the perspective of atmosphere/ocean science, cryospheric science, carbon-cycle science, and research related to land surface and hydrological processes. This collaborative research occurs within Canada and internationally, within government and academic settings, and within academic-government partnerships. Whatever the setting, the complexity and technical challenges associated with ESMs pose barriers to their development, application, and analysis without formal collaborative structures and advanced technical tools to facilitate their use. New technologies, including machine-learning and novel data-science approaches, advanced version control systems, reproducible runtime environments (containers), community analysis packages, and common computing resources are affording new collaborative opportunities from development to analysis to application. This session invites submissions on Earth System Models and modelling applications taking place in Canada, ranging from model descriptions through to applications and analysis procedures, across many earth system science domains that are unified by their use of ESMs and could be enhanced by stronger collaborative partnerships. Areas of interest include atmospheric/ocean model process and parameterization development (including sea-ice modelling), short-lived climate forcers and geoengineering/climate intervention, carbon cycle modelling (including climate change mitigation approaches such as atmospheric carbon dioxide removal), land-surface model development and application, and sea-ice/land-ice modelling. We invite submissions covering the modelling environment within Canada (including CanESM, the UVic ESM, GEM-NEMO, CanRCM, CRCM, etc.) and internationally (including CESM, WRF, CliMA, etc.). We seek to continue the discussion concerning challenges and opportunities for collaboration between universities, government laboratories, and the private sector; and the scientific results emerging from such collaborations.

Session: 2020 Collaborative Earth System Modelling in Canada Modélisation collaborative du système terrestre au Canada **28/05/2025 10:30**

ID: 12291 Contributed abstract

Virtual

Impacts of Climate and Land Use Change on the Terrestrial Water Cycle in North America from Regional Climate Model Simulations

Juliette Goulet [1] , *Olivier Asselin* [2] , *Alexis Berg* [3]

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[2] Ouranos
[3] Université de Montréal

Presented by / Présenté par: *Alexis Berg*

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Human activities influence the water cycle globally through greenhouse gas emissions and associated climate warming, but also regionally through land use changes. Altering land surface properties, such as reflectivity, roughness, or evaporative capacity, can cause significant regional impacts surface climate conditions and land water fluxes. Understanding these interactions is essential to predict future water cycle changes.

The objective of this study is to assess regional impacts of historical and future use cover changes on the water cycle in North America, in the context of climate change. We perform a set of regional climate simulations with the Canadian Regional Climate Model (CRCM5) over the North American CORDEX domain, with a horizontal resolution of 0.11 degree. These simulations use different combinations of climate and land cover conditions for present (1986-2015) and future (2071-2100) periods, for two distinct future socio-economic scenarios, SSP1 and SSP3, which correspond to different types and patterns of land use changes. We aim to compare future land cover and climate change impacts on surface climate and water fluxes.

Results from these simulations indicate significant regional impacts of future land use changes - separate from climate change - on regional mean near-surface climate and land surface hydrology, generally co-localized with the regions of maximal surface changes and thus showing different spatial patterns depending on the SSP scenario. Precipitation partitioning (into evapotranspiration ET and surface runoff Q) is generally modified in favor of ET at the expense of Q in regions of croplands expansion and of reforestation, which differ in the two scenarios. A Budyko-based analysis highlights the fundamentally different nature of land use change impacts on the water cycle from those of climate change. Under the SSP1 scenario, land use change impacts on the water cycle appear comparable in amplitude to those of climate warming.

Session: 2020 Collaborative Earth System Modelling in Canada
Modélisation collaborative du système terrestre au Canada **28/05/2025 10:45**

ID: 12225 Contributed abstract

Projected changes in wind speed and cloud fraction over Quebec using high-resolution climate models.

Yoandy Alonso [1] , *James King* [2] , *Biljana Music* [3] , *Hélène Côté* [4]

[1] Université de Montréal
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Presented by / Présenté par: *Yoandy Alonso*
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Climate models are essential tools for understanding and projecting changes in the Earth's climate system. By simulating the interactions between the atmosphere, ocean, land surface, and cryosphere, these models provide valuable insights into past, present,

and future climate conditions. Among their key applications, realistic simulations of wind and cloud patterns are crucial for understanding regional climate dynamics and assessing the potential impacts of climate change. This study analyses projected changes in wind speed and total cloud fraction for the period 2071-2100, using 1980-2010 as a reference, under the RCP 4.5 and RCP 8.5 scenarios. Simulations from an ensemble of Earth System Models (ESMs) and Regional Climate Models (RCMs) are examined over North America at two spatial resolutions: 0.22° (25 km) and 0.44° (50 km). Different pressure levels (surface, 850, 500, and 200 hPa) are analyzed to estimate how wind speed projections vary with altitude between global and regional models. These comparisons provide insight into the influence of model resolution and emission scenarios on projected wind and cloud patterns. Additionally, detailed wind speed and cloud fraction trends are analyzed at four Quebec locations: Pierre Elliott Trudeau, Gaspé, Kuujjuarapik, and Kuujjuaq. This local approach provides a fine-scale perspective on potential climate change, offering insights into regional variability and their impact on surface processes and local climate adaptation strategies. By improving our understanding of wind and cloud projections at different scales, this research contributes to refining regional climate projections and improving preparedness for future climate conditions.

Session: 2020 Collaborative Earth System Modelling in Canada
Modélisation collaborative du système terrestre au Canada **28/05/2025 11:00**

ID: 12247 Contributed abstract

Evaluation of the Growing Season Soil Moisture-Evapotranspiration Relationship in the Soil, Vegetation, and Snow (SVS) Land Surface Model

Charlie Ballantyne [1] , *Aaron Berg* [2] , *Marco Carrera* [3]

[1] University of Guelph
[2] University of Guelph
[3] Environment and Climate Change Canada

Presented by / Présenté par: *Charlie Ballantyne*
Contact: cballa01@uoguelph.ca

Land surface models are a crucial component of earth system modeling, simulating the influence of the land surface on atmospheric processes through the exchange of energy, water, and carbon. A key variable in the land-atmosphere relationship is evapotranspiration, which represents a large portion of the moisture and energy transferred from the surface to the atmosphere and is controlled by a combination of soil moisture, energy, and plant characteristics. Of particular interest is the critical soil moisture threshold, where evapotranspiration transitions from a soil moisture-limited regime to an energy-limited regime, as this value is generally considered a good indicator of local land-atmosphere coupling strength. However, the exact nature of this relationship represents a major source of uncertainty in land surface models. While previous studies of the Soil, Vegetation, and Snow (SVS) land surface model have evaluated soil moisture and land-atmosphere fluxes individually, none have done a detailed assessment of how it models the relationship between soil moisture and

evapotranspiration. This study compares SVS model outputs to observations from the University of Guelph's lysimeter site in Elora, Ontario, over the April-October growing season from 2017-2022. SVS tended to underestimate seasonal means of both evapotranspiration and soil moisture as well as the vertical soil moisture variation. It was also found to overestimate the critical soil moisture threshold, which in turn suggests that the land-atmosphere coupling in SVS is too strong. Overall, these results identify a number of weaknesses in the representation of key variables for land-atmosphere coupling, the improvement of which will serve to reduce overall model uncertainty.

Session: 2020 Collaborative Earth System Modelling in Canada
Modélisation collaborative du système terrestre au Canada **28/05/2025 11:15**

ID: 12308 Contributed abstract

How does tropospheric VOC chemistry affect radiative forcing in preindustrial climates? Investigations using the Community Earth System Model version 2

Noah Stanton [1] , *Neil Tandon* [2]

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Presented by / Présenté par: *Noah Stanton*
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The representation of volatile organic compound (VOC) chemistry in Earth System Models directly impacts secondary organic aerosol (SOA) formation, modifies aerosol abundances, and significantly changes concentrations of atmospheric oxidants. These changes have significant impacts on climate, as shown in Stanton and Tandon (2023) [https://doi.org/10.5194/acp-23-9191-2023]. Presently, we assess effective radiative forcing (ERF) of tropospheric VOC chemistry in the Community Earth System Model version 2 in preindustrial climate (1850 C.E.) using the fixed sea surface temperature (fSST) approach. fSST cases were run over 150 years in the following configurations: 1) WCtlF, whole atmosphere chemistry, and 2) MCtlF, middle atmosphere chemistry only. WCtlF has detailed VOC-SOA chemistry with 231 resolved species, while MCtlF only has detailed chemistry in the middle atmosphere. ERF is the difference of the cosine-weighted global mean (GM) of top-of-atmosphere net radiation as WCtlF – MCtlF. Two coupled simulations, WCtlC and MCtlC, with improved initialization from Stanton and Tandon (2023), were performed over 250 years to capture the "full" climate response. Spatial mean differences (WCtl – MCtl) of climatological variables and aerosol fields were taken. The ERF of including VOC chemistry is 0.49 Wm-2, which in the coupled comparison results in a GM surface temperature difference of 0.326 K. The percent GM difference (PGMD) of dry aerosol column burden (ACB) between WCtlF minus MCtlF is -5.10%, which has spatial correspondence to aerosol optical depth (AOD) changes with a PGMD of -4.94%. Regions with high SOA production (Amazon, SE Asia, and Central Africa) have regional increases in AOD and ACB, with reductions outside of these regions driving the GM difference. Spatial breakdowns of differences between each aerosol type and mode are presented. ERF is likely driven by a reduction in dry aerosol, resulting in more shortwave absorption at the surface. Modification of the direct effect feeds back on cloud formation, further modulating the response.

Session: 2020 Collaborative Earth System Modelling in Canada
Modélisation collaborative du système terrestre au Canada **28/05/2025 11:30**

ID: 12569 Contributed abstract

The Collaborative Platform for CanESM (CP4C) – Progress in 2024-2025

Matthew Toohey [1] , *Paul Kushner* [2]

[1] University of Saskatchewan
[2] University of Toronto

Presented by / Présenté par: *Matthew Toohey*
Contact: matthew.toohey@usask.ca

This presentation will summarize our ongoing work on CP4C, which is a computational platform developed, in partnership with the federal government, to enable use of Environment and Climate Change Canada's (ECCC's) Canadian Earth System Model (CanESM) in the academic community. In its fourth year of development, CP4C is now capable of providing reliable access and application of CanESM through several active Earth system modelling projects. This year's activities focused on expanding the user base, with CanESM now being run by multiple groups across Canada, streamlining user experience and training and workshop activities, and support of an expanding set of experiments. We will discuss our working group structure, our user policy, and proposed technical liason support from ECCC to enable porting of CanESM to various platforms external to ECCC. We will also discuss future plans for CanESM, including its potential role in supporting science development related to the High-altitude Aerosol, Water vapour and Clouds (HAWC) mission. Our efforts are continuing to foster easier collaboration with ECCC in R&D activities focused on CanESM.

Session: 10041 Ocean - Theoretical to applied science - Part 2 Océan - De la théorie à la science appliquée - Partie 2

Convenors: Nancy Soontiens, Susan Allen

Related to scientific studies and/or information sharing about the ocean, including studies in physical, chemical, and biological oceanography, ocean waves and storm surge using various approaches.

This session covers many topics, including, but not limited to, theoretical research, model development, observation techniques, real-time monitoring, databases, diagnostic methods, data analysis and artificial intelligence.

Session: 10041 Ocean - Theoretical to applied science - Part 2 Océan - De la théorie à la science appliquée - Partie 2 **28/05/2025 10:30**

ID: 12548 Contributed abstract

Fluctuating tides in the Gulf of Maine/Bay of Fundy system: a model of energy transfer at the sea-bottom interface

Pierre-Michel Rouleau [1]

[1] Memorial University

Presented by / Présenté par: *Pierre-Michel Rouleau*
Contact: r6pr@mun.ca

The amplitude of the principal semi-diurnal (M2) marine tides in the Bay of Fundy and Gulf of Maine has been fluctuating over the past century, with an average positive trend of the order of cm/y. Of several mechanisms that can contribute to such fluctuations, a most efficient one involves a barotropic-to-baroclinic wave-energy transfer, via scattering at steeply sloping topography. Such predominant mechanism, although not accounting fully for the M2 tide amplitude fluctuations, underscores the importance of wave dynamics at the water-rock boundary layer. Here, an energy transfer mechanism at the water-bottom interface is elaborated, in which the permeable nature of the harmonically-loaded sea floor is taken into account. This mechanism, quantified by a quality factor (Q), can affect the bottom friction term commonly used in the Navier-Stokes equations employed to model tidal regimes in resonant systems. The modeled energy-transfer mechanism can be ephemeral due to natural permeability perturbation and, consequently, modify the near-resonant frequency of the system and so modulate the amplitude and phase of the predominant tidal constituent.

Session: 10041 Ocean - Theoretical to applied science - Part 2 Océan - De la théorie à la science appliquée - Partie 2 **28/05/2025 10:45**

ID: 12520 Contributed abstract
Virtual

Driving processes and associated variations of physical environmental conditions in the St. Anns Bank Marine Protected Area.

Michael Casey [1] , *Hui Shen* [2]

[1] Bedford Institute of Oceanography, Department of Fisheries and Oceans Canada

[2] Bedford Institute of Oceanography, Department of Fisheries and Oceans Canada

Presented by / Présenté par: *Michael Casey*

Contact: mpcasey70@gmail.com

Physical oceanographic conditions in the St. Anns Bank (SAB) Marine Protected Area

(MPA) are studied using ocean-modelling data products and in-situ observations. On SAB, waters from the Northumberland Strait/western Gulf of St. Lawrence interact and meet with those of the eastern Gulf of St. Lawrence/Laurentian Channel, causing significant temperature and salinity variations on different time scales. We quantify these variations, with a focus on their potential impact on the MPA, and make linkages to habitat suitability analysis for various marine species. The analysis highlights the value of incorporating physical oceanographic data in understanding MPA baseline environmental conditions and changes, and contributes to MPA monitoring and conservation.

Session: 10041 Ocean - Theoretical to applied science - Part 2 Océan - De la théorie à la science appliquée - Partie 2 **28/05/2025 11:00**

ID: 12421 Contributed abstract

Connectivity across the border in the Salish Sea: Fluxes, river water and plastics

Susan Allen [1] , *Cassidy Donaldson* [2] , *Camryn Stang* [3] , *Jose Valenti* [4]

[1] University of British Columbia

[2] University of British Columbia

[3] University of British Columbia

[4] University of British Columbia

Presented by / Présenté par: *Susan Allen*

Contact: sallen@eoas.ubc.ca

The Salish Sea is a semi-enclosed body of water on the West Coast of Canada straddling the border with the United States. It has a strong estuarine-type circulation: less dense river-derived water moving out to the ocean and more dense ocean-derived water moving in. With over 200 individual rivers, it is not a single estuarine system. Often, partially due to the border, it is studied as two separate estuarine systems: the Strait of Georgia and Puget Sound with a common exit to the open ocean: Juan de Fuca Strait. How separate are these systems? In this talk, we will present connectivity from a Lagrangian point of view, both discussing freshwater (generally buoyant) and the microplastic, polyester fibers (dense). It is well known that there is significant Fraser River water in Puget Sound but we will explore the distribution in the Salish Sea of the water from the 11 representative rivers showing very large scale connectivity. On the

other hand, the dense microfibers, which sink at a rate of about 30 m/day, show the isolation of sinking matter. Using Ariane flux tracking, we will describe the pathways of the water moving from one estuarine system to the other and the processes driving the strength of these fluxes. Putting together the three studies results in a rich context for the coupled estuaries of the Salish Sea.

Session: 10041 Ocean - Theoretical to applied science - Part 2 Océan - De la théorie à la science appliquée - Partie 2 **28/05/2025 11:15**

ID: 12499 Contributed abstract
Virtual

Application of dimensional reduction in the training of Machine Learning-based emulators for biogeochemical downscaling of the Northeast Pacific ocean

Albert Hermann [1]

[1] University of Washington CICOES

Presented by / Présenté par: *Albert Hermann*
Contact: hermann@uw.edu

Some of the key spatial/temporal features captured by dynamically downscaling models can be replicated through Machine Learning-based emulators based on Recurrent Neural Networks, and trained using a mixture of forcing fields, dynamical model output, and regional data. Such emulators consequently have the potential to dramatically expand ensemble size and sensitivity analyses in dynamically-based downscaling projections. Independent of modern ML development, there is a long history of using EOF decomposition - a popular form of dimensional reduction - in summarizing and understanding the primary dynamics of atmospheric and oceanic phenomena. While broadly popular and frequently effective, there are many situations where EOF decomposition struggles to capture important oceanic phenomena such as propagating waves and spatially localized features. Here we consider both the value (greater efficiency) and limits (lost dynamics) of EOF decomposition as an encoding method for spatially complex training data (here, the dynamical forcing and the dynamically produced regional response), prior to their use in training RNN-based emulators. Examples will be presented based on dynamically downscaling models of the Northeast Pacific, and ML-based emulators of these models.

Session: 10041 Ocean - Theoretical to applied science - Part 2 Océan - De la théorie à la science appliquée - Partie 2 **28/05/2025 11:30**

ID: 12441 Contributed abstract
Virtual

A neural network remapping of climate model projections and thermal tolerance in eastern Canadian marine protected area species

Rick Danielson [1] , *Erin McKee* [2] , *Brendan DeTracey* [3] , *Marc Skinner* [4] , *Blair Greenan* [5] , *Ellen Kenchington* [6] , *Zeliang Wang* [7]

[1] Fisheries and Oceans Canada

[2] Fisheries and Oceans Canada

[3] Fisheries and Oceans Canada

[4] Fisheries and Oceans Canada

[5] Fisheries and Oceans Canada

[6] Fisheries and Oceans Canada

[7] Fisheries and Oceans Canada

Presented by / Présenté par: *Rick Danielson*
Contact: rick.danielson@dfo-mpo.gc.ca

Differences in ocean state are examined for an ensemble of Coupled Model Intercomparison Project (CMIP6) models under historical and future climate scenarios. The Global Ocean Reanalysis and Simulation (GLORYS12) is taken as a reference for historical CMIP data and neural networks are trained to adjust historical and future projections for each of 22 CMIP models (across four emissions scenarios and for surface and bottom temperature and salinity, mixed-layer depth, and bottom current speed). Three-level neural networks allow us to represent only a few CMIP gridpoints in each MPA as if they were at GLORYS spatial resolution (1/12-degree), but without altering 2015-2100 trends, and with a reduction in bias and variance among most CMIP model variables. An ensemble comparison is given of the time of emergence of thermal tolerance in eastern Canadian marine protected area species. The so-called "hot" CMIP models are found to have less impact after applying the historical GLORYS adjustment to projections through 2100.

Session: 10041 Ocean - Theoretical to applied science - Part 2 Océan - De la théorie à la science appliquée - Partie 2

28/05/2025 11:45

ID: 12408 Contributed abstract
Virtual

Statistical downscaling for the northeastern Pacific Ocean

Amber Holdsworth [1]

1

Presented by / Présenté par: *Amber Holdsworth*
Contact: northpacificbgc@gmail.com

There is a growing need for statistical downscaling for ocean modelling applications including refining the forcing fields used to drive high resolution models, refining seasonal predictions, reconstructing historical environmental data, and expanding ensembles of high-resolution climate projections for climate adaptation planning. However, most of the examples of statistical downscaling in climate science are focused on terrestrial and atmospheric applications. In 2024, we formed an interdisciplinary working group to tackle the challenges of statistical downscaling for the northeastern Pacific Ocean. There is significant interest in fostering open, cross-disciplinary collaboration around ocean-specific applications of statistical downscaling. Building a shared, accessible framework can advance tools and methodologies, enabling broader validation and innovation. This talk will give an overview of the working group's activities and plans.

Session: 3050 Peatland disturbance and policy in Canada - Part 1 Perturbation des tourbières et politique au Canada - Partie 1

Convenors:
Adam Kirkwood, WCS Canada
Lorna Harris, WCS Canada
Bin Xu, Centre for Boreal Research, NAIT
Sophie Wilkinson, Simon Fraser University

Peatlands across Canada store ~150 billion tonnes of carbon (C) and are subject to increased pressures from climate change and the push for industrial development in peatland rich regions. For Canada to meet net-zero carbon emissions, it is critical that irrecoverable C remain in peatlands, and that the C sink function of peatlands remains intact. To adequately understand how disturbances to peatlands will contribute to climate change through the release of carbon dioxide (CO2) and methane (CH4) or through weakened C sink capacity, research on the response and recovery of peatlands to disturbances is needed. Equally as important is understanding the laws and policies across Canada that impact peatlands, including those designed to protect, mitigate damage to, or legislate recovery from industrial disturbances. This session welcomes all submissions related to peatland research, with preference given to submissions that examine the response of peatlands to impacts of climate change (e.g. fire, warming and drying, permafrost thaw) and industrial disturbances (e.g. drainage, roads, mining - including exploration activities, peat harvesting). Additionally, we encourage the submission of abstracts that discuss the policy relevance of their work, or how Canada's policies applicable to peatlands (which may include law and policy for water management, industry – e.g., roads and mining, and other) have reduced impacts to, or managed or recovered, critical ecosystem services provided by peatlands.

Session: 3050 Peatland disturbance and policy in Canada - Part 1
Perturbation des tourbières et politique au Canada - Partie 1 **28/05/2025 10:30**

ID: 12306 Invited session speaker

Virtual

Assessing Canadian Law and Policy for Peatlands

Victoria Goodday [1] , *Laura Tanguay* [2] , *Nicola Radatus-Smith* [3] , *Lorna Harris* [4]

[1] Wildlife Conservation Society Canada
[2] Wildlife Conservation Society Canada
[3] Wildlife Conservation Society Canada
[4] Wildlife Conservation Society Canada

Presented by / Présenté par: *Victoria Goodday*
Contact: vgoodday@wcs.org

Canada plays a critical role in global peatland stewardship: Canada contains roughly one-quarter of the world's peatlands – amounting to the world's largest peat carbon stock (Tarnocai and others 2011) – and some of the world's largest remaining intact, unconverted peatland complexes are located in Canada, particularly in the north. Despite its disproportionate global responsibility, Canada has no strategy or coordinated action at the national level for peatlands and there is wide variance in sub-national policy objectives and approaches. As part of the National Peatland Policy Project, WCS Canada conducted a systematic review of peatland-related law and policy and is undertaking conversations with peatland knowledge-holders across the country to identify gaps and opportunities for the protection, restoration, and stewardship of peatlands. Initial findings of this work reveal a limited variety of policy approaches and mechanisms being applied to achieve peatland protection goals – each with its own advantages and shortcomings. We will present an overview of the main policy approaches commonly used for the purpose of protecting peatlands, the key characteristics and challenges associated with these approaches, and opportunities for strengthened peatland law and policy in Canada.

Session: 3050 Peatland disturbance and policy in Canada - Part 1
Perturbation des tourbières et politique au Canada - Partie 1 **28/05/2025 11:00**

ID: 12200 Contributed abstract

Quantifying greenhouse gas emissions across vegetation communities on a peat stockpile in northern Alberta

Veronica Santia [1] , *Maria Strack* [2]

[1] University of Waterloo

[2] University of Waterloo

Presented by / Présenté par: *Veronica Santia*

Contact: vsantia@uwaterloo.ca

The Oil Sands Region (OSR) in Alberta, within Canada's boreal forest, is a combination of three recognized oil deposits. The boreal forest in the OSR can reach peatland coverage of over 50%. Peatlands are natural carbon (C) sinks through a net uptake of atmospheric carbon dioxide (CO2). The removal of peat for mining operations and the subsequent stockpiling of the peat under aerated conditions promotes organic matter decomposition, potentially emitting significant amounts of C into the atmosphere. Peat stockpiles in the oil sands can stand for decades, often with actively introduced vegetation on the surface, leaving the actual decomposition rates largely unknown. This research aims to improve our accounting of wetland soil C losses for national emissions reporting by evaluating the C emissions on a peat stockpile at an in-situ oil sands lease across different vegetation communities, locations, and soil moisture contents. C fluxes were measured weekly using the closed chamber technique for both CO2 and methane (CH4) exchange to evaluate C emissions. Paired plots with intact vegetation, clipped vegetation, and trenching were set up along a transect to compare soil respiration and net C exchange. Biomass was collected to determine the total addition of new organic matter. The net C exchange of the stockpile treatments will be estimated as the difference between soil respiration and C accumulation in biomass. Preliminary results suggest significantly higher ecosystem respiration at intact collars compared to bare peat, due to contributions from autotrophic respiration. No statistical difference between stockpile locations for ecosystem respiration, gross ecosystem production, or net ecosystem exchange, but CH4 emissions were significantly higher at depressions on the

top of the stockpile. Large peat stockpiles on oil sand leases have substantial implications for C emissions and accurate emission reporting is needed. This data will be utilized for annual estimates of peat stockpile-related C losses, which can add to our limited knowledge of national scale estimates of C losses from organic soils disturbed by oil sands operations and other infrastructure.

Session: 3050 Peatland disturbance and policy in Canada - Part 1
Perturbation des tourbières et politique au Canada - Partie 1 **28/05/2025 11:15**

ID: 12348 Contributed abstract

Wildfire impacts on CH4 emissions - insights into long-term recovery in boreal peatlands

Emma Wegener [1] , *Maria Strack* [2] , *Scott Davidson* [3]

[1] University of Guelph

[2] University of Waterloo

[3] University of Plymouth

Presented by / Présenté par: *Emma Wegener*
Contact: emmawegener4@gmail.com

Northern peatlands are under threat of drying in response to climate change and the warmer summers and drought conditions that may arise because of it. These conditions are resulting in increasing wildfire frequency and intensity, allowing for greater greenhouse gas emissions from burned peatlands. However, few studies have documented the effect of wildfire and the changing wildfire regime on peatland CH4 dynamics and the pattern of recovery. Thus, climate models have not yet successfully included peatland burning or recovery, which is necessary to produce accurate accounts of global C contributions. This study addresses recovery following wildfire, considering the depth of organic soil subject to pyrolysis and the consequent impact on C cycling. We consider the timing of recovery by monitoring greenhouse gas fluxes 6–7 years post-fire and comparing these to those measured 2–3 years post-fire within a fen peatland in northern Alberta, Canada with varying degrees of burn severity. Results suggest that C cycling recovery within peat soils (i.e., CH4 flux) may take longer to recover under more severe fire regimes, which are projected to become more common with climate change.

Session: 3050 Peatland disturbance and policy in Canada - Part 1
Perturbation des tourbières et politique au Canada - Partie 1 **28/05/2025 11:30**

ID: 12333 Contributed abstract

Carbon Dynamics in Managed Peatlands: Understanding the Early Recovery Phase Post-Wildfire

Edmund Strachan [1]

[1] Simon Fraser University

Presented by / Présenté par: *Edmund Strachan*
Contact: eds10@sfu.ca

Peatlands are recognized as one of the most crucial ecosystems on a global scale, due to their remarkable capacity to store significant amounts of carbon (~600 gigatons [Gt] C) and their influence on the carbon cycle. Peatland's ability to recover their important carbon sink function depends on their capacity to reinitiate soil organic carbon accumulation, which is dictated by the re-establishment of vegetation, nutrient availability, and the hydrological setting. Currently, there are knowledge gaps regarding the response of managed peatlands to wildfire, including determining the time required for fire-impacted peatlands to commence the process of soil organic carbon accumulation once again. In the summer of 2024, CO_2 flux measurements were taken using a closed-chamber method at a burned-unharvested peatland, a burned-harvested peatland, and an unburned-harvested peatland near Drayton Valley. Measurements were taken at the centre and margins of the peatlands where burn severity was most prominent. Flux measurements occurred between the hours of 09:00 and 16:00 to encompass different sun and light positions throughout the day. Environmental variables (e.g., water depth, surface temperature, soil moisture) were taken to evaluate their relationship with carbon emissions at each site. To determine the relationship between vegetational species and CO2 fluxes, species identification and percent coverage of functional groups (e.g., mosses, forbs, shrubs, and trees) were analyzed in conjunction with CO2 measurements.

Session: 3050 Peatland disturbance and policy in Canada - Part 1
Perturbation des tourbières et politique au Canada - Partie 1 **28/05/2025 11:45**

ID: 12414 Contributed abstract

Impact of permafrost thaw on the long-term C storage along permafrost peat-plateau to thawed fen gradient.

Bidhya Sharma [1] , *Michelle Garneau* [2] , *Klaus-Holger Knorr* [3] , *David Olefeldt* [4]

[1] University of Alberta

[2] Université du Québec à Montréal

[3] University of Münster

[4] University of Alberta

Presented by / Présenté par: *Bidhya Sharma*

Contact: bidhya@ualberta.ca

Northern permafrost peatlands store a significant portion of global soil carbon. With accelerating permafrost thaw, previously frozen carbon (C) could undergo accelerated mineralization, releasing stored carbon back into the atmosphere as CO2. Our research aimed to quantify the impact of permafrost thaw on long-term carbon storage along a permafrost peat-plateau to thawed fen gradient. We collected 9 full cores and 8 surface cores along this gradient in the discontinuous permafrost region of northern Alberta. We measured total carbon stocks, constructed the history of permafrost development in the region using macrofossil analysis, and compared the biogeochemistry of thawed and permafrost peat.

Our preliminary results show that the thawing of permafrost does not cause drastic changes in peat bulk density or loss on ignition. However, the peat accumulation rate is noticeably higher in thawed fens than in permafrost plateaus. In addition, we will present the changes in the vegetation community over time for permafrost plateaus and thawed fens, as revealed by macrofossil analysis. Furthermore, we will present initial results from FT-MIR analysis that could enhance our understanding of the potential vulnerability of thawed peat. The findings from our study will help in projecting the impact of climate change on the carbon balance of fens in northern permafrost peatlands.

Session: 4050 Transforming Canada’s Weather Services for a Resilient Future - Part 1 Transformer les services météorologiques du Canada pour un avenir résilient - Partie 1

Convenor: Eric de Groot

The Meteorological Service of Canada (MSC), a cornerstone of Canada's weather enterprise within Environment and Climate Change Canada, is undergoing a significant transformation to meet the evolving needs of Canadians. The MSC will bring speakers to showcase ongoing initiatives that aim to modernize the MSC's services, leveraging new technologies and public feedback to enhance risk communication in the face of weather-related impacts.

Session: 4050 Transforming Canada’s Weather Services for a Resilient Future - Part 1 Transformer les services météorologiques du Canada pour un avenir résilient - Partie 1 **28/05/2025 10:30**

ID: 12571 Contributed abstract

Service Transformation of the Meteorological Service of Canada

Erik de Groot [1]

[1] Environment and Climate Change Canada

Presented by / Présenté par: *Erik de Groot*
Contact: blake.barber@canada.ca

The Meteorological Service of Canada (MSC) is undergoing a significant service transformation to meet the evolving needs of Canadians. This presentation will provide a broad overview of initiatives that aim to modernize the MSC's services, leveraging new technologies and public feedback to enhance risk communication in the face of weather-related impacts. Detailed presentations on each initiative will be provided in proceeding presentations in the session.

Session: 4050 Transforming Canada’s Weather Services for a Resilient Future - Part 1 Transformer les services météorologiques du Canada pour un avenir résilient - Partie 1 **28/05/2025 10:45**

ID: 12359 Contributed abstract
Virtual

Public Opinion Research: Leveraging public feedback to refine warning and forecast services

Lisa Vitols [1]

[1] Environment and Climate Change Canada

Presented by / Présenté par: *Lisa Vitols*

Contact: lisa.vitols@ec.gc.ca

MSC has utilized public opinion research (POR) services in the past, namely omnibus national surveys of Canadians about their weather information sources and understanding. With several new MSC initiatives being explored, like risk-tiered alerting, we are trying new methods of feedback collection which are helping to better inform our products and services. Learnings from the research have already helped the proposed programs evolve to better resonate with and serve Canadians. Recent findings from client evaluations, post-warning surveys of Canadians, and specifically a series of twelve focus groups held across the country will be presented in the context of the programs they are supporting.

Session: 4050 Transforming Canada's Weather Services for a Resilient Future - Part 1 Transformer les services météorologiques du Canada pour un avenir résilient - Partie 1 **28/05/2025 11:00**

ID: 12186 Contributed abstract

Introducing Risk-Tiered Weather Alerting in Canada

Desjanelle Matthews [1]

[1] Environment and Climate Change Canada (Meteorological Service of Canada)

Presented by / Présenté par: *Desjanelle Matthews*
Contact: desjanelle.matthews@ec.gc.ca

Environment and Climate Change Canada's (ECCC) Meteorological Service of Canada (MSC) is planning to move to a tiered alerting service to warn Canadians about expected hazardous weather. The aim is to improve communication by using simple escalating colour levels to provide high-glance value risk information on the expected severity of impacts of a weather event. A three-tier system was chosen, with yellow, orange or red alerts presented to the public.

As part of this warning modernization, the MSC will also introduce impact-informed hazard thresholds, to align with recommendations from the World Meteorological Organization (WMO) to move towards Impact-based Forecast and Warning Services. Colour selection will be based on an impact vs. confidence matrix with forecast guidance

shifting from prescriptive geographically-based criteria thresholds towards hazard ranges associated with general potential impacts, grouped into moderate, high and extreme impact categories. Forecasters will incorporate an impact assessment into their alerting workflow and have the flexibility to take known vulnerabilities into account in their warning decisions.

Alert colour will be included in new alert titles, displayed on dissemination platforms and used to prioritize alerts. Externally available warning XML files (Common Alerting Protocol – Canadian Profile) will include new colour, impact and confidence data for use by third parties to allow for consistent alert level messaging.

Session: 4050 Transforming Canada's Weather Services for a Resilient Future - Part 1 Transformer les services météorologiques du Canada pour un avenir résilient - Partie 1 **28/05/2025 11:15**

ID: 12403 Contributed abstract

Modernizing The Meteorological Service of Canada's Public Forecast Service: Weather Information for Next-Generation Services (WINGS)

Neil Taylor [1] , *Isabelle Leclerc* [2] , *Christopher Emond* [3] , *Alexandre Parent* [4] , *Kyle Locquiao* [5] , *Lawrence Sham* [6] , *Jody Boyd* [7]

[1] Meteorological Service of Canada, Environment and Climate Change Canada

[2] Meteorological Service of Canada, Environment and Climate Change Canada

[3] Meteorological Service of Canada, Environment and Climate Change Canada

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[5] Meteorological Service of Canada, Environment and Climate Change Canada

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[7] Meteorological Service of Canada, Environment and Climate Change Canada

Presented by / Présenté par: *Neil Taylor*

Contact: neil.taylor@ec.gc.ca

At its core, the Meteorological Service of Canada (MSC) aims to mitigate the impacts of weather-related hazards on Canadians. Whether through the issuance of timely alerts and forecasts, decision support to emergency management and other partners, or

partnerships with media as a message amplifier, our dedicated teams keep Canadians informed with detailed weather and alert information. A cornerstone of this service is regularly scheduled weather forecasts from coast to coast, to coast. While science, computing, and forecasting techniques have evolved over time, the format and dissemination of MSC public forecasts have remained largely unchanged for decades.

As the MSC transforms how we deliver critical services to Canadians, we are modernizing the underlying data, and delivery, of our scheduled weather forecasts. We will shift from forecaster-modified text-based forecasts over fixed regions to a forecast comprising a suite of complementary information. Detailed weather element forecasts will be available in modern formats anywhere in Canada via high-resolution gridded data. Forecasters will share key messages with contextual information, and a text-based regional forecast will continue to support specialized dissemination platforms like Hello Weather and some anticipated media needs. This presentation will highlight the approach we're taking in the MSC and introduce the components of our next-generation public forecast service to Canadians.

Session: 4050 Transforming Canada's Weather Services for a Resilient Future - Part 1 Transformer les services météorologiques du Canada pour un avenir résilient - Partie 1 **28/05/2025 11:30**

ID: 12412 Contributed abstract
Virtual

MSC Information Pool (IP):
Fully leveraging the significant value of the MSC's increasingly large data assets to modernize the MSC's IT systems.

Patrick Curran [1]

1

Presented by / Présenté par: *Patrick Curran*
Contact: patrick.curran@ec.gc.ca

Abstract:
As with many weather enterprises across the world, ECCC-MSC must deal with rapidly increasing volumes of data. In the absence of a purposeful mitigation plan, organizations will encounter greater complexity and cost when managing and using their data, finding

complexity and cost scale with data volume. Mitigating efforts are currently underway at the MSC to realize a new and robust MSC data environment, which has been named the MSC Information Pool (IP). The IP will provide the MSC with a modern approach to the packaging, storing, and usage of data. This presentation will provide a history of IP related work and emphasizes what the MSC expects to realize from the IP.

Draft Deck Outline:
• Outline the business and technical challenges from which the IP emerges as a solution
• Detail work completed to date and lessons learned
• Detail current work being done towards the realization of the IP and the factors driving this work
• Detail how the IP is expected to evolve moving forward and how MSC service could evolve along with it

Session: 4050 Transforming Canada's Weather Services for a Resilient Future - Part 1 Transformer les services météorologiques du Canada pour un avenir résilient - Partie 1 **28/05/2025 11:45**

ID: 12187 Contributed abstract

WeatherCAN App and Weatheroffice Website Enhancements

Francis Wu [1] , *Stéphanie Tremblay-Therrien* [2]

[1] MSC
[2] MSC

Presented by / Présenté par: *Stéphanie Tremblay-Therrien*
Contact: francis.wu@ec.gc.ca

MSC's public platforms, including the WeatherCAN app and the weather.gc.ca website, provide Canadians with easy access to weather forecasts and alerts. The WeatherCAN app was launched in 2019, enabling users to check weather information on their mobile devices. A major redesign of the app was released in October 2024 to enhance its functionality and user experience, with improvements such as a more streamlined interface, more prominent air quality information, and the addition of temperature notifications. Meanwhile, the weather.gc.ca website has been undergoing modernization over the last few years, introducing several new features and updates to improve user experience. Both platforms are continuously evolving, with exciting future developments planned, such as enhanced map layers including lightning, precipitation type, and forecast radar, ensuring that Canadians stay informed with the most up-to-date weather information.

Session: 6012 Observation and modelling of snow and glacier processes - Part 3

Observation et modélisation des processus liés à la neige et aux glaciers - Partie 3

Convenors:
Christopher Marsh 1 , Phillip Harder 2 , Vincent Vionnet 3 , Caroline Aubry-Wake 4 , Libo Wang 1
1 Climate Research Division, Environment and Climate Change Canada, Canada
2 Croptimistic Technology Inc, Canada
3 Meteorological Research Division, Environment and Climate Change Canada, Canada
4 University of Lethbridge, Canada

Unprecedented anthropogenic climate and land use change are dramatically impacting the cold region processes that shape seasonal snowcovers and glaciers worldwide. Billions of people depend on the seasonal snowcovers and glaciers to provide essential freshwater flows for local and downstream communities and ecosystems. There are therefore significant incentives to provide better estimates of these changing physical processes through improved observations, analysis, and modelling. In this session, we invite contributions on all aspects of snow, ice, and glaciers including impacts on cold-regions meteorology, hydrology, surface-atmosphere-energy exchanges, frozen soil dynamics, glacier dynamics, and groundwater coupling. Contributors are encouraged to share their experiences, insights, and advances in utilizing existing and next-generation tools for observations, analysis, and/or modelling spanning all climate zones. Contributions that span the traditional CMOS and CGU boundaries are particularly encouraged.

Session: 6012 Observation and modelling of snow and glacier processes - Part 3 Observation et modélisation des processus liés à la neige et aux glaciers - Partie 3 **28/05/2025 10:30**

ID: 12482 Contributed abstract

An extreme snow season in the Canadian Arctic: How extreme was it?

Robin Thorne [1] , *Rosy Tutton* [2] , *Brampton Dakin* [3] , *Richard Essery* [4] , *Jory Griffith* [5] , *Gabriel Hould-Gosselin* [6] , *Malcolm Brockett* [7] , *Branden Walker* [8] , *Phil Marsh* [9] , *Oliver Sonnentag* [10] , *Alex Fogal* [11] , *Julie Mireille Thériault* [12]

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Presented by / Présenté par: *Robin Thorne*
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As the Arctic climate changes, there is a growing need for an increased understanding of the Arctic snow environment, how it is changing and how it will change in the coming decades. In this paper, we will combine data from our Arctic-Snow project, carried out during the 2023-24 winter, and put this snow year into a long-term perspective using a unique multi-decadal data set from the western Canadian Arctic. This data set will be publicly available from the Laurier Borealis data repository.
The Arctic-Snow project was carried out at the Laurier Trail Valley Creek Research Watershed, north of Inuvik, NWT, in the low-Arctic tundra. This study used a large array of novel instrumentation and models to quantify all aspects of the Arctic snow environment with unprecedented accuracy. This interdisciplinary study demonstrated that this winter was one of the most extreme winters on record in this area with very high snow accumulation, many extreme blowing snow events, and delayed snowmelt runoff. But, how extreme was it?
Answering this question is difficult in the Arctic due to the limited long-term data sets and large errors in data collection. The Trail Valley Creek site has a unique data set with snow, discharge and climate data that began in 1979. Our data sets also include gap filled data sets for the full period of record. We will examine snowfall, snow on the ground at the end of winter, distribution of snow over different terrain and vegetation types, winter temperature and wind speed, and the timing of spring discharge.
These data and our models will allow us to put the 2023-24 winter/spring period into the long-term perspective allowing us to understand with new accuracy how the snow environment has changed in this region and how extreme was the winter of 2023-24.

Session: 6012 Observation and modelling of snow and glacier processes - Part 3 Observation et modélisation des processus liés à la neige et aux glaciers - Partie 3 **28/05/2025 10:45**

ID: 12377 Contributed abstract

Integrating field observations, remote sensing and modelling for improved understanding of Arctic snow: Case study from an extreme snow year

Philip Marsh [1] , *J Theriault* [2] , *R Melnik* [3] , *R Kelly* [4] , *B Dakin* [5] , *A Fogal* [6] , *J Pomeroy* [7] , *C Smith* [8] , *O Sonnentag* [9] , *C Derksen* [10] , *C Marsh* [11] , *G Sentlinger* [12]

[1] Wilfrid Laurier University
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Presented by / Présenté par: *Philip Marsh*
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A keystone feature of the Arctic is the snowcover that impacts the hydrology, lake ice, permafrost, greenhouse gas fluxes, ecosystem function and climate for example. However, measuring Arctic snowfall is prone to large errors due to undercatch during periods with low snowfall rates and high winds. In addition, large measurement errors are typical for all other aspects of the Arctic snow environment, including sublimation during frequent blowing snow events, extreme spatial variability of snow on the ground, and streamflow during periods of snow and ice clogged channels. These problems can be so extreme that measured snowfall can often be less than measured snow on the ground. This is a significant problem as these data are relied upon by climate, weather, water agencies, and researchers, to document climate impacts on the Arctic snowscape, predict streamflow for understanding changes to Arctic ecosystems, and to test and validate water and climate prediction models. To solve the challenge of accurately measuring all aspects of the Arctic snow environment, our team carried out a unique interdisciplinary study that is using recent advances to apply a large array of novel instrumentation and models, including upward looking weather radar, eddy covariance, blowing snow detectors, cosmic ray sensors, unmanned areal systems, aircraft and airborne radar, next generation snow models, satellite observations of snowcover, and new stream discharge methods to quantify all aspects of the Arctic snow environment across an experimental watershed. This presentation will provide results from our Arctic-Snow project that was carried out over the full 2023-24 fall/winter/spring season at the Laurier Trail Valley Creek Research Watershed north of Inuvik, NWT. This winter had one of the largest snowfalls in the last 30 years, presenting a large logistical and scientific challenge, but also providing a unique test for understanding and predicting the Arctic snow environment.

Session: 6012 Observation and modelling of snow and glacier processes - Part 3 Observation et modélisation des processus liés à la neige et aux glaciers - Partie 3

28/05/2025 11:00

ID: 12439 Contributed abstract

Modelling the Spatial Variability in Snow Accumulation, Sublimation, and Melt in the Canadian Arctic

Brampton Dakin [1] , *Alex Fogal* [2] , *Gabriel Hould-Gosselin* [3] , *Christopher Marsh* [4] , *Philip Marsh* [5] , *Oliver Sonnentag* [6] , *Julie Theriault* [7] , *Robin Thorne* [8]

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Presented by / Présenté par: *Brampton Dakin*
Contact: bdakin@wlu.ca

Snow plays an important role in controlling the hydrology of the Arctic, with the spring melt freshet typically the largest streamflow event of the year. However, our understanding of spring freshet is limited by the combination of a sparse hydrometric network across the Canadian Arctic, snow gauge undercatch, uncertainty in the magnitude of sublimation during winter blowing snow events, and the limited ability to model snow accumulation and melt over the winter and spring months – all of which affect the timing and magnitude of freshet. In this presentation, we will focus on results from our unique Arctic-Snow experiment to test a next generation hydrologic model: the Canadian Hydrological Model (CHM). Our goal is to demonstrate a greatly improved ability to model snow accumulation and melt. Model performance will be tested through a unique combination of observations collected at the Laurier Trail Valley Creek Research watershed during the winter of 2023-2024. These observations include improved snowfall measurements, eddy covariance measurements of sublimation, snow surveys and drone mapping of snow depth and snow water equivalents across the study domain, and satellite observations of snow-covered areas during the melt period. Being able to accurately measure, simulate, and validate snowfall, snow accumulation, and sublimation will help researchers more accurately predict the changes we are beginning to see across the Arctic. This will be an important tool for communities to more accurately assess changes to their future water resources.

Session: 6012 Observation and modelling of snow and glacier processes - Part 3 Observation et modélisation des processus liés à la neige et aux glaciers - Partie 3 **28/05/2025 11:15**

ID: 12459 Contributed abstract

Impact of an Alternate Snow Cover Fraction Parameterization on Snow Simulation in the CLASSIC and CanESM models

Libo Wang [1] , *Joe R. Melton* [2] , *Jason Cole* [3] , *Lawrence Mudryk* [4] , *Vivek Arora* [5] , *Salvatore R. Curasi* [6] , *Colleen Mortimer* [7] , *Ed Chan* [8] , *Gesa Meyer* [9] , *Luke Grant* [10]

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Presented by / Présenté par: *Libo Wang*
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Accurate simulation of snow cover is crucial for future climate predictions in the Earth system models due to snow-albedo feedback mechanism. To improve the simulation of snow cover fraction (SCF) in the Canadian Earth System Model (CanESM), an alternate SCF parameterization (SL12) has been implemented in the Canadian Land Surface Scheme Including Biogeochemical Cycles (CLASSIC). The impact of the SL12 parameterization on simulated SCF is tested using offline CLASSIC v2.0 and CanESM v5.1 in which CLASSIC simulates land processes. The default SCF parameterization (CTL) utilizes a simple linear relationship between SCF and snow depth with no dependency on topography, while the SL12 parameterization accounts for the topographic effects of sub-grid terrain. Three reanalysis-based meteorological datasets are used to drive offline CLASSIC simulations. For all datasets, SCF overestimation in mountainous areas by the CTL parameterization is much improved by the SL12 parameterization. Annual mean bias, unbiased root mean squared area, and correlation improve by 75%, 32%, and 7% when evaluated with MODIS observations over the Northern Hemisphere. The improved simulation of SCF leads to improvements in the surface radiation, energy fluxes, and the water cycle in CLASSIC. The offline simulations also demonstrate the large impact due to the choice of meteorological forcing on snow in CLASSIC. Simulations using datasets without bias correction outperform relative to simulations using datasets with bias correction, suggesting that there are large uncertainties in the observation-based datasets and/or methods used for bias correction. To evaluate the effect of the SL12 parameterization on the climate simulated by CanESM5.1, an ensemble of simulations using prescribed sea surface temperatures and sea-ice are examined. The change from the CTL to the SL12 parameterization leads to similar improvements as seen in offline CLASSIC simulations. Since CanESM5.1 allows interactions and feedbacks between the surface and atmosphere, we also present the effect on other aspects of the climate, focusing on land and snow-related variables.

Session: 6012 Observation and modelling of snow and glacier processes - Part 3 Observation et modélisation des processus liés à la neige et aux glaciers - Partie 3 **28/05/2025 11:30**

ID: 12329 Contributed abstract

Virtual

Evaluating the pySnowClim Model for High-Resolution Snowpack Simulations in Western Canada

Aranildo Lima [1] , *Abby Lute* [2] , *Rajesh Shrestha* [3]

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Presented by / Présenté par: *Aranildo Lima*
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This study explores the application of the SnowClim model in western Canada, as the first phase of a two-phase project aimed at projecting future hydrologic changes across the pan-Canadian domain, with a focus on hydrologic extremes such as floods and droughts. SnowClim is a computationally efficient, process-based snow model that incorporates fully distributed energy and mass balance components. It simulates the snowpack as a single layer while accounting for both surface and internal pack temperatures . The Python implementation of the model (pySnowClim) was developed, evaluated, and calibrated using the Canadian historical Snow Water Equivalent dataset (CanSWE, 1950–2020). Additionally, pySnowClim simulations were benchmarked against ERA5-land snow water equivalent (SWE). The study domain covers western Canada, using daily ERA5-Land atmospheric forcings at a 5-minute resolution. Results indicate that pySnowClim can produce accurate, high-resolution snowpack simulations across this large spatial domain with a very good computational efficiency. In the second phase, pySnowClim will be integrated with the Community Water Model (CWatM) to generate future hydrologic projections.

Session: 6012 Observation and modelling of snow and glacier processes - Part 3 Observation et modélisation des processus liés à la neige et aux glaciers - Partie 3 **28/05/2025 11:45**

ID: 12437 Contributed abstract

Evaluating re-analysis forcing data to produce emergent snowcover behaviours

Christopher Marsh [1] , *Vincent Vionnet* [2] , *Lawrence Mudryk* [3] , *Brian Menounos* [4] , *John Pomeroy* [5]

[1] Environment and Climate Change Canada
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Presented by / Présenté par: *Christopher Marsh*
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Mountain snowpacks are a source of freshwater for billions of people globally. However, these snowpacks are under profound threat due to climate change as patterns of snowfall and ablation change. There is a significant and timely need to diagnose how these snowpacks are currently changing and how they will change under future climates to better provide estimates of freshwater availability. Mountain snowpacks are influenced by a set of cascading emergent behaviours, where periods of snowfall, wind redistribution events and avalanches shape the snowpacks before spring and summer

ablation via spatially distributed energy fluxes. Models at snowdrift permitting scale are required to capture these spatially varying processes. The complex spatial pattern of snowpack ablation impacts freshwater inputs to local ecology, stream flows, and groundwater recharge. Contextualizing the current and predicted snowpack changes against historical trends motivates using global and continental reanalysis products to provide historical forcing data for snowpack simulations. However, these reanalyses are spatially coarse (~10 to 25 km), and it has not been well established if key forcing variables, such as wind speed and direction, are sufficient to drive snowdrift permitting scale snow models. In this work, the multiscale Canadian Hydrological Model (CHM) is driven by the newly released 10 km Canadian Surface reanalysis v3 (CaSR) reanalysis at a snowdrift permitting resolution in Kananaskis region of the Canadian Rockies. The downscaled windfields and simulated snowpack are evaluated against in situ station observations of near-surface meteorology at high elevations and snow depth and density surveys from the Global Water Futures Observatories' Canadian Rockies Hydrological Observatory and against airborne-lidar snow depth.

Session: 8022 Changing Chemical Loads in Evolving Watershed - Part 3
Modification des charges chimiques dans un bassin versant en évolution - Partie 3

Convenors:
Xiaochuang Bu (University of Waterloo)
Serghei Bocaniov (University of Waterloo)
Noelle Starling (University of Waterloo)
Raoul-Marie Couture (Université Laval)
Helen Baulch (University of Saskatchewan)

Global environmental changes—driven by accelerated climate shifts and intensified human activities—are reshaping water systems worldwide. Canada, endowed with vast and diverse water systems including the Great Lakes, extensive river networks, expansive wetlands, coastal and estuarine systems, provides a unique and critical context for investigating these changes. As sentinels of environmental disturbance, water bodies reflect changes in climate, land use, and pollutant transport through measurable variations in chemical loads of key elements (e.g., C, N, P, Cl) and contaminants. Faced with challenges such as permafrost thaw, cultural eutrophication, increasing salinization and aquatic pollution, it is imperative to understand the factors that contribute to and shape chemical loads, discharge and biogeochemical fluxes across waterbodies is imperative.
This session aims to advance the systematic study of chemical loads, discharge and biogeochemical fluxes in changing water systems. It also focuses on quantitative and qualitative characterization of these processes not only under past and present climates but also their predictions under future climatic conditions or extreme events. We invite abstracts utilizing field experiments, observations, and modeling to characterize the transport and biogeochemical transformations of carbon, nutrients, metals, major ions, and contaminants in inland waters, estuaries, and coastal environments. We welcome contributions related to existing databases, diagnostic methods, data analysis, and applications of artificial intelligence.

Session: 8022 Changing Chemical Loads in Evolving Watershed - Part 3 Modification des charges chimiques dans un bassin versant en évolution - Partie 3 **10:30**

ID: 12404 Contributed abstract

Assessing downstream transport of Chloride using Spatial Regressions on Watershed Attributes (SPARROW) in an urbanizing basin

Christopher Wellen [1] , *Wukai Jiang* [2] , *Mir Jafar Sadegh Safari* [3] , *Claire Oswald* [4] , *Wyatt Weatherson* [5] , *Alex Neumann* [6] , *George Arhonditsis* [7] , *Bill Thompson* [8]

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Presented by / Présenté par: *Christopher Wellen*
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In seasonally frozen environments, chemical de-icers are typically applied to impervious surfaces to clear roads and sidewalks and maintain safe walking and driving conditions. The most widely used such chemical is road salt (NaCl). Chloride is highly mobile in the surface and subsurface and is washed into groundwater, soils, streams, and downstream ecosystems. Chloride is a known toxic substance at high concentrations and poses ecotoxicological risks to aquatic ecosystems. Road salt is applied on many different types of impervious surfaces (e.g. roads, parking lots, sidewalks, driveways) at different rates, and the relative importance of these different surfaces for downstream Cl loading is not well understood. There is also a need for quantitative management tools to assess Cl sources and anticipate the effects of different management interventions. This talk reports on work that uses Spatial Regressions on Watershed Attributes (SPARROW) to simulate the downstream transport of Cl from impervious and pervious surfaces to Lake Simcoe, a large lake in Southern Ontario. Results show that the SPARROW model is able to simulate Cl downstream transport, and various sources and transport factors are identified. These results validate the use of SPARROW as a Cl downstream transport tool.

Session: 8022 Changing Chemical Loads in Evolving Watershed - Part 3 Modification des charges chimiques dans un bassin versant en évolution - Partie 3 **28/05/2025 10:45**

ID: 12425 Contributed abstract

Virtual

Projected impacts of climate change on river flow and nutrient loading in the Assiniboine River Basin

Yonas Dibike [1] , *Yongbo Liu* [2] , *Rajesh Shrestha* [3]

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[3] Environment and Climate Change Canada

Presented by / Présenté par: *Yonas Dibike*
Contact: yonas.dibike@ec.gc.ca

Potential impacts of projected climate change on river flow and nutrient loading of the Assiniboine River Basin (ARB) are investigated using the Soil and Water Assessment Tool (SWAT) hydrologic model with the current land management practices. Climate change scenarios from seven global climate models (GCMs) and two shared socioeconomic pathways (SSP245 and SSP585) were considered. The impact of climate change for various future warming levels (1.5°C, 2°C, 3°C, and 4°C above the preindustrial level) on runoff, TSS, and nutrient loadings were assessed. Compared to the results of the 1980-2010 reference period, the ensemble mean of the multiple climate change scenarios showed an increasing trend in annual flow, TSS, TN, and TP for the 1.5°C, 2°C, and 3°C warming levels and a decreasing trend for the 4°C warming level. Significant increases were found in the winter and spring snowmelt runoff periods and decreases in the summer and fall. These findings indicate that agricultural best management practices (BMPs) designed to reduce nutrient loadings from snowmelt runoff would be more effective in mitigating the potential impact of future climate changes in the basin.

Session: 8022 Changing Chemical Loads in Evolving Watershed - Part 3 Modification des charges chimiques dans un bassin versant en évolution - Partie 3 **28/05/2025 11:00**

ID: 12379 Contributed abstract

Assessing the Freshwater Salinization Syndrome and Water Quality Stratification in Urban Stormwater Management Ponds

Rayden Laliberte [1] , *Akshara Withanage* [2] , *Maria Strack* [3]

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Presented by / Présenté par: *Rayden Laliberte*
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Stormwater management (SWM) ponds are vital infrastructure for cities and urban areas. Not only are SWM ponds a key design tool for urban SWM, they also provide other functions including storing nutrients in the pond water and sediment. The contaminants a SWM pond receives from the surrounding urban watershed includes road salt applied in the winter months and flushed during periods of thaw. The road salt entering the ponds every year continuously increases the levels of salinization within them, leading to SWM ponds developing freshwater salinization syndrome (FSS). FSS can lead to many physical and biochemical changes within a water body, including

increased water layer stratification that leads to lower levels of dissolved oxygen (DO) within the pond and greater methane production and emission. To determine the extent and impact of freshwater salinization on varying types of SWM ponds, we conducted a study across four ponds in the Kitchener-Waterloo, ON region: with high/low water salinity orthogonal to high/low water depth. The ponds underwent sampling twice a month from June to August (peak microbial activity), and once a month from September to November (less microbial activity due to cooler temperatures). Preliminary results imply that, in both low and high-water depths, increased salinization results in increased water layer stratification, leading to a thicker layer in the pond with anoxic conditions. The ponds with high levels of salinity, measured in specific conductivity, had maximum concentrations ~3x and ~7x larger (3600 μs/cm and 7500 μs/cm), deep and shallow ponds, respectively, than their low salt level counterparts. The high salt level ponds also had low levels of DO at higher occurrences throughout the sampling period. The implications of FSS on the ponds methane production and emissions will be explored to better inform the interactions between SWM pond water quality and urban greenhouse gas emissions.

Session: 8022 Changing Chemical Loads in Evolving Watershed - Part 3 Modification des charges chimiques dans un bassin versant en évolution - Partie 3

28/05/2025 11:15

ID: 12521 Contributed abstract

Contrasting cold weather physical and chemical conditions of closed and open urban ponds

Tim Duval [1] , *Kaileigh Rador* [2] , *Stefanie Rajkumarsingh* [3] , *Imran Smlatic* [4] , *Mathilde Tremblay* [5]

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Presented by / Présenté par: *Tim Duval*

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Stormwater management (SWM) ponds are ubiquitous landscape features in the urban environment, accepting runoff from nearby impervious surfaces, delaying transport to downstream water courses. Other older manmade and/or natural ponds without connection channelized drainage water do exist in the urban environment. Both may

provide ecosystem services to the landscape; however, the relative physical, chemical, and biological conditions between the two types have rarely been studied, even less so in non-growing season months. In this study we present two winters' temperature, salinity, and other water quality data of two ponds on the UTM campus, demonstrating the stark difference between pond types. The 2024 winter was mild, with minimal ice cover on both ponds, whereas the 2025 winter was cold, with several months of ice cover. The open SWM pond's salinity was significantly higher than the closed pond in both winters; however, the lack of ice in 2024 limited salinity-based stratification of the water column to weeks'-long periods, with intermittent overturning. In contrast, the forebay of the open pond remained stratified due to road salt inputs for the entirety of the 2025 winter, and much of the main-bay became stratified by mid-February. These dynamics led to significant differences in dissolved oxygen and phosphate concentrations between winters, ponds, and depths. In the mild 2024 winter, near-surface water in both ponds were consistently near saturation (>10 mg/L), whereas levels at depth in the open pond became anoxic. In contrast, under ice in the cold 2025 winter the open pond was anoxic throughout most of the water column, with the closed pond aerated throughout the first half of the season. Results of this study demonstrate that winter phenology and hydrogeomorphology are important controls on urban pond ecosystem dynamics and need to be considered in process and conceptual models of urban water courses.

Session: 7051 The Polar Night Experiment (PONEX) Aircraft Campaign in Inuvik - Part 2 Campagne aérienne de Polar Night Experiment (PONEX) à Inuvik - Partie 2

Convenors:
Xiaochuang Bu (University of Waterloo)
Serghei Bocaniov (University of Waterloo)
Noelle Starling (University of Waterloo)
Raoul-Marie Couture (Université Laval)
Helen Baulch (University of Saskatchewan)

Global environmental changes—driven by accelerated climate shifts and intensified human activities—are reshaping water systems worldwide. Canada, endowed with vast and diverse water systems including the Great Lakes, extensive river networks, expansive wetlands, coastal and estuarine systems, provides a unique and critical context for investigating these changes. As sentinels of environmental disturbance, water bodies reflect changes in climate, land use, and pollutant transport through measurable variations in chemical loads of key elements (e.g., C, N, P, Cl) and contaminants. Faced with challenges such as permafrost thaw, cultural eutrophication, increasing salinization and aquatic pollution, it is imperative to understand the factors that contribute to and shape chemical loads, discharge and biogeochemical fluxes across waterbodies is imperative.

This session aims to advance the systematic study of chemical loads, discharge and biogeochemical fluxes in changing water systems. It also focuses on quantitative and qualitative characterization of these processes not only under past and present climates but also their predictions under future climatic conditions or extreme events. We invite abstracts utilizing field experiments, observations, and modeling to characterize the transport and biogeochemical transformations of carbon, nutrients, metals, major ions, and contaminants in inland waters, estuaries, and coastal environments. We welcome contributions related to existing databases, diagnostic methods, data analysis, and applications of artificial intelligence.

Session: 7051 The Polar Night Experiment (PONEX) Aircraft Campaign in Inuvik - Part 2 Campagne aérienne de Polar Night Experiment (PONEX) à Inuvik - Partie 2

28/05/2025 13:30

ID: 12297 Contributed abstract

Virtual

Preliminary Results from EarthCARE Commissioning Calibration/Validation Campaign in Ottawa (ECALOT)

Zhipeng Qu [1] , *Paloma Borque* [2] , *Keyvan Ranjbar* [3] , *Cuong Nguyen* [4] , *Zen Mariani* [5] , *Lei Liu* [6] , *Alexei Korolev* [7] , *Ivan Heckman* [8] , *Howard Barker* [9] , *Meriem Kacimi* [10] , *Benjamin Riot-Bretêcher* [11] , *Natalia Bliankinshtein* [12]

[1] Environment and Climate Change Canada
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Presented by / Présenté par: *Zhipeng Qu*
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The European Space Agency (ESA) and the Japan Aerospace Exploration Agency (JAXA) launched the EarthCARE satellite on 28 May 2024 to provide unprecedented data for advancing the understanding of cloud-aerosol-radiation interactions. Equipped with a Cloud Profiling Radar (CPR), Atmospheric Lidar (ATLID), Multispectral Imager (MSI), and Broadband Radiometer (BBR), EarthCARE provides unique opportunities for synergistic retrievals of aerosol, cloud, precipitation and atmospheric radiative properties. Ultimately, these data should improve numerical predictions of both weather and climate.
As part of ESA's global calibration and validation (cal/val) initiative for the EarthCARE mission, the EarthCARE Commissioning Cal/Val Campaign in Ottawa (ECALOT) was

conducted from October 2024 to March 2025 to characterize continental fall and winter conditions over south-central Canada. The campaign's primary objective was to conduct coordinated underflights of EarthCARE, collecting airborne and ground-based observations to calibrate and assess the satellite's Level 1 and Level 2 products.
ECALOT utilized the National Research Council Canada's (NRC) Convair-580 aircraft, which was instrumented with W- and X-band radars (NAWX), 355 nm lidars and a suite of in situ cloud microphysics and aerosol probes, providing critical measurements for validating EarthCARE products. These airborne observations were supplemented by ground-based instruments from Environment and Climate Change Canada (ECCC) and McGill University near Ottawa Airport, along with two additional climate sentinel sites in the Montreal region, operated by McGill University and Université du Québec à Montréal. Each of these three sites features an Atmospheric Emitted Radiance Interferometer (AERI).
This presentation provides an overview of ECALOT and summarizes the validation results for EarthCARE products, including Level 1 CPR and ATLID measurements, as well as Level 2 single-instrument, composite and synergistic cloud and aerosol retrievals, as well as radiative quantities using both airborne and surface-based observations.

Session: 7051 The Polar Night Experiment (PONEX) Aircraft Campaign in Inuvik - Part 2 Campagne aérienne de Polar Night Experiment (PONEX) à Inuvik - Partie 2 **28/05/2025 13:45**

ID: 12307 Contributed abstract

Virtual

Modeling activities during the POlar Night EXperiment (PONEX) aircraft campaign

Melissa Cholette [1] , *Jason Milbrandt* [2] , *Zen Mariani* [3] , *Zhipeng Qu* [4] , *Alexei Korolev* [5]

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Presented by / Présenté par: *Melissa Cholette*
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Atmospheric and microphysics data collection is essential to explore the challenges that numerical weather prediction (NWP) models may still exhibit, especially in regions where less instrumentation is installed or available, such as in the Arctic. The Canadian Arctic Prediction System (CAPS) is used for Arctic NWP at Environment and Climate Change Canada (ECCC). CAPS is a 3-km horizontal grid spacing operational configuration based on the Global Environmental Multiscale (GEM) model. In the Arctic region, several modeling challenges remain, such as the cooling and drying anomalies during the polar night, the role of polluted transport on the local weather, and the accurate prediction of optically thin ice clouds and ice properties.
The POlar Night EXperiment (PONEX) aircraft missions that will take place in January-February 2026 will be instrumental to study these specific challenges within the

operational CAPS in order to improve the Arctic forecasts and these specific challenges. To do that, real-time high resolution (1-km grid spacing) GEM simulations will be performed using a similar configuration than CAPS and its outputs as lateral and initial conditions. The impacts of using new improvements to the Predicted Particle Properties (P3) microphysics parameterization will also be studied. For example, the role of predicting the liquid fraction of mixed-phase particles and the use of the triple-moment ice particle size distribution on the simulations of ice properties as well as the impacts of prognosing water-friendly and ice-friendly aerosols particles in the P3 scheme will be investigated. The modeling plan and progresses including preliminary results, such as a decrease of mean ice size particle with triple-moment ice will be shown.

Session: 7051 The Polar Night Experiment (PONEX) Aircraft Campaign in Inuvik - Part 2 Campagne aérienne de Polar Night Experiment (PONEX) à Inuvik - Partie 2 **28/05/2025 14:00**

ID: 12449 Contributed abstract

Ground-Based Observations for the POlarNight EXperiment(PONEX) Aircraft Campaign

Kaley A. Walker [1] , *Kimberly Strong* [2] , *Julie Thériault* [3] , *Zen Mariani* [4]

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Presented by / Présenté par: *Kaley Walker*
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In support of the upcoming POlarNight EXperiment (PONEX) Aircraft Campaign, a complementary ground-based measurement program is being developed. A suite of instruments planned to be deployed include microwave and infrared radiometers, scanning Doppler lidars, water vapour profiling differential absorption lidar (DIAL), Micro Rain Radar (MRR), and surface meteorology instruments. The instrument operations will be automated with the goal of collecting observations 24/7.

The ground-based instruments will provide detailed observations from the surface into the troposphere. These observations will be used to provide insights into the local and synoptic meteorological conditions during each PONEX flight and to conduct calibration and validation of the aircraft remote sensing observations. In addition, a fixed-point dataset will be generated to perform comparisons with the EarthCARE mission.

This presentation will discuss the plans for the ground-based comparison component of PONEX. In addition to the contributions to the PONEX mission objectives, the ground-based observations will serve as a testbed for future campaigns for the Canadian High-altitude Aerosol, Water Vapour, and Cloud (HAWC mission). The experience from PONEX will enable the HAWC suborbital team to better plan for the calibration/validation and science campaigns during this future mission.

Session 7052

Convenors:
Zen Mariani, ECCC
Kaley Walker, University of Toronto
Natalia Bliankinshtein, NRC Canada

An informal discussion on PONEX science objectives, activities, flight plans, logistics, and collaborations. This is an open discussion for all to attend; additional collaborators and ideas are welcome.

No abstracts

Session: 10030 Discussions on development, evaluation and analysis of ocean circulation and biogeochemical models or Developing Ocean Modelling Capacity in Canada - Part 1 Discussions sur le développement, l'évaluation et l'analyse des modèles de circulation océanique et de biogéochimie ou Développer la capacité de modélisation océanique au Canada - Partie 1

Convenors:
Paul Myers (University of Alberta), Youyu Lu (DFO – BIO), Susan Allen (University of British Columbia), Greg Smith (ECCC), David Greenberg (DFO – BIO retired), Frederic Dupont (ECCC), Juliana Marson (University of Manitoba), Inge Deschepper (University of Alberta), Tahya Weiss-Gibbons (University of Alberta)

Ocean circulation and biogeochemical models are widely used for both research and operational forecasting. However, there are challenges for small research groups to handle the increasing complexity of the model codes, evaluation with various observational datasets, and analysis of the increasing amount of model output data.

This session aims to stimulate discussions on potential coordination and collaboration between Canadian government laboratories and universities in the development, evaluation and analysis of ocean circulation and biogeochemical models for hindcast and forecast at various time scales. Specific topics may include: 1) progress of model research and applications in various regions with different spatial resolutions; 2) new evaluation and analysis results that demonstrate the strength and weakness of the models; 3) improvements in model numerics and parameterization of sub-grid processes; 4) new analysis methods; 5) new forcing and evaluation datasets; 6) model inter-comparison; and 7) data presentation and visualization tools.

Session: 10030 Discussions on development, evaluation and analysis of ocean circulation and biogeochemical models or Developing Ocean Modelling Capacity in Canada - Part 1 Discussions sur le développement, l'évaluation et l'analyse des modèles de circulation océanique et de biogéochimie ou Développer la capacité de modélisation océanique au Canada - Partie 1

28/05/2025 13:30

ID: 12203 Contributed abstract

Development of the Canadian Three Oceans Downscaling System

Natasha Ridenour [1] , *Jonathan Izett* [2] , *Elise Olson* [3] , *Jim Christian* [4] , *Nicolas Lambert* [5] , *Bill Merryfield* [6] , *Damien Ringeisen* [7] , *Krysten Rutherford* [8] , *John Scinocca* [9] , *Geoff Stanley* [10] , *Nadja Steiner* [11] , *Neil Swart* [12]

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Presented by / Présenté par: *Natasha Ridenour*
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The Canadian Centre for Climate Modelling and Analysis (CCCma), in collaboration with Fisheries and Oceans Canada, is developing the Canadian Three Oceans Downscaling System (CanTODS), based on the ocean circulation model NEMO 4.2. The development of this model configuration is motivated by the need to have consistent, high resolution climate projection data for Canada's three oceans. Applications of CanTODS include seasonal to decadal predictions, production of boundary conditions for higher resolution regional models, as well as the ability to provide actionable data for regional decision making. Our goal is to produce downscaled climate projections at 1/12-degree resolution by 2026. Longer term, we plan to couple CanTODS with the Canadian Regional Climate Model (CanRCM) to produce a Canada-focused regional earth-system model. For CanTODS to reach its full potential, this project requires the collaboration and expertise from modellers throughout the country, with the long-term vision being a shared community model system.
We will present an overview of CanTODS domain development at ¼-degree resolution, including creating a flexible model forcings pipeline with specific focus on downscaling forcing from the Canadian Earth System Model (CanESM) and Coupled Model Intercomparison Project (CMIP) models. Part of this procedure includes remapping and downscaling all the required atmospheric forcing fields as well as the river discharge from relatively coarse land models to a higher-resolution coastline. We have also integrated two biogeochemical models into CanTODS, the Canadian Model of Ocean Carbon (CMOC) and Canadian Ocean Ecosystem model (CanOE). Presently, we are exploring the placement of our Pacific and Atlantic boundaries such that the model effectively resolves remote drivers while maximizing computational efficiency; feedback from the Canadian modelling community on this topic would be beneficial.

océanique et de biogéochimie ou Développer la capacité de modélisation océanique au Canada - Partie 1

ID: 12430 Contributed abstract

The Role of River Runoff in Arctic Freshwater Inflow Across Bering Strait

Tahya Weiss-Gibbons [1] , *Clark Pennelly* [2] , *Paul Myers* [3]

[1] University of Alberta
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Presented by / Présenté par: *Tahya Weiss-Gibbons*
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With climate change, and warming Arctic temperatures, there has been a large increase in freshwater sources into the Arctic Ocean. A large part of this increase has come from river runoff and inflow from the North Pacific across the Bering Strait, which has increased the surface freshwater observed in the central Arctic Ocean. Using the NEMO framework, version 4.2 run at ¼ degree resolution, I present a new regional configuration which aims to improve inflow across the Bering Strait and as well updates the river runoff forcing. Boundary locations in regional ocean model configurations can have a large impact on model results, and will be investigated. The impact and propagation of important river waters in the Arctic, such as the Yukon river off the coast of Alaska, will also be investigated. Understanding and development of improved regional ocean models is a crucial step in understanding the processes and mechanisms which drive changes in the Arctic.

Session: 10030 Discussions on development, evaluation and analysis of ocean circulation and biogeochemical models or Developing Ocean Modelling Capacity in Canada - Part 1 Discussions sur le développement, l'évaluation et l'analyse des modèles de circulation océanique et de biogéochimie ou Développer la capacité de modélisation océanique au Canada - Partie 1 **28/05/2025 14:00**

ID: 12508 Contributed abstract

Virtual

Decadal simulations of ocean temperature and salinity in Canada Basin

Zhenxia Long [1] , *Will Perrie* [2] , *Minghong Zhang* [3]

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Presented by / Présenté par: *Zhenxia Long*
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Ocean temperature and salinity are key ocean tracers of ecosystems in the Arctic Ocean. To examine their decadal variations of ocean temperature and salinity in the Canada Basin, NEMO 3.6 is implemented in the Arctic Ocean, forced by PHC temperature (salinity), GLORYS currents, and JRA-55 atmospheric surface fields from1958 to 2019. Compared to observations, NEMO can successfully reproduce mean sea ice, ocean temperature and salinity in the Arctic Ocean. Simulations also indicate that the Beaufort Gyre has intensified in recent decades, primarily driven by increased anticyclonic weather systems in the western Arctic. As a response to the intensifying Beaufort Gyre, the freshwater content in Canada Basin has significantly increased in recent decades, mainly due to enhanced Ekman convergence and accelerated ice melting. While sea surface temperature increases in the Basin rises, dominated by the impacts of accelerated ice melting, the ocean temperature associated with the Atlantic water layer tends to decrease. Furthermore, the decadal variations in freshwater content and ocean temperature are linked to decadal variability in the upper troposphere and lower stratosphere.

Session: 10030 Discussions on development, evaluation and analysis of ocean circulation and biogeochemical models or Developing Ocean Modelling Capacity in Canada - Part 1 Discussions sur le développement, l'évaluation et l'analyse des modèles de circulation océanique et de biogéochimie ou Développer la capacité de modélisation océanique au Canada - Partie 1 **28/05/2025 14:15**

ID: 12528 Contributed abstract

On the formation mechanisms of Nares Strait ice arches in the NEMO model.

Yarisbel Garcia Quintana [1] , *Clark Pennelly* [2] , *Paul G. Myers* [3] , *Kent Moore* [4]

[1] University of Toronto at Mississauga
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Presented by / Présenté par: *Yarisbel Garcia Quintana*
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Nares Strait, between Greenland and Ellesmere Island, is one of the main pathways connecting the Arctic Ocean to the North Atlantic, and a major conduit along which multi-year sea-ice leaves the Arctic. This transport is modulated by the winter-time formation of ice arches at both ends of the strait. The arches are tightly linked to the maintenance of the North Water Polynya. Therefore, the strait plays an important role in the mass balance of the Arctic sea-ice, influencing the climate of the North Atlantic region. However, the remoteness of Nares Strait and the harsh atmospheric and oceanic conditions that predominate nearly all year round, makes it difficult for data collection. While the satellite imagery might offer a very high spatial resolution, their usage is considerably limited as they fail in providing information on sub-surface ocean dynamics properties. As such, many studies have used numerical models to investigate the mechanisms behind Nares Strait ice arches formation.
Initial studies suggested that the formation and the stability of the arches depend on the parameterization of the elastic–viscous–plastic rheology. However, more recent

research has suggested that, even when using an EVP approach, a specific set of parameters may need to be modified to better simulate Arctic sea-ice on a basin-scale. Our study presents a suit of experiments carried using the state-of-the-art ocean model Nucleus for European Modelling of the Ocean, coupled to two different sea-ice models LIM3 and SI3. Through these experiments we explore Nares Strait sea-ice sensitivity to atmospheric forcing, model resolution, tides and to a set of parameters involved in ice dynamics and mechanical redistribution. Our main goal is to identify the ideal numerical setting to realistically simulate Nares Strait arches formation, and therefore, the mechanisms behind it. The preliminary results of this project will be presented during the Congress.

Session: 10030 Discussions on development, evaluation and analysis of ocean circulation and biogeochemical models or Developing Ocean Modelling Capacity in Canada - Part 1 Discussions sur le développement, l'évaluation et l'analyse des modèles de circulation océanique et de biogéochimie ou Développer la capacité de modélisation océanique au Canada - Partie 1

28/05/2025 14:30

ID: 12406 Contributed abstract

Virtual

From Origins to Fate: The Circulation and Transformation of Baffin Bay Polar Water

Laura Gillard [1] , *Søren Rysgaard* [2] , *Paul Myers* [3]

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Presented by / Présenté par: *Laura Gillard*
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Baffin Bay is a marginal sea, partially enclosed by the Canadian Arctic Archipelago and Kalaallit Nunaat (Greenland). The interaction between warm Atlantic and cold Arctic ocean currents governs the distribution of water masses in Baffin Bay and its outflows. Understanding the dynamics of these water masses in the Baffin Bay system is crucial in the context of a rapidly changing cryosphere.
This study focuses on the Baffin Bay Polar Water, a water mass near the freezing point (-1.8°C) with a salinity of approximately 33.6. In the literature, Baffin Bay Polar Water has been referred to by various names; however, its definition was formally established in a study in 2020. The novelty of this water mass, in regards to West Greenland, is the directionality of the current. It has been observed to flow southward along West Greenland, contrary to the classic circulation convention in this region of northward currents. Baffin Bay Polar Water has been detected as far south as Nuuk (64°N).
The cold polar water mass contributes to decreasing temperatures locally and opposes the northward transport of modified Atlantic water, thereby limiting Atlantic Water intrusion into fjords and reducing oceanic heat forcing on marine-terminating glaciers. To

investigate the pathways of Baffin Bay Polar Water, this study uses a state-of-the-art ocean model, NEMOv3.6, coupled with a sea ice model (LIM3) at a 1/4° resolution, along with the Lagrangian particle tracking tool, OceanParcels. This research aims to track the Baffin Bay Polar Water, determine its origins, and analyze its trajectory and transformation along the West Greenland coast.

Session: 10030 Discussions on development, evaluation and analysis of ocean circulation and biogeochemical models or Developing Ocean Modelling Capacity in Canada - Part 1 Discussions sur le développement, l'évaluation et l'analyse des modèles de circulation océanique et de biogéochimie ou Développer la capacité de modélisation océanique au Canada - Partie 1 **28/05/2025 14:45**

ID: 12481 Contributed abstract

Virtual

Development of a coupled model for shellfish carrying capacity application: Tuning/Validation of the circulation model

Marilena Geng [1] , *Andry Ratsimandresy* [2] , *Sebastien Donnet* [3] , *Daria Gallardi* [4] , *Thomas Guyondet* [5] , *Michael Dunphy* [6] , *Yuehua (Andy) Lin* [7]

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Presented by / Présenté par: *Andry Ratsimandresy*
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Newfoundland is the second-largest producer of cultured blue mussels (Mytilus edulis) in Canada, with about 50 active sites, the majority of which are located in Notre Dame Bay, on the northern coast of the island. This research aims to develop a coupled hydrodynamic/BGC model to study the ecological carrying capacity of the region.
The NEMO-based relocatable system developed for ports in Canada is applied to a small fjord-like arm in Notre Dame Bay to provide hydrodynamic information. The area of interest is the head of this arm, an approximately 8 × 8 km² region where mussel farming takes place.
Two levels of downscaling are used: first, CIOPS-E (~3 km resolution) provides boundary and initial conditions for a bay-scale model (~500 m resolution), which in turn forces a small arm model (~100 m resolution). Surface atmospheric forcing comes from the ECCC HRDPS 2.5 km-resolution system, and river runoff is based on climatological data from a nearby gauged river.
Monthly profiles of temperature and salinity from three sites and continuous ocean currents at two stations spanning one year period were collected around the mussel farm. These observation data were used to validate and tune the circulation model. A comparison of model output with observations reveals significant discrepancies, leading us to reconstruct the model’s initial conditions using a combination of observations and

model data.
This presentation focuses on the tuning of the physical model and provides insight into the challenges of applying a circulation model to a small area with a complex shoreline and bathymetry.

Session: 8030 General Hydrology - Part 1 Hydrologie générale - Partie 1

Convenors:
Dr. Barret Kurylyk, Dalhousie University
Dr. Lauren Somers, Dalhousie University

The general hydrology session invites a broad range of research contributions, including, but not limited to, field-, laboratory-, and/or modelling-based studies of the water cycle. Studies carried out at different spatial scales and situated in both pristine and disturbed landscapes are welcome.

Session: 8030 General Hydrology - Part 1 Hydrologie générale - Partie 1 **28/05/2025 13:30**

ID: 12391 Contributed abstract

How Well Do Evapotranspiration Partitioning Approaches Perform in Moss Covered Wetlands?

Yi Wang [1] , *Richard Petrone* [2]

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Presented by / Présenté par: *Yi Wang*
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Accurate evapotranspiration (ET) partitioning into evaporation (E) and transpiration (T) is essential for characterizing water flux dynamics, guiding sustainable water management practices, and predicting responses to climate change. However, ET partitioning in wetland ecosystems remains understudied, and the mechanisms governing this process are poorly understood. Many existing approaches rely on periods of T dominance, which may not be well suited for wetlands. Additionally, most methods do not explicitly account for the role of mosses in regulating water fluxes between the soil and atmosphere. This study evaluates the assumptions, suitability, accuracy, uncertainty, and temporal dynamics of existing ET partitioning methods in wetland ecosystems. The analysis is based on field data from boreal wetlands and high-elevation wetlands in the Canadian Rocky Mountains, where chamber, microlysimeter, sap flow, and eddy covariance measurements were integrated to quantify E, T and ET. The results showed that none of the evaluated methods provided both accurate and precise estimates of ET partitioning (T/ET ratio). However, high-frequency eddy covariance-based methods generally outperformed conventional carbon and water coupling methods, as they demonstrated

more stable performance across sites and better alignment with measured temporal dynamics. These findings highlight the need for better ET partitioning methods in wetlands and provide insights to improve water and carbon flux estimations in hydrological and climate models.

Session: 8030 General Hydrology - Part 1 Hydrologie générale - Partie 1 **28/05/2025 13:45**

ID: 12455 Contributed abstract

Multi-year evapotranspiration and energy dynamics of a reclaimed fen in the Athabasca Oil Sands Region

Daniel Amaro Medina [1] , *Graham Clark* [2] , *Sean Carey* [3]

[1] McMaster University
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Presented by / Présenté par: *Daniel Amaro Medina*
Contact: amaromed@mcmaster.ca

The Athabasca Oil Sands Region (AOSR) in Alberta covers ~93,000 km², with mining activities disrupting ~4,750 km² and permanently altering hydrological function. Provincial legislation mandates companies to restore disturbed landscapes to an equivalent land capability, maintaining pre-disturbance functions. Wetlands account for ~55% of the region's landscape, ~90% of which are fen peatlands – ecosystems challenging to construct due to their complex hydrology and reliance on water exchange with adjacent uplands. In the subhumid AOSR, evapotranspiration (ET) is a key component of the water balance, with its variability crucial for understanding ecohydrological feedbacks and the long-term sustainability of landforms. This study evaluates growing season ET responses to environmental conditions in a reclaimed fen over five non-consecutive years within a decade, using eddy covariance (EC) measurements and vegetation surveys. The study site, Sandhill Fen, is a constructed wetland built atop a 60–100 m layer of composite tailings, capped with 10 m of tailings sand. The mean annual ET for the study period was 250 ± 49.9 mm. Intra-annual variability in vapour pressure deficit and net radiation explained ~50% of the variability in ET. A decline in ET is linked to the expansion of cattail (Typha latifolia), whose stomatal control and emergent properties regulate water loss. During drier periods, surface conductance explained up to 25% of ET variability, emphasizing Typha's role in ET reduction. Flux partitioning showed that transpiration (T) consistently exceeded evaporation (E) by ~50%, with a higher T/ET ratio of 0.64–0.68 and E/ET below 0.30, indicating that dense macrophyte cover enhanced T. Despite the declining ET, latent heat remained the dominant energy flux (~55%), aligning with findings from natural and constructed boreal peatlands. As mining operations expand, deeper insights into ET and energy dynamics are essential for predicting peatland reclamation trajectories and optimizing post-mining landscape sustainability.

Session: 8030 General Hydrology - Part 1 Hydrologie générale - Partie 1 **28/05/2025 14:00**

ID: 12530 Contributed abstract

Early phase energy balance of a pilot-scale constructed watershed within the Athabasca Oil-sands region.

Timothy Trembath [1] , *Richard Petrone* [2] , *Scott Ketcheson* [3]

[1] University of Waterloo
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[3] Athabasca University

Presented by / Présenté par: *Timothy Trembath*
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Post-mine closure reclamation in the Athabasca oil-sands region (AOSR) is becoming an increasingly more important area of research. With some mining projects coming towards the end of their project life and new explorations being commenced, efficient long-term remediation of the tailings produced is an essential regulatory component and essential part of improving environmental sustainability in mining operations. In this study, the developing energy balance of a constructed watershed was assessed as part of a pilot-scale pit-lake storage system. The energy balance of the watershed was monitored through a combination of surface energy flux measurements, meteorological data, soil moisture data and vegetation assessments. The aim of the study is to identify how the dynamics of the energy balance and soil moisture regime shift within the initial years post-construction and what role does establishing vegetation play in these shifts? These shifts could provide insight into the future success of the watershed with respect to supplying water to sustain the tailings water cap and establishing effective ecosystem reclamation.

Session: 8030 General Hydrology - Part 1 Hydrologie générale - Partie 1 **28/05/2025 14:15**

ID: 12533 Contributed abstract

Perched Peatlands: insights into eco-hydrologic roles of peatlands in water limited boreal environments

Kevin Devito [1] , *Mika Little-Devito* [2] , *Lindsay James* [3] , *Daniel Alessi* [4] , *Kelly Hokanson* [5] , *Nick Kettridge* [6] , *Carl Mendoza* [7]

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Presented by / Présenté par: *Kevin Devito*

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Despite the regional moisture deficit of the Boreal Plains ecoregion of Canada, peatlands exist on topographic highs isolated from surface water and local and regional groundwater inputs. The water generating mechanisms (external water sources, internal feedback mechanisms) that enable peatland formation with such delicate water balances in these unique hydrogeological settings are not well known. Hydrometric, geochemical (DOC, pH, major cations and anions), and isotopic (D/H, 18O/16O) data from a small isolated peatland-margin swamp complex were collected to explored the relative roles of adjacent forest, margin swamp and peatland feedbacks on maintaining peatland moisture and ecosystem function. Continuous water table gradients from the peatland to the adjacent forest and water balance calculations show the peatland is a source of water to adjacent forests and illustrate the dominance of autogenic wetland feedbacks over allogenic controls (external sources) in peatland development at this location. Contrasts in water storage due to depth to the clogging layer determine peatland, swamp and forest form and function. Peat and swamp soil properties promoted frequent soil saturation and anoxia, and extended soil frost duration and reduced evapotranspiration losses resulting from shading and wind protection from adjacent forests combined to limit forest advancement and water uptake in the wetland contributing to a moisture surplus in the wetland complex relative to the adjacent forest. Understanding the water balance and moisture surplus controls in isolated peatlands sheds light on the relative role of allogenic and autogenic controls on natural peatlands with implications for: 1) assessing regional eco-hydrological roles of peatland and forestland covers, 2) predicting landscape-scale response to environmental change and land use, and 3) directing landscape scale reclamation or large reconstruction projects over a range of geologic settings in water-limited boreal regions.

Session: 8030 General Hydrology - Part 1 Hydrologie générale - Partie 1 **28/05/2025 14:30**

ID: 12540 Contributed abstract

Towards Modeling Hydrological Processes of Boreal Wetlands: A Comprehensive Intercomparison of Three Land Surface Models

Danqiong Dai [1] , *Zhenhua Li* [2] , *Lauren Bortolotti* [3] , *Cenlin He* [4] , *Tzushun Lin* [5] , *Oliver Sonnentag* [6] , *Vanessa Harriman* [7] , *Yanping Li* [8]

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Presented by / Présenté par: *Danqiong Dai*
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The Canadian and Alaskan boreal zones represent one of the most water-rich areas globally, with diverse wetland ecosystems serving as crucial hydrological regulators. However, the distinctive characteristics of these environments pose significant challenges for land surface modeling. This study presents the first comprehensive intercomparison of three leading land surface models (LSMs) - Noah-MP, Community Land Model (CLM), and Canadian Land Surface Scheme (CLASSIC) - specifically evaluated in boreal forest wetland ecosystems. We assessed model performance using observational data from six representative sites across this region over a multi-year period, focusing on key hydrological processes including soil moisture dynamics, water table fluctuation, and soil thermal profiles. All models exhibited notable deficiencies in representing the complex hydrological connectivity characteristic of these wetland-dominated landscapes. This intercomparison provides crucial insights for improving model parameterizations specific to boreal wetlands, enhancing our capacity to predict their responses to climate change and their role in regional and global water cycles. Our findings highlight the need for a refined representation of lateral water flow, freeze-thaw dynamics, and vegetation-water interactions in LSMs to better capture the unique hydrological processes of boreal wetland ecosystems.

Session: 3051 Peatland disturbance and policy in Canada - Part 2 Perturbation des tourbières et politique au Canada - Partie 2

Convenors:
Adam Kirkwood, WCS Canada
Lorna Harris, WCS Canada
Bin Xu, Centre for Boreal Research, NAIT
Sophie Wilkinson, Simon Fraser University

Peatlands across Canada store ~150 billion tonnes of carbon (C) and are subject to increased pressures from climate change and the push for industrial development in peatland rich regions. For Canada to meet net-zero carbon emissions, it is critical that irrecoverable C remain in peatlands, and that the C sink function of peatlands remains intact. To adequately understand how disturbances to peatlands will contribute to climate change through the release of carbon dioxide (CO_2) and methane (CH_4) or through weakened C sink capacity, research on the response and recovery of peatlands to disturbances is needed. Equally as important is understanding the laws and policies across Canada that impact peatlands, including those designed to protect, mitigate damage to, or legislate recovery from industrial disturbances. This session welcomes all submissions related to peatland research, with preference given to submissions that examine the response of peatlands to impacts of climate change (e.g. fire, warming and drying, permafrost thaw) and industrial disturbances (e.g. drainage, roads, mining - including exploration activities, peat harvesting). Additionally, we encourage the submission of abstracts that discuss the policy relevance of their work, or how Canada’s policies applicable to peatlands (which may include law and policy for water management, industry – e.g., roads and mining, and other) have reduced impacts to, or managed or recovered, critical ecosystem services provided by peatlands.

Perturbation des tourbières et politique au Canada - Partie 2

13:30

ID: 12562 Contributed abstract

Closing the Gap: Improving Wetland Greenhouse Gas Inventories for Effective Policy

Kelly Ann Bona [1] , *Daniel Aydalla* [2] , *Erik Emilson* [3] , *Madeleine Garibaldi* [4] , *Oleksandra Hararuk* [5] , *Hongxing He* [6] , *Kara Webster* [7] , *Nicolas Perciballi* [8]

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Presented by / Présenté par: *Kelly Ann Bona*
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Robust national greenhouse gas (GHG) monitoring and reporting systems for wetland land-use change are critical for evidence-based climate change mitigation and adaptation policy development. A significant gap exists in Canada's national GHG inventory regarding industrial disturbance of boreal wetlands, primarily due to a lack of operational tools, maps, and emission factors. This presentation highlights recent progress in addressing these deficiencies, specifically: (1) advancements in the Canadian Model for Peatlands, (2) the development of updated emission factors for industrial wetland disturbances, and (3) improved mapping of peat depth and extent within the Alberta oil sands region. We will conclude by discussing future challenges and opportunities for further refining these efforts to inform national wetland policy development.

Session: 3051 Peatland disturbance and policy in Canada - Part 2
Perturbation des tourbières et politique au Canada - Partie 2

28/05/2025
14:00

ID: 12445 Contributed abstract

The influence of the hydrogeomorphic setting on wetland hydrology and vegetation in central Yukon

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Presented by / Présenté par: *Leila Rashid*
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Mining activities within the Traditional Territory of the First Nation of Na-Cho Nyak Dun (FNNND) in central Yukon pose a significant threat to wetlands and the critical ecosystem services they provide. To support decision-making and land-use planning, FNNND requires information about wetland hydrology and how these ecosystems connect to the broader landscape.

This study explores an efficient method for estimating a wetland's hydrologic function based on its hydrogeomorphic setting. Understanding a wetland's hydrologic function is important because it influences both vegetation composition and connectivity to the larger groundwater system both of which are used to determine the wetland's classification. Specifically, the objectives are to: (1) characterize dominant hydrologic regimes and water sources using hydrometric monitoring, geochemical analysis, and stable water isotopes; (2) identify landscape controls on wetland type and distribution through digital terrain analysis and statistical modeling; and (3) assess wetland vegetation communities and their relationship to hydrologic conditions across different hydrogeomorphic settings.

To achieve these objectives, hydrometric instruments (wells and piezometers) were installed at eight wetland sites not underlain by permafrost to measure water table fluctuations and vertical groundwater movement. Water isotope and geochemical analyses were used alongside these measurements to characterize hydrologic regimes. UAV surveys were conducted at 20 wetland sites to collect multispectral imagery, which was used to analyze vegetation structure and canopy height across different wetland types. Principal component analysis (PCA) was applied to the collected data to identify dominant patterns, and the resulting scores were compared to terrain derivatives (e.g., topographic wetness index) to assess how geochemical variation relates to topographic controls on wetland function.

Through ongoing collaboration, the results of this work will help inform FNNND's land-use planning, supporting wetland conservation and water quality protection.

Session: 3051 Peatland disturbance and policy in Canada - Part 2
Perturbation des tourbières et politique au Canada - Partie 2 **28/05/2025 14:15**

ID: 12517 Contributed abstract

When water meets the road: hydrological sensitivities of two peatland types

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Presented by / Présenté par: *Joseph Tuffner*
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The Athabasca Oil Sands Region (AOSR) is the largest crude bitumen deposit globally, with ~97% of reserves accessible only via in-situ extraction. These methods are spatially extensive and require a network of linear infrastructure, including roads, which often intersect peatlands. Peatlands occupy ~50% of the AOSR and provide critical carbon and water storage functions. Roads may disrupt peatland hydrology, causing impoundment up-gradient and desiccation down-gradient, which alters vegetation communities and carbon dynamics. This study involves a patterned fen, of alternating shrub- and conifer-dominated peatland types, intersected by a road oriented perpendicular to regional drainage with the overall goal to quantify the hydrological sensitivities of these peatland types to the presence of a road. To achieve this, wells were installed along transects perpendicular to the road, following the regional hydraulic gradient along each peatland type, including beyond the anticipated influence of the road. Weekly measurements and hourly pressure transducer data tracked water table levels. Preliminary analysis suggests that local compression in areas next to the road, among both peatland types produces a local horizontal hydraulic gradient towards the road on both sides . A gradient is also present from conifer- to shrub-dominated sites on the up-gradient side, while the reverse is observed on the down-gradient side , suggesting that the road is differentially influencing the hydrological connectivity of the peatland types across the road. In general, shrub- dominated sites were wetter than conifer-dominated sites (mean difference = 13cm, $p < 0.01$). Both peatland types were wetter immediately up-gradient than down-gradient (mean difference = 3.5 cm, $p < 0.01$), and water table positions were 48% more variable immediately down-gradient than up-gradient of the road. Quantifying hydrological sensitivities among peatland types to access roads will inform future development, minimizing disturbance to the most sensitive peatland types and contributing to positive restoration outcomes in the AOSR.

Session: 3051 Peatland disturbance and policy in Canada - Part 2
Perturbation des tourbières et politique au Canada - Partie 2 **28/05/2025 14:30**

ID: 12451 Contributed abstract

Modelling peatland disruption in bisected bogs and the potential impacts on source water protection

Lauren Somers [1] , *Rory McPhail* [2] , *Anthony Mazzocca* [3] , *Nicholas Hill* [4]

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Presented by / Présenté par: *Lauren Somers*
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In flat terrain and humid climates, raised bogs can form the topographic watershed boundary of protected source watersheds. In these cases, only half of the “bisected bog” is protected. A GIS analysis revealed that bisected bogs are common in Protected Water Areas (PWAs) in the province of Nova Scotia, Canada. We consider if these bisected bogs should be included in PWAs by exploring how drainage in the unprotected side of the bog may impact the protected watershed. Groundwater monitoring and slug tests were performed in a transect of piezometers in a large, bisected bog in Cape Breton,

Nova Scotia, Canada to constrain a groundwater flow model. Under varying drainage scenarios (1 m, 3 m and complete harvest), simulations showed that the groundwater divide shifts 41 to 398 m inwards, 219,000 m3 to 1,570,000 m3 of water storage are lost and up to 23,600 to 156,100 tonnes of soil carbon become unstable. These findings suggest that it is illogical to protect only part of a bisected bog and that the entire bog should be protected to preserve hydrologic functionality. We provide recommendations for water managers to identify and address bisected wetlands to improve source water protection and maintain wetland ecosystem services.

Session: 4051 Transforming Canada’s Weather Services for a Resilient Future - Part 2 Transformer les services météorologiques du Canada pour un avenir résilient - Partie 2

Convenor: Erik de Groot

The Meteorological Service of Canada (MSC), a cornerstone of Canada's weather enterprise within Environment and Climate Change Canada, is undergoing a significant transformation to meet the evolving needs of Canadians. The MSC will bring speakers to showcase ongoing initiatives that aim to modernize the MSC's services, leveraging new technologies and public feedback to enhance risk communication in the face of weather-related impacts.

Session: 4051 Transforming Canada’s Weather Services for a Resilient Future - Part 2 Transformer les services météorologiques du Canada pour un avenir résilient - Partie 2 **28/05/2025 13:30**

ID: 12342 Contributed abstract

Analysis of “Re-Alert” Areas Resulting from Free Form Polygon-Based Convective Warnings.

Bradley Power [1]

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Presented by / Présenté par: *Bradley Power*
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As the Meteorological Service of Canada progresses down the path of introducing free form polygon (FFP) based warnings to its summertime convective warning program, authoritatively informing the public of the potential threat is crucial. If the public receive a series of alternating notifications indicating they are either in or out of an alert, there is potential to create confusion. We refer to areas where alternating alert notifications occur as “Re-Alert” areas. If the public is subjected to re-alerting frequently enough, the public’s trust in the agency’s ability to accurately forecast severe threats may be diminished.
Since FFP-based warnings that move with the storm threat are a new concept in Canada, the rate of occurrence of re-alert areas is unknown. This talk will describe the

causes of re-alert areas and findings from the analysis of FFP-based warnings. In addition, we will present potential impacts on various dissemination platforms and strategies being explored to mitigate them.

Session: 4051 Transforming Canada's Weather Services for a Resilient Future - Part 2 Transformer les services météorologiques du Canada pour un avenir résilient - Partie 2

28/05/2025 13:45

ID: 12341 Contributed abstract

Update on the Meteorological Service of Canada's Convective Alert Modernization project

Bradley Power [1]

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Presented by / Présenté par: *Bradley Power*
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The Convective Alert Modernization (CAM) project aims to modernize the production and delivery of convective warnings in Canada. By shifting from predefined zones to forecaster defined free-form polygons, one of the CAM project's primary goals is to reduce areal over-alerting. This presentation will highlight key lessons learned relating to expected service changes and warning management that were uncovered during a 2024 internal evaluation. We will showcase changes coming to ECCC dissemination platforms for the CAM project and unveil plans for engaging key stakeholders.

Session: 4051 Transforming Canada's Weather Services for a Resilient Future - Part 2 Transformer les services météorologiques du Canada pour un avenir résilient - Partie 2

28/05/2025 14:00

ID: 12371 Contributed abstract

Virtual

Evaluating the Canadian Risk Assessment and Communication Framework Theory of the Framework

Claude Masse [1] , *Rebecca Wagner* [2]

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Presented by / Présenté par: *Claude Masse*
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Many national meteorological services worldwide are transitioning to impact-based forecasting (IBF) and early notification (EN) systems. This shift is driven by the need for actionable information that goes beyond traditional weather forecasts, helping

communities better prepare for and respond to weather-related hazards.

The Meteorological Service of Canada (MSC) at Environment and Climate Change Canada has been exploring the implementation of IBF and EN in parts of Canada. To support this effort, the MSC has developed the Canadian Risk Assessment and Communication Framework (RACF), which follows the continuous risk communication and value-adding processes described by Lazo and Mills (2021).

To assess the robustness of the RACF, we have been working with Emergency Management Organizations (EMOs) on a tiered alerting vigilance system. As part of this evaluation, we developed a Winter Storm Playbook—a resource designed to help ECCC ensure timely action and response before, during, and after major winter storms. This playbook fosters a collaborative approach to enhancing resilience, supporting communities, emergency agencies, and first responders.

Our approach involved conducting interviews with internal and external partners. We developed a workflow that synchronizes the actions of key internal contributors—such as scientists, operational and service meteorologists—and coordinates interactions with EMOs. Communications with various target audiences, including EMOs, public health and safety organizations, and individuals, were incorporated and aligned with the RACF.

Session: 4051 Transforming Canada's Weather Services for a Resilient Future - Part 2 Transformer les services météorologiques du Canada pour un avenir résilient - Partie 2 **28/05/2025 14:15**

ID: 12374 Contributed abstract

Evaluating the Canadian Risk Assessment and Communication Framework Part II (Case study)

Rebecca Wagner [1] , *Claude Masse* [2]

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Presented by / Présenté par: *Rebecca Wagner*
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Using the established Risk Assessment and Communication Framework (RACF), we initiated an evaluation process in the winter of 2024 to validate the workflow.

We studied continuous risk communication throughout the phases of a typical winter storm event: Early Notification (Awareness), Timely Notification (Action-oriented), Crisis (During the event), and Post-event (Evaluation).

We conducted a comparative study of four winter events to evaluate the synoptic-scale playbook against the RACF. While each event had its own nuances, we were able to illustrate the effectiveness of our risk communication in mitigating impacts on affected Canadians.

The lessons learned and recommendations will serve to improve our performance while

supporting our continuous improvement as we move toward implementing risk-tiered alerting in Canada in 2025.

Session: 4051 Transforming Canada's Weather Services for a Resilient Future - Part 2 Transformer les services météorologiques du Canada pour un avenir résilient - Partie 2 **28/05/2025 14:30**

ID: 12372 Contributed abstract

Transformation of the Meteorological Service of Canada: Evolving Role of the Meteorologist

Rebecca Wagner [1]

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Presented by / Présenté par: *Rebecca Wagner*
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Project Talent is an initiative by the Meteorological Service of Canada (MSC) aimed at redefining the skillsets required for new functions in meteorology at the MSC. This project focuses on identifying and cultivating the competencies needed to thrive in our evolving field, ensuring our workforce is equipped to meet future challenges and opportunities.

Key initiatives include:
1. Broadening Recruitment Efforts: Expanding recruitment to include a wider range of atmospheric and physical sciences disciplines.
2. Modernized Training Programs: Emphasizing decision support, client engagement, AI, risk communication, and behavioral science training.
3. Career Pathways and Certifications: Developing clear career pathways and specialized certifications in areas such as media services, decision support, and AI.
4. Embracing Technology and Innovation: Incorporating AI and automation into professional development programs and fostering a culture of innovation.
5. Diversifying Skillsets and Backgrounds: Providing opportunities to develop competencies and gain varied experiences to enhance multidisciplinary collaboration and innovation.

We invite students, partners, and stakeholders to join us to learn more about opportunities we are exploring to shape a resilient and adaptable workforce.

Session: 4051 Transforming Canada's Weather Services for a Resilient Future - Part 2 Transformer les services météorologiques du Canada pour un avenir résilient - Partie 2 **28/05/2025 14:45**

ID: 12243 Contributed abstract

Advances in Storm Impact Communication at the Canadian Hurricane Centre

Chris Fogarty [1]

[1] Canadian Hurricane Centre

Presented by / Présenté par: *Chris Fogarty*
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As the Meteorological Service of Canada (MSC) continues to focus on developing an impact-based alerting system (with less focus on current hazard threshold-centric one), the CHC is also enhancing its service in line with the MSC efforts through ongoing projects such as 'RiTA'(Risk-Tiered Alerting using a Y-O-R colour scale) and products including 'GeoJSON' (open format for encoding geospatial data based on JavaScript) and coastal flooding forecasts with new coastal forecast zones. One specific example is the CFRO (Coastal Flooding Risk Outlook) which presents a visual means of communicating areas most likely to be impacted by storm surge and waves out to six days into the future. These projects and products will help improve our ability to communicate the impact of hurricanes and post-tropical storms impacting Eastern Canada. During this presentation I will focus on some examples of tropical-related storms in Canada and compare the distribution and types of weather alerts from the past with the new colour-tiered approach along with samples of outreach material we will use to communicate the changes.

Session: 6013 Observation and modelling of snow and glacier processes - Part 4
Observation et modélisation des processus liés à la neige et aux glaciers - Partie 4

Convenors:

Christopher Marsh 1 , Phillip Harder 2 , Vincent Vionnet 3 , Caroline Aubry-Wake 4 , Libo Wang 1
1 Climate Research Division, Environment and Climate Change Canada, Canada
2 Croptimistic Technology Inc, Canada
3 Meteorological Research Division, Environment and Climate Change Canada, Canada
4 University of Lethbridge, Canada

Unprecedented anthropogenic climate and land use change are dramatically impacting the cold region processes that shape seasonal snowcovers and glaciers worldwide. Billions of people depend on the seasonal snowcovers and glaciers to provide essential freshwater flows for local and downstream communities and ecosystems. There are therefore significant incentives to provide better estimates of these changing physical processes through improved observations, analysis, and modelling. In this session, we invite contributions on all aspects of snow, ice, and glaciers including impacts on cold-regions meteorology, hydrology, surface-atmosphere-energy exchanges, frozen soil dynamics, glacier dynamics, and groundwater coupling. Contributors are encouraged to share their experiences, insights, and advances in utilizing existing and next-generation tools for observations, analysis, and/or modelling spanning all climate zones. Contributions that span the traditional CMOS and CGU boundaries are particularly encouraged.

Session: 6013 Observation and modelling of snow and glacier processes - Part 4 Observation et modélisation des processus liés à la neige et aux glaciers - Partie 4 **28/05/2025 13:30**

ID: 12182 Contributed abstract

Canadian Lake Ice Phenology : Data Gap and Remote Sensing

Julie Cambron [1] , *Saeid Homayouni* [2] , *Taha B. M. J. Ouarda* [3]

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Presented by / Présenté par: *Julie Cambron*
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Lake ice serves various purposes, including road development, winter recreation, and habitat preservation for aquatic life. However, Canadian lakes lack crucial on-site data, making remote sensing necessary to measure physical and meteorological data that affect freeze and thaw dates. Understanding how environmental variables affect lake winter phenology can help Canada be resilient to climate change.
The National Snow and Ice Data Centre's freeze-thaw database identifies lakes of interest with both ice events. The ERA5-Land dataset offers monthly average reanalysis of various meteorological factors, including wind speed, dew point, air temperature, evaporation, water column temperature, runoff, skin temperature, snowfall, atmospheric pressure, total precipitation, rainfall, and downward surface solar radiation, on a continental and global scale. The HydroLAKE dataset provides information on lakes, such as surface area, shoreline length, shoreline deviation, volume, average lake depth, average long-term discharge, average residence time, elevation, watershed area, longitude, and latitude. Using Google Earth Engine, we can intersect the lake polygons with a meteorological dataset to obtain the necessary variables and lags for each lake. Lake polygons were created using the modified normalized difference water index (MNDWI) to Sentinel-2 imagery. Their surface areas were compared to literature values and HydroLAKE data. MNDWI-calculated lake areas showed lower bias than HydroLAKE, whose lake shapes differed from basic cartography, explaining the better performance of MNDWI polygons. Despite this, HydroLAKE's many features make it valuable, causing us to remove lakes with unusual shapes from the selection. This unified database fills the initial data gap, making it easier to determine significant parameters for lake ice events. All parameters listed, as well as their lags, matter for at least one event, freeze or thaw. By the proxy of temperature, global warming threatens Canadian lake ice.

Session: 6013 Observation and modelling of snow and glacier processes - Part 4 Observation et modélisation des processus liés à la neige et aux glaciers - Partie 4 **28/05/2025 13:45**

ID: 12236 Contributed abstract

The relationship of snow phenology and lake ice thickness at High Arctic lakes

Lisa Marno [1] , *Laura Brown* [2]

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Presented by / Présenté par: *Lisa Marno*
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The cryosphere is a prevalent feature of the Arctic, where it plays a pivotal role with respect to climate, hydrological processes, ecology, and human activity. Given projected climate change scenarios, the effects of Arctic amplification are presumed to increase, resulting in alterations to snow spatiotemporal patterns. This study focuses on snow phenology and distribution patterns at two High Arctic lakes in Resolute, Nunavut: Resolute Lake and Small Lake. Snow temporal and spatial patterns, as well as lake ice formation and melt, will be analyzed through the collection of in situ data observations over the course of several fieldwork campaigns. Snow depth measurements are obtained through the use of an automatic GPS snow depth probe (magnaprobe) and will be compared to the underlying ice thickness, which is determined through the use of an ice auger. Preliminary results highlight spatial discrepancies in where snow accumulation on the lakes typically occurs, where deeper snow is often found at the southern end of Resolute Lake versus at the northern end of Small Lake. Local temperature data will be analyzed in order to investigate the influencing factors behind these observations. In addition to the spatial characteristics of snow, the temporal patterns of snow onset will be studied using trail camera imagery, as earlier (later) snow-on can result in thinner (thicker) underlying ice. Early analyses reveal a strong, negative relationship between snow depth and total ice thickness at both lakes. However, with a warming climate, this relationship could weaken if snow-on shifts later into the season, potentially aligning with a shorter ice formation period due to delayed freeze-up. Monitoring the local distribution of snow on two typical High Arctic lakes will highlight the intricate relationship between snow and ice dynamics under current climate conditions, providing insight on how such dynamics may respond to projected climate warming.

Session: 6013 Observation and modelling of snow and glacier processes - Part 4 Observation et modélisation des processus liés à la neige et aux glaciers - Partie 4 **28/05/2025 14:00**

ID: 12223 Contributed abstract

Bias Correction of Model Based Soil Temperatures Using Machine Learning

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Presented by / Présenté par: *Tyler Herrington*
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Reanalysis products provide spatially homogeneous coverage for a variety of climate variables, which is invaluable for regions where direct measurements are limited. However, previous research has shown soil temperature estimates in many reanalysis products show substantial biases; particularly in winter. Here we compare the soil temperature performance of two products – ERA5-Land and FLDAS against in-situ soil temperatures across the northern hemisphere and test a hierarchy of statistical techniques to bias-correct their soil temperatures. ERA5-Land is a state-of-the-art reanalysis system, while FLDAS is an advanced Land Data Assimilation System (LDAS). Both products provide high-resolution (~9 km) estimates of critical land surface variables such as vertically resolved soil temperature. Recent research has shown that ERA5-Land soil temperatures show substantial warm biases over permafrost regions, while FLDAS exhibits sizeable cold biases. Here we use mean bias subtraction (MBS), multiple linear regression (MLR) and random forest regression (RF) to perform bias correction of the ERA5-Land and FLDAS soil temperature products. The MLR and RF models employ 10 predictors, including soil depth, product soil temperature, air temperature, vegetation, snow cover, elevation, latitude and longitude. The RF model substantially outperforms MBS and MLR over all regions and latitudes, providing an average RMSE reduction (relative to ERA5-Land and FLDAS soil temperatures) of between 46% and 77% when the ground is snow-covered, and between 56% and 64% during the snow-free season. The bias-corrected soil temperature product provides gridded soil temperature data over the extratropical northern hemisphere, and will be useful for a wide range of applications, including as an initialization condition for hydrological models, and as a tool to validate model soil temperatures.

Session: 6013 Observation and modelling of snow and glacier processes - Part 4 Observation et modélisation des processus liés à la neige et aux glaciers - Partie 4 **28/05/2025 14:15**

ID: 12287 Contributed abstract

Development of a snow-clearing device for net radiometers: an essential tool for snowmelt modeling

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1

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Seasonal snow cover and glacier dynamics are changing rapidly as a result of global warming. Their melting processes, which are mainly controlled by shortwave solar radiation and longwave radiation from the atmosphere and the Earth's surface, are affected by the changing energy input from rising temperatures. In-situ measurements of net radiation are therefore essential to refine snowmelt models to account for these changes. Net radiometers, like the Kipp & Zonen CNR4, are equipped with two pyranometers and pyrgeometers, one pair facing upwards and the other downwards. While these instruments include a heating module to mitigate frost and dew, winter conditions often result in persistent snow cover that prevents downwelling radiation measurements for extended periods. This presentation proposes a new approach to overcome this problem: an automated device (called the CNB4), attached to the CNR4 rod, capable of removing the snow accumulation with a telescopic broom. To compare

the effects of snow removal and heating, two CNR4s were installed side by side, one of which was equipped with the CNB4. The setup is located at the Forêt Montmorency (47.3230°N, 71.1505°W), known for very high snowfall. Data was monitored in real time using IoT techniques to ensure good data recovery. Photos were taken every time the CNB4 was deployed and every hour to assess the amount of snow on the CNR4. Preliminary results showed that the CNB4 improved measurements during snow events and on subsequent days. It has been observed that the CNB4 can reduce by 300x the amount of energy needed to remove snow accumulation compared with traditional heating techniques. In terms of improvements, snow accumulation on the CNB4 was an issue that was not expected to be as important. In addition, freezing rain tends to block the telescopic mechanism, affecting its reliability. A new version correcting these is currently under development.

Session: 6013 Observation and modelling of snow and glacier processes - Part 4 Observation et modélisation des processus liés à la neige et aux glaciers - Partie 4 **28/05/2025 14:30**

ID: 12188 Contributed abstract

Assessing the impact of the Pluvio 2 L precipitation gauge firmware and output processing on solid precipitation measurement

Amber Ross [1] , *Craig Smith* [2] , *Summer Warren* [3] , *Jeffery Hoover* [4] , *Kai Wong* [5]

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Presented by / Présenté par: *Amber Ross*
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The Environment and Climate Change Canada (ECCC) surface weather network began transitioning the standard precipitation gauge used in the network from the single Alter-shielded (SAS) Geonor to the double Alter-shielded (DAS) OTT Pluvio 2 L in 2017. This transition has accelerated with about 302 DAS Pluvio 2 Ls installed in the network by the end of 2024. During the winter of 2022/2023, it became apparent that some transitioned Prairie and Arctic ECCC auto stations were under-reporting precipitation that couldn't be completely attributed to wind-induced undercatch (as quantified during the WMO Solid Precipitation Inter-Comparison Experiment or SPICE). This suggested that the issue was possibly related to the Pluvio 2 L firmware dependent data processing. The extent of this potential issue was largely based on measurements by nearby automated gauges, community observations, and anecdotal snowfall amounts. Indications of under-reporting at sites with low intensity snowfall during relatively high wind conditions continued for the subsequent winters of 2022/2023 and 2023/2024. To assess the cause and implications of the DAS Pluvio 2 L under-reporting issue, three ECCC automated weather stations were selected for an intercomparison: Bratt's Lake SK (XBK), Saskatoon SK (POX), and Yellowknife NT (NYE). Both POX and NYE were supplemented with a SAS Geonor T-200B gauge and a Lufft WS100 disdrometer for comparison to the operational DAS Pluvio 2 L with OTT firmware v1.05. The XBK station DAS Pluvio 2 L, also with firmware

v1.05, is collocated with the Bratt's Lake WMO SPICE site which includes a WMO Double Fence Automated Reference, a SAS Geonor T-200B, a WS100, and three additional DAS Pluvio 2 Ls with firmware v1.03, v1.04, and v1.05. Preliminary analysis has shown that DAS Pluvio 2 Ls with later firmware versions generally measure less solid precipitation than DAS Pluvio 2 Ls with earlier firmware versions. While gauges with double Alter-shields should almost always measure more solid precipitation than collocated gauges with sing Alter- shields (due to increased shielding), results indicate that the DAS Pluvio2L with later firmware (especially v1.05) measures less solid precipitation than the co-located SAS Geonor T-200B.

Session: 6013 Observation and modelling of snow and glacier processes - Part 4 Observation et modélisation des processus liés à la neige et aux glaciers - Partie 4 **28/05/2025 14:45**

ID: 12189 Contributed abstract

A preliminary assessment of disdrometers for supplementing and improving winter precipitation measurements

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Presented by / Présenté par: *Craig Smith*
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The measurement of winter precipitation in cold regions is extremely important for flood and water resource forecasting, drought monitoring, and climate change analysis, yet solid precipitation remains one of the hardest meteorological parameters to measure with any known level of uncertainty. The gauge measurement of solid precipitation is prone to relatively large systematic biases (e.g. undercatch due to wind) and many automated precipitation instruments produce data with inherent signal noise, often because of the harsh measurement environment, that typically requires the application of a filtering algorithm during or following the measurement. Concurrent high frequency disdrometer observations may potentially provide supplemental information for improving the automated gauge measurement of winter precipitation. Disdrometers using microwave or optical measurement principles may provide improved detection of light precipitation events, supplement and verify noise filtering algorithms, provide precipitation phase partitioning (as a climatological measurement otherwise not available at automated stations), and aid in reducing the uncertainty in the development and application of wind-bias adjustment functions.

To initiate the assessment of disdrometers for improving winter precipitation measurements, the Climate Research Division of Environment and Climate Change Canada has been operating a Lufft WS100 (microwave) and an OTT Parsivel 2 (optical) disdrometer at the Bratt's Lake SK Solid Precipitation Inter-Comparison Experiment (SPICE) site since October 2021. Similar intercomparison data is also being collected at the Caribou Creek SK SPICE site. Preliminary comparisons between the disdrometers, and with the WMO Double Fence Automated Reference precipitation observations, will be presented to demonstrate that the capabilities of these two sensors vary for detecting

events and for typing precipitation, with one sensor not necessarily more capable than the other. Preliminary results will contribute to the planning and implementation of a new WMO collaborative assessment of disdrometers (and other non-catchment devices) for measuring solid precipitation as a follow up to WMO-SPICE.

Session: 9010 Advances and applications of artificial intelligence in meteorology Progrès et applications de l'intelligence artificielle en météorologie

Convenors:

Miguel Tremblay (Environment and Climate Change Canada)
Ann Dacres (Environment and Climate Change Canada)

We invite the meteorological community to contribute to an exciting session on the integration of Artificial Intelligence (AI) into meteorology. This session aims to explore how AI, in particular machine learning (AI/ML) and high performance computing, is revolutionising modern meteorology.

Potential topics:
• Data-driven modelling in meteorology: Examples of fully data-driven models offering new insights into the understanding of meteorological phenomena.
• Hybridization of models: Fusion of data-driven approaches and traditional physical models for more accurate and robust weather forecasting.
• AI/ML for nowcasting: Innovation in very short-term forecasting, using AI to improve the speed and accuracy of forecasts.
• Improvements in S2S forecasting: Use of innovative statistical methods and AI/ML to refine sub-seasonal to seasonal predictions.
• Operationalisation of AI/ML: Discussion on how to make AI/ML technologies more accessible and useful for daily weather forecasting and decision support.
• Ethical and responsible AI: Importance of developing and using AI ethically and responsibly in meteorological research.
• Improving AI Literacy: Encouraging AI adoption by improving AI understanding and skills within the meteorological community.

In order to align this session with the Resilient Futures theme of the congress, we particularly encourage presentations that highlight the application of AI for high-impact weather forecasting, as well as interdisciplinary approaches incorporating social sciences. Proposals addressing risk communication, crisis decision making, and other AI-based solutions for building resilience to extreme weather events and environmental challenges are strongly encouraged.

Session: 9010 Advances and applications of artificial intelligence in meteorology Progrès et applications de l'intelligence artificielle en météorologie

28/05/2025
13:30

ID: 12382 Invited session speaker

Virtual

Recent advances in AI weather forecasting at ECCC

Christopher Subich [1]

Presented by / Présenté par: *Christopher Subich*
Contact: csubich@gmail.com

Artificial intelligence (AI) and Machine Learning (ML) technologies have been developed and deployed within Environment and Climate Change Canada's weather forecasting systems. The AI Roadmap announced last year has been fully published and adopted, and its principles have guided the adoption of several AI-based projects and affected ongoing research plans.

This talk highlights the operationalization of the spectral nudging system, a hybridization of data-driven and traditional numerical weather prediction which uses ECCC-GraphCast to providing a piloting forecast for the ECCC global atmospheric model. Additionally, this talk discusses recent innovations in loss functions to preserve forecast sharpness in deterministic data-driven weather systems alongside other, ongoing research work in the Meteorological Research Division.

Finally, this talk will discuss the future of data-driven weather forecasting. On a technical level, ECCC is implementing an infrastructure upgrade that will allow a significant expansion of research into and deployment of data-driven systems. Talk will conclude with an examination of global trends in data-driven numerical weather prediction and speculation about the long-term role of machine learning in atmospheric forecasting.

Session: 9010 Advances and applications of artificial intelligence in meteorology Progrès et applications de l'intelligence artificielle en météorologie

28/05/2025 14:00

ID: 12356 Contributed abstract

Bridging Science and AI: Building AI Expertise at the Meteorological Service of Canada

Ann Dacres [1] , *Miguel Tremblay* [2]

[1] ECCC
[2] ECCC

Presented by / Présenté par: *Ann Dacres*
Contact: miguel.tremblay@ec.gc.ca

As part of the Meteorological Service of Canada's AI Roadmap, we established a dedicated unit for AI expertise development to support AI integration. One of our main goals is to empower our scientists to explore, experiment, and eventually adopt AI in their work. This presentation will outline our initiatives to promote AI literacy, including a learning needs analysis, a series of scientific seminars held in collaboration with government institutions, academia, and the private sector, and the co-creation of an AI 101 course, customized for ECCC scientists, with IVADO. We have launched an AI for All Forum to share resources and updates, hosted webinars showcasing AI applications within the organization, and encouraged managerial engagement to ensure smooth AI

integration. Through these efforts, we aim to cultivate a culture of innovation, equip our workforce with essential AI skills, and pave the way for AI-driven advancements in meteorology.

Session: 9010 Advances and applications of artificial intelligence in meteorology Progrès et applications de l'intelligence artificielle en météorologie **28/05/2025 14:15**

ID: 12450 Contributed abstract

PARADIS: A Physics-Inspired Neural Network with Learned Semi-Lagrangian Advection

Raymond Spiteri [1] , *Stephane Gaudreault* [2] , *Carlos Pereira* [3] , *Siqi Wei* [4] , *Mahta Abdollahzadehzare* [5] , *Eldad Haber* [6] , *Christopher Subich* [7]

[1] University of Saskatchewan
[2] Environment and Climate Change Canada
[3] Environment and Climate Change Canada
[4] Environment and Climate Change Canada
[5] University of Saskatchewan
[6] University of British Columbia
[7] Environment and Climate Change Canada

Presented by / Présenté par: *Raymond Spiteri*
Contact: spiteri@cs.usask.ca

The Weather Alliance—a consortium of eight Canadian universities, Environment and Climate Change Canada, and various public and private partners—is developing a new numerical weather model called PARADIS. This model introduces a physics-inspired approach that enhances convolutional neural networks (CNNs) with advection. Specifically, we design a novel learned semi-Lagrangian method on the sphere. This approach allows for non-local information transformation, overcoming the limitations of standard convolutional kernels. PARADIS is trained using the ERA5 reanalysis dataset.

Session: 9010 Advances and applications of artificial intelligence in meteorology Progrès et applications de l'intelligence artificielle en météorologie **28/05/2025 14:30**

ID: 12513 Contributed abstract

Enhanced Short-Term Forecasting of Meteorological Variables Using Stepwise Regression: A Case Study of the Quesnel Lake Basin

Alireza Hakimi [1] , *Parvin Ghafarian* [2] , *Stephen Dery* [3] , *Peter Jackson* [4]

[1] Iranian National Institute for Oceanography and Atmospheric Science
[2] University of Northern British Columbia

[3] University of Northern British Columbia
[4] University of Northern British Columbia

Presented by / Présenté par: *Parvin Ghafarian*
Contact: peterj@unbc.ca

Accurate short-term forecasting of meteorological variables is critical for disaster management, agriculture, and energy distribution. In this study, we introduce a multivariate multi-step forecasting framework based on stepwise regression to predict three key meteorological parameters—air temperature, relative humidity, and atmospheric pressure—in the Quesnel Lake Basin, a region characterized by steep topography. Historical data were acquired from the automated weather station at the Quesnel River Research Centre spanning January 1, 2018 to December 31, 2021 with 15-minute intervals. After data cleaning (removing records with missing values), 23,403 observations remained. The last 1,000 records were set aside for external validation, while the remaining data were randomly split into 70% training and 30% testing subsets. The proposed architecture utilizes historical values from three consecutive time steps (t–2, t–1, and t) as inputs to 15 specialized stepwise regression models. These models incrementally capture both linear and nonlinear relationships among the input variables to predict the target variables over the next five-time steps (t+1 to t+5). Evaluation using standard statistical metrics—Mean Absolute Error (MAE), Root Mean Square Error (RMSE), and Coefficient of Determination (R^2)—demonstrates that the model yields excellent accuracy for immediate forecasts, with errors moderately increasing as the forecast horizon extends. Moreover, a comparative analysis with conventional machine learning methods such as Artificial Neural Networks, XGBoost, and Decision Trees confirms that the stepwise regression approach not only provides higher accuracy but also greater interpretability. Future research will focus on integrating additional meteorological parameters and extending the forecast horizon to further test the robustness of the proposed method.

Session: 9010 Advances and applications of artificial intelligence in meteorology Progrès et applications de l'intelligence artificielle en météorologie **28/05/2025 14:45**

ID: 12354 Contributed abstract

Re-training GraphCast at ECCC: Strategy and Implementation

Miguel Tremblay [1] , *Charlie Hébert-Pinard* [2] , *Christopher Subich* [3] , *Leo Separovic* [4] , *Hugo Vandenbroucke-Menu* [5] , *Vikram Khade* [6] , *Syed Husain* [7]

[1]
[2] ECCC
[3] ECCC
[4] ECCC
[5] ECCC
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[7] ECCC

Presented by / Présenté par: *Miguel Tremblay*

Contact: miguel.tremblay@ec.gc.ca

To remove the constraints of GraphCast's CC-BY-SA-NC license, we conducted a full re-training of the model at ECCC, recalculating its weights in-house. The result, named ECCC-GraphCast, allowed us to gain critical expertise in training such models, from script and function development to hardware optimization.

Since the original paper did not fully detail the training methodology, we had to make strategic decisions regarding data handling, hyperparameters, and optimization. Our final weights outperform those of the original model, a result that may stem either from chance or from the specific adjustments we made.

This re-training was also a necessary step in implementing the spectral nudging approach we deployed afterward. This presentation will highlight the key decisions behind our training strategy and the lessons learned for AI-based meteorological modeling.

Session: 4052 Enhancing Collaboration for Weather Preparedness in Canada Renforcer la collaboration pour améliorer la préparation météorologique au Canada

Panel discussion

In the face of increasing extreme weather events, it is crucial for various sectors to collaborate effectively to enhance preparedness and resilience. This panel discussion will bring together representatives spanning key areas of the weather enterprise, including the Meteorological Service of Canada (MSC), academia, media, and the private sector, to explore strategies for improving weather preparedness in Canada.

Key topics to be discussed include strategies employed by different organizations to better prepare their clients and the public for extreme weather events, and opportunities for collaboration across the weather enterprise to improve preparedness and response to extreme weather events.

This session aims to foster a dialogue on how different sectors can work together to enhance weather preparedness and resilience, ultimately contributing to a safer and more resilient Canada.

Panelists:

Doris Fortin – Director General of Policy, Partnership and Planning at the Meteorological Service of Canada
Scott Kehler – President & Chief Scientist at Weatherlogics
Peter Quinlan – Meteorologist at Global News in Saskatoon
Julie Mireille Thériault – Professor at UQAM's Earth and Atmospheric science department

15:30-15:40 Introduce theme and Panelists

15:40-16:00 Introductory Presentations

16:00-16:20 Follow-up questions

16:20-16:40 General Q&A

16:40-16:50 Final comments

16:50-17:00 Closing and Next Steps

Session: 4052 Enhancing Collaboration for Weather Preparedness in Canada Renforcer la collaboration pour améliorer la préparation météorologique au Canada **28/05/2025 15:30**

ID: 12549 Invited session speaker

Enhancing Collaboration for Weather Preparedness in Canada
1

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Presented by / Présenté par:
Contact: blake.barber@canada.ca

In the face of increasing extreme weather events, it is crucial for various sectors to collaborate effectively to enhance preparedness and resilience. This panel discussion will bring together representatives spanning key areas of the weather enterprise, including the Meteorological Service of Canada (MSC), academia, media, and the private sector, to explore strategies for improving weather preparedness in Canada.

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Session: 10031 Discussions on development, evaluation and analysis of ocean circulation and biogeochemical models or Developing Ocean Modelling Capacity in Canada - Part 2 Discussions sur le développement, l'évaluation et l'analyse des modèles de circulation océanique et de biogéochimie ou Développer la capacité de modélisation océanique au Canada - Partie 2

Convenors:

Paul Myers (University of Alberta), Youyu Lu (DFO – BIO), Susan Allen (University of British Columbia), Greg Smith (ECCC), David Greenberg (DFO – BIO retired), Frederic Dupont (ECCC), Juliana Marson (University of Manitoba), Inge Deschepper (University of Alberta), Tahya Weiss-Gibbons (University of Alberta)

Ocean circulation and biogeochemical models are widely used for both research and operational forecasting. However, there are challenges for small research groups to handle the increasing complexity of the model codes, evaluation with various observational datasets, and analysis of the increasing amount of model output data.

This session aims to stimulate discussions on potential coordination and collaboration between Canadian government laboratories and universities in the development, evaluation and analysis of ocean circulation and biogeochemical models for hindcast and forecast at various time scales. Specific topics may include: 1) progress of model research and applications in various regions with different spatial resolutions; 2) new evaluation and analysis results that demonstrate the strength and weakness of the models; 3) improvements in model numerics and parameterization of sub-grid processes; 4) new analysis methods; 5) new forcing and evaluation datasets; 6) model inter-comparison; and 7) data presentation and visualization tools.

Session: 10031 Discussions on development, evaluation and analysis of ocean circulation and biogeochemical models or Developing Ocean Modelling Capacity in Canada - Part 2 Discussions sur le développement, l'évaluation et l'analyse des modèles de circulation océanique et de biogéochimie ou Développer la capacité de modélisation océanique au Canada - Partie 2 **28/05/2025 15:30**

ID: 12376 Contributed abstract

The origins of turbulent energy spectra in a global stratified ocean model

Nicholas Kevlahan [1] , *Francis Poulin* [2]

[1] McMaster University
[2] University of Waterloo

Presented by / Présenté par: *Nicholas Kevlahan*
Contact: kevlahan@mcmaster.ca

Energy spectra of ocean flows are complex and poorly understood. Numerical simulations and observations have found two classes of energy spectrum scaling E(k) = k^p: -2 <= p <= -5/3 (possibly generated by 3D turbulence, an inverse energy cascade, or wave turbulence) and -4 <= p < =-3 (possibly generated by 2D turbulence, or a forward enstrophy cascade).

In previous work (Kevlahan and Poulin 2022 JPO 52) we found that a western boundary current (WBC) configuration of a two-layer shallow water model has a spectrum with p = -3, while its weak baroclinic mode has a p = -2 spectrum. In this follow-up study we use the WAVETRISK-OCEAN global model to run 4, 12 and 60 layer wind-driven slow rotation WBC high resolution simulations. There is a shallow constant density surface layer to z=-200m and a deep linearly stratified layer extending to z = -4000m. Analytic vertical diffusivity is strong at the surface and decays exponentially to small values below the surface.

We find that the energy spectrum converges to p = -5/3 near the surface and transitions to -4 <= p < =-3 at depth for the 12 and 60 layer cases. The 4-layer case has a scaling close to -3 for all layers (similar to the two layer case). We show that the shallow p = -5/3 spectrum is also produced by a simple surface quasi-geostrophic (SQG) simulation. The 60-layer results give a complete description of how wind stress and associated strong surface vertical diffusion generates 3D turbulence in the surface layers. Weak vertical diffusion below the surface keeps the surface layer strongly energized, enhancing turbulence. In contrast, at depth energy is much lower and the turbulence is 2D. The complete profile of energy spectrum slopes, p(z), shows a rather complex structure. These results should help explain observations and transfer of energy in WBC.

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ID: 12566 Contributed abstract

Enhancing the realism of ocean tides in global ocean models

Chengzhu Xu [1] , *Edward Zaron* [2]

[1] Oregon State University
[2] Oregon State University

Presented by / Présenté par: *Chengzhu Xu*
Contact: Chengzhu.xu@oregonstate.edu

Input of barotropic tidal energy into the global oceans is about 3.5 TW, of which about 70% is dissipated in the shallow waters due to bottom friction, and the remaining 30% is converted into internal wave (baroclinic) energy in the deep, open oceans due to tide-topography interaction. The effect of barotropic-to-baroclinic energy conversion on the barotropic tidal current is similar to that of a linear, directional, spatially varying, and frequency-dependent drag, which must be parameterized in global ocean models that cannot fully resolve internal gravity waves. In forward ocean models, however, the frequency dependence of the internal wave drag is difficult to implement, because the tidal velocities are not readily available while the model is running. Here, we will present a filtering technique that allows us to approximate the instantaneous tidal velocities while the model is running and to impose the wave drag on its targeted frequency bands, without affecting the low-frequency, non-tidal motions. Our simulation results suggest that, by correctly representing the tidal energy conversion in different frequency bands, we were able to reduced the errors of model-predicted tides associated with all tidal constituents simultaneously, and to predict the nonlinear interaction of different tidal constituents more accurately.

Session: 10031 Discussions on development, evaluation and analysis of ocean circulation and biogeochemical models or Developing Ocean Modelling Capacity in Canada - Part 2 Discussions sur le développement, l'évaluation et l'analyse des modèles de circulation océanique et de biogéochimie ou Développer la capacité **28/05/2025 16:00**

ID: 12461 Contributed abstract

ANHALYZE: Handling and Visualizing NEMO-ANHA outputs

Luiz Henrique da Silva [1] , *Emilio Enriquez* [2] , *Juliana Marson* [3]

[1] University of Manitoba
[2] University of Manitoba
[3] University of Manitoba

Presented by / Présenté par: *Luiz Henrique da Silva*
Contact: dasilvlh@myumanitoba.ca

ANHALYZE is an open-source package, actively being developed in Python, aiming to simplify the analysis of outputs from the Arctic and North Hemisphere Atlantic (ANHA) configuration of the NEMO ocean model. This toolbox is designed to enhance oceanographic research by providing an accessible framework for users with different levels of experience. The main goal of the first release is to support users who are not familiar with ANHA outputs and/or Python programming, while also offering a starting point for more advanced analyses. The first version of ANHALYZE handles netCDF files in the ANHA-specific format, and has key functionalities such as region selection with automatic awareness of units and dimensions, and the ability of easy map generation. Users can create maps with customizable projections, property-specific color schemes, and on-the-fly masking. Additionally, comprehensive documentation and tutorials are provided to guide users through the available features. Looking ahead, future versions will introduce addition scientific functions (e.g. heat and freshwater content calculators), and incorporate advanced tools, such as an interactive mask generator. ANHALYZE follows open-source principles and is hosted on GitHub, promoting collaboration and further development by the scientific community.

Session: 10031 Discussions on development, evaluation and analysis of ocean circulation and biogeochemical models or Developing Ocean Modelling Capacity in Canada - Part 2 Discussions sur le développement, l'évaluation et l'analyse des modèles de circulation océanique et de biogéochimie ou Développer la capacité de modélisation océanique au Canada - Partie 2	**28/05/2025 16:15**

ID: 12334 Contributed abstract

An examination of daily averaged output from ocean models

David Greenberg [1]

[1] Bedford Institute of Oceanography

Presented by / Présenté par: *David Greenberg*
Contact: davidgreenberg@alumni.uwaterloo.ca

With growing computer power and improvements in computation algorithms, global and regional ocean models have been able to produce longer computations at greatly increased resolution. This has lead to an unmanageable proliferation of output that cannot possibly be saved in its entirety, even for a single production run. Since the focus is often on longer term and climate time scales, output is often time averaged, frequently to daily output. We look at what might be lost and possible errors that might be created in making these daily averages.

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28/05/2025 16:30

ID: 12317 Contributed abstract

A Nested-grid Modelling System for Simulating Circulation and Sea Ice over the Northwest Atlantic Ocean

Jinyu Sheng [1] , *Kyoko Ohashi* [2] , *Qiantong Pei* [3]

[1] Dalhousie University
[2] Dalhousie University
[3] Dalhousie University

Presented by / Présenté par: *Kyoko Ohashi*
Contact: jinyu.sheng@dal.ca

A coupled circulation-ice modelling system with multi-grid nesting capacity was developed for the northwest Atlantic (CCIMS-nWA) based on the Regional Ocean Modeling System (ROMS) and Los Alamos Sea Ice Model (CICE). CCIMS-nwA is forced by atmospheric forcing at the surface, tidal forcing, inflows and ice conditions specified at lateral open boundaries, riverine freshwater discharges, and continental runoff due to melting of ice and snow over land. This paper provides an overview on different nested-grid setups developed by the regional modelling group at Dalhousie University for different research projects. Performance of CCIMS-nwA is assessed using the in-situ oceanographic observations, satellite remote sensing data, and ocean reanalysis. Model results in three applications demonstrate the feasibility and skills of CCIMs-nwA in simulating both the large-scale hydrodynamics over the eastern Canadian shelf and fine-resolution currents and hydrography over three different coastal waters. These three different coastal waters include (a) Baffin Bay and David Strait, (b) Halifax Harbour and Bedford Basin and (c) Bras d’Or Lake of Cape Breton. The temporal and spatial variability of circulation and hydrography simulated by this modelling system for these three coastal waters will be discussed

Session: 10031 Discussions on development, evaluation and analysis of ocean circulation and biogeochemical models or Developing Ocean Modelling Capacity in Canada - Part 2 Discussions sur le développement, l'évaluation et l'analyse des modèles de circulation océanique et de biogéochimie ou Développer la capacité de modélisation océanique au Canada - Partie 2 **28/05/2025 16:45**

ID: 12375 Contributed abstract

Modelling of the Arctic Ocean and Labrador Sea at 1/60th Degree

Paul Myers [1] , *Clark Pennelly* [2] , *Pouneh Hoshyar* [3]

[1] University of Alberta
[2] University of Alberta
[3] University of Alberta

Presented by / Présenté par: *Paul Myers*
Contact: pmyers@ualberta.ca

Our group has carried out simulations of the Labrador Sea at 1/60th and shown that very-high resolution significantly improves the model solution. That resolution, by representing the mesoscale and part of the sub-mesoscale significantly improves the simulation of boundary current system, eddies and shelf-basin exchange, with the small-scale processes combining to also improve the large-scale circulation and overturning. Given such improvements for the Labrador Sea, we now examine modelling the entire Arctic Ocean and the subpolar North Atlantic Ocean north of 53N latitude. The configuration is named ARC60. The experiment also includes an iceberg module and tidal forcing.

Here we present some of our ongoing analysis using the two very high resolution configurations and how it changes the solution compared to lower resolution simulations. We explore questions related to water formation in the Labrador Sea and Greenland melt, behavior of the Labrador Current and the Deep Western Boundary Current. We also explore the impact of Greenland runoff on driving coastal seasonal features in Melville Bay. Finally we look at eddies and small scale processes in the Arctic Ocean and Beaufort Gyre.

Session: 8031 General Hydrology - Part 2 Hydrologie générale - Partie 2

Convenors:

Dr. Barret Kurylyk, Dalhousie University
Dr. Lauren Somers, Dalhousie University

The general hydrology session invites a broad range of research contributions, including, but not limited to, field-, laboratory-, and/or modelling-based studies of the water cycle. Studies carried out at different spatial scales and situated in both pristine and disturbed landscapes are welcome.

Session: 8031 General Hydrology - Part 2 Hydrologie générale - Partie 2 **28/05/2025 15:30**

ID: 12321 Contributed abstract

Modelling Storage-Discharge Relationship in an Alpine Basin in the Canadian Rockies

Xing Fang [1] , *John Pomeroy* [2]

[1] Centre for Hydrology, University of Saskatchewan
[2] Centre for Hydrology, University of Saskatchewan

Presented by / Présenté par: *Xing Fang*
Contact: xing.fang@usask.ca

This study examines storage-discharge relationships for a well-instrumented alpine headwater basin in the Canadian Rockies: Fortress Mountain Research Basin (~5.9 km2) using a physically based hydrological model set up in the Cold Regions Hydrological Modelling platform. The basin is a high mountain basin dominated by steep fractured limestone rock faces, with lower elevation talus slopes, subalpine forest moraine slopes, valley forests, clearings, wetlands and ponds that drain to a stream. The hydrological model was parameterised from field research results in the region and includes relevant streamflow generation processes such as blowing snow, snow avalanching, snow interception and sublimation, energy budget snowmelt, evapotranspiration, infiltration to frozen and unfrozen soils, overland, subsurface and groundwater flow along hillslopes, and streamflow routing. Uncalibrated simulations during 11 hydrological years (2013-2024) generally matched the observations of snow accumulation, snowmelt, and liquid soil moisture. Uncalibrated streamflow simulations during 2013-2024 achieved Nash-Sutcliffe efficiency of 0.6 and 0.66 and modified Kling-Gupta efficiency of 0.58 and 0.76 for Bonsai Creek and Fortress Creek gauges, with model bias within 24%, and normalised root mean square difference no higher than 65%. The model was then used to examine the storage-discharge relationships in the basin. The results show the significant positive correlations between storage and discharge for the gauged Bonsai Creek (r = 0.74) and Fortress Creek (r = 0.58) and nonlinear hysteretic storage-discharge relationships for both creeks. A “catchment sensitivity function” was combined with modelled water balance components during 2013-2024 recession periods to derive exponential storage-discharge functions for estimating discharge at Bonsai Creek and Fortress Creek, which showed only marginal or no improvement over the CRHM simulated discharge. This suggests that the simple exponential storage-discharge functions are not sufficient to capture the complex hydrological dynamics of such a basin.

Session: 8031 General Hydrology - Part 2 Hydrologie générale - Partie 2 **28/05/2025 15:45**

ID: 12272 Contributed abstract

Combining ERT, GPR and sMNR to map buried ice and groundwater pathways: case study in Shár Shaw Tagà (Yukon)

Eole Valence [1] , *Bastien Charonnat* [2] , *Adam Tjoelker* [3] , *Michel Baraer* [4] , *Adrien Dimech* [5] , *Janie Masse-Dufresne* [6] , *Jessy Richard* [7] , *Pierre-Allain Duvillard* [8] , *Jeffrey McKenzie* [9]

[1] McGill University
[2] École de Technologie Supérieure
[3] Ohio State University
[4] École de Technologie Supérieure
[5] École de Technologie Supérieure
[6] École de Technologie Supérieure
[7] Naga Geophysics
[8] Naga Geophysics
[9] McGill University

Presented by / Présenté par: *Eole Valence*
Contact: eole.valence@mail.mcgill.ca

Glacierized catchments are essential for sustaining freshwater resources in Northern and Western Canada. While research over the past decade has primarily focused on clean-ice glaciers, the interactions between permafrost, ground ice degradation, and groundwater remain poorly understood. Since ice and permafrost can act as impermeable barriers, debris-covered ice may significantly influence meltwater storage and partitioning between runoff and infiltration.
Debris-covered ice, defined as massive ice buried beneath rock and sediment, is particularly challenging to quantify and delineate, even with advances in remote sensing techniques. Geophysical methods such as electrical resistivity tomography (ERT) combined with induced polarization (IP) or ground-penetrating radar (GPR), are widely used to investigate permafrost and ice volumes. However, few studies have achieved high-resolution, catchment-scale subsurface hydrological mapping in glacierized valleys, primarily due to logistical constraints such as safety, cost, and operational time limitations.
Our project integrates drone-based GPR, ERT with IP, and surface nuclear magnetic resonance (sMNR) to map the subsurface of a deglaciating valley. ERT and IP provide high confidence in distinguishing buried ice from sediments and rock debris, though they are time-consuming and impractical for large-scale surveys. To address this limitation, drone-based GPR offers higher measurement density and improved access to unstable and steep terrains. Finally, sMNR, the only geophysical method solely sensitive to liquid water, can detect groundwater presence constrained by buried ice.
Preliminary results show combining geophysical techniques is crucial to characterize subsurface hydrology in glacierized catchment, due to the high heterogeneity of the subsurface in these environments. This approach is expected to enhance our understanding of water storage and transfer processes in deglaciating valleys.

ID: 12295 Contributed abstract

How do seismic line disturbances affect snow accumulation in boreal forests?

Maryam Bayatvarkeshi [1] , *Maria Strack* [2] , *Scott Ketcheson* [3] , *Melanie Dickie* [4] , *Robert Serrouya* [5]

[1] University of Waterloo
[2] University of Waterloo
[3] Athabasca University
[4] Alberta Biodiversity Monitoring Institute
[5] University of British Columbia

Presented by / Présenté par: *Maryam Bayatvarkeshi*
Contact: m.bayat.v@gmail.com

Despite several investigations on changes to environmental conditions on seismic lines (linear clearings created for geologic exploration), their effect on wintertime conditions remains less understood. This study used time lapse photography to investigate whether snowpack conditions were affected by the presence of seismic lines by investigating average and maximum snow depth, timing of maximum snow depth, and timing of snow-free conditions. We deployed 50 pairs of cameras across two study sites in northern Alberta with different characteristics including orientation, width, and ecosite type. The depth of snow captured from the photos between 2017 and 2021 was analyzed. The average snow depth on the line was 12% higher than offline, but the difference was not statistically significant; however, the maximum depth of snow on the line was significantly 10% greater than offline. The maximum depth of snow on the line was reached five days later than offline and snow-free conditions occurred one day after offline. However, the duration of snow ablation online was five days shorter than that offline, indicating a faster rate of snow loss on the seismic lines. To assess the specific seismic line effect, we calculated the difference in snow depth between online and offline for each camera pair. These differences were primarily influenced by the width and orientation of the seismic lines, with wider lines and north-south-oriented lines showing greater difference in snowpack conditions. Since snowpack conditions significantly effect soil thermal and hydrological dynamics, these findings highlight the need for further research on winter conditions, particularly through field-based measurements of snow properties across a network of seismic line locations.

Session: 8031 General Hydrology - Part 2 Hydrologie générale - Partie 2 **28/05/2025 16:15**

ID: 12299 Contributed abstract

Modelling snow drought, groundwater drought, and the effects of groundwater evapotranspiration in North Saskatchewan River Basin, Canada.

Monireh Faramarzi [1] , *Yinlong Huang* [2] , *Luis Carlos Serrano Diaz* [3]

[1] University of Alberta
[2] University of Alberta
[3] University of Alberta

Presented by / Présenté par: *Monireh Faramarzi*
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Snow is a key hydrological process in cold watersheds, which can affect groundwater (GW). Climate change is projected to affect snow processes in cold regions. A prolonged deficit in snow precipitation or accelerated snowmelt due to warming can initiate, develop, and intensify snow drought, which can be propagated to GW drought. To understand how snow and GW droughts are connected and how evapotranspiration (AET) is sourced from GW at a watershed scale, we simulated snow water equivalent, GW head, and source water of AET under historical (1980-2013) and future (2040-2073) global warming scenarios in North Saskatchewan River Basin in western Canada. The model outputs were analyzed to study the intensity and characteristics of snow droughts, GW droughts, water sources of AET, and their relationships across different eco-hydro(geo)logical (EHG) regions such as Mountains, Foothills, and Plains. The study results indicated that characteristics of snow and GW droughts were reversed across different EHG regions under future SSP scenarios compared to the historical period. The projected changes in the frequency, intensity, and duration of snow and GW droughts imply a potential propagation of snow drought events to GW droughts in the Mountains due to a rapid snow melt, while the opposite processes in the Plains due to a lack of adequate snow precipitation were observed in the future. The dominant role of GW in supplying AET in foothills where perennial long-rooted plants dominate the landscape and water table is relatively shallow, play critical role in affecting snow-to-GW droughts in these regions.
Learning from the strength and limitations of SWAT-MODFLOW and HydroGeoSphere models this study, provides a unified approach for analyzing snow drought, GW drought, and the effects of GW ET in shaping their relationships and propagation mechanism in these regions.

Session: 8031 General Hydrology - Part 2 Hydrologie générale - Partie 2 **28/05/2025 16:30**

ID: 12457 Contributed abstract

Stream temperature response to increased shading due to riparian shrubification in northern latitudes

Andras Szeitz [1] , *Cory Wallace* [2] , *Faye Jackson* [3] , *Iain Malcolm* [4] , *David Hannah* [5] , *Sean Carey* [6]

[1] McMaster University
[2] McMaster University
[3] Marine Directorate of Scottish Government
[4] Marine Directorate of Scottish Government
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[6] McMaster University

Presented by / Présenté par: *Andras Szeitz*
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Global heating is causing rapid and profound impacts on northern ecosystems. Shifts in precipitation phase and timing, permafrost thaw, and rapid shrub advance into tundra environments are combining to alter stream temperature in uncertain ways. The expansion and increased abundance of shrub vegetation, termed shrubification, has the potential to moderate warming stream temperatures through greater riparian shading, as often observed in temperate environments. However, there has been no evaluation of how shrub expansion will affect the radiative balance and subsequent stream temperature of northern streams to date. To address this shortcoming, this study investigates (1) the variability in insolation by modelling direct and canopy-transmitted insolation across a range of stream scenarios and (2) the stream temperature response to summer low flow conditions. The stream scenarios consisted of a range of stream widths (1-35 m), aspects (16 orientations), and gradients (0-20%) for three shrub height distributions. Streamflow data from 16 gauged streams in Yukon, Canada, ranging in width from 1.5 to 32.3 m, was used to assess the stream temperature response to shrubification for Q85 low flows, a thermally and ecologically sensitive period. Modelling shrub growth from a 'low' to 'high' scenario reduced mean daily net incident radiation by 5.5 to 122.4 W m^-2, with a median of 40.0 W m^-2, across the range of stream widths. A metric characterizing shrubification effects on net incident radiation, while accounting for flow volumes and residence times (Tdiff), suggests increased vegetation growth in the riparian zone can reduce rates of warming. However, the magnitude of this effect varies substantially depending on aspect, stream width, and shrub height. When applied to flow and temperature data from a headwater catchment in Yukon, model outputs indicate that increased shading from riparian shrubs may moderate stream warming in headwater catchments in response to climate warming.

Session: 8031 General Hydrology - Part 2 Hydrologie générale - Partie 2 **28/05/2025 16:45**

ID: 12492 Contributed abstract

Virtual

Seasonal Isotope Hydrology of Arctic Tundra Lakes in a Region Impacted by Permafrost Disturbance: Examination of a Pair of Representative Lake Basins

Daniel Peters [1] , *John Gibson* [2]

[1] Environment and Climate Change Canada
[2] InnoTech Alberta

Presented by / Présenté par: *Daniel Peters*
Contact: daniel.peters@ec.gc.ca

Permafrost degradation in Canada's western Arctic has led to the formation of shoreline retrogressive thaw slumps (SRTS), a process influential in modifying hydrological dynamics and environmental processes in tundra lakes by modifying the movement and transfer water, sediments, and chemical constituents from the surrounding basin to the lake. To investigate hydro-ecological effects of SRTS, annual water sampling campaigns were conducted at 10 to 25+ pairs of lake basins (undisturbed vs SRTS) in the upland region adjacent to the Mackenzie Delta over the years 2004 to 2010. These regional campaigns were supplemented with targeted observation/sampling of inputs (rain, snow,

inflows), storage (ice, water level) and outputs (evaporation, outflow) for select pairs of representative lake basins.

A prior isotope mass balance of 18O/2H study in these lakes by Wan et al. (2020) using end of summer data revealed key hydrological characteristics: i) higher evaporation/inflow and precipitation/inflow for lakes with active SRTS compared to undisturbed lake basins, and typically higher ratios for lakes with stabilized versus active SRTS; ii) water yields higher for active SRTS sites compared to undisturbed/stabilized SRTS sites, suggesting that slumping is an initial but not a sustained source of water delivery to lakes; iii) basins with wildfire history had lower water yields, attributed to reduced permafrost influence on runoff.

This follow-up study focuses on examining the seasonal hydrological and stable isotope signature (18O/2H) dynamics of a pair of lake basins and addresses three questions: (i) what roles do snow and ice cover play in influencing “snow damming” and “snowmelt bypass” flow on late spring/early summer lake water quantity and isotope signature; (ii) what role does SRTS play in influencing the amount and signature of lake water inputs; and iii) how do (i) and (ii) affect the observed seasonal variation in lake hydrology and water signatures.

Session: 5010 Deep understanding of weather and climate extremes through regional climate modeling Approfondir la compréhension des extrêmes météorologiques et climatiques grâce à la modélisation climatique régionale

Convenors:

Di Luca, Alejandro (UQAM)
Paquin, Dominique (Ouranos)

Regional climate models (RCMs), whether using parameterized or partially resolved deep convection schemes, offer a more realistic simulation of weather and climate extremes than global models. This capability makes RCMs a valuable tool for answering several major scientific questions concerning extremes, including:
- What are the different types of weather and climate extremes?
- How does climate change influence the frequency and intensity of these extremes?
- How can we assess the quality of simulated extremes despite the limitations of available observations?
- What impact do model configurations have on the representation of extremes?
- How can large ensembles of regional models be used to better understand these phenomena?
- How can we effectively compare extremes simulated by different types of model, including regional models?

This session invites contributions using regional climate modeling to explore these and other related scientific challenges. Submissions focusing on methodological advances, innovative applications of regional models and intercomparison studies between regional and global models are particularly encouraged. We aim to stimulate in-depth discussions on the understanding of weather and climate extremes, and to strengthen the role of regional models in studying their past, present and future evolution.

Session: 5010 Deep understanding of weather and climate extremes through regional climate modeling Approfondir la compréhension des extrêmes météorologiques et climatiques grâce à la modélisation climatique régionale — 28/05/2025 15:30

ID: 12390 Contributed abstract

Virtual

Assessing the Performance of Regional Climate Model Wind Speeds over Canada

Michael Morris [1] , *Housseyni Sankare* [2] , *Emilia Diaconescu* [3]

[1] Environment and Climate Change Canada
[2] Environment and Climate Change Canada
[3] Environment and Climate Change Canada

Presented by / Présenté par: *Michael Morris*
Contact: michael.morris@ec.gc.ca

Stakeholders in fields including wing energy and infrastructure require projections of near-surface wind speed (WS) under climate change to conduct risk assessments and adaptation planning. Due to limited availability of suitable gridded observational data, statistically downscaled WS data is not widely available from Canadian climate service providers. Dynamically downscaled projections from Regional Climate Models (RCMs) may provide a useful source of WS data for future climate scenarios. This study assesses the capability of RCMs in simulating WS across Canada by analyzing outputs from various RCM ensembles, including the NA-CORDEX multi-model ensemble and the CanRCM4 single-model large ensemble. These RCM outputs are compared against observational data, two reanalysis datasets (ERA5 and AgERA5), and Global Climate Model (GCM) ensembles from CMIP5 and CMIP6. The evaluation examines the models' ability to replicate historical WS distributions, biases in mean and extreme WS, trends, and temporal variability. The findings reveal that, despite the higher spatial resolution of RCMs, added value over the CMIP6 ensemble is limited. Therefore, the suitability of RCM-derived WS projections without further bias adjustment or statistical downscaling is unclear. The inability of both RCMs and GCMs to accurately simulate WS trends and variability demands caution. It is important for risk assessments to consider this low degree of confidence when using GCM and RCM projections of WS.

Session: 5010 Deep understanding of weather and climate extremes through regional climate modeling Approfondir la compréhension des extrêmes météorologiques et climatiques grâce à la modélisation climatique régionale — 28/05/2025 15:45

ID: 12279 Contributed abstract

Évaluation des vents horaires et des rafales de vent simulés dans la version « convection-permitting » du modèle régional du climat (version 6) : Études de cas en hiver et en été dans le sud du Québec

Amélie Michaud1, Philippe Gachon1, Martin Leduc2
1 ESCER (Étude et Simulation du Climat à l'Échelle Régionale) centre, Université

du Québec à Montréal, Montréal, Québec, Canada; 2 Ouranos, Montréal, Canada
Amelie Michaud [1] , *Philippe Gachon* [2] , *Martin Leduc* [3]

[1] Université du Québec à Montréal
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Presented by / Présenté par: *Amelie Michaud*
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Les rafales de vent sont la cause principale de dommages lors des tempêtes extrêmes en lien avec des changements soudains de direction ou de vitesse qu'elles engendrent. Ce sont ces événements qui sont responsables de la majorité des pertes matérielles et des pannes d'électricité sur le territoire québécois. Cette étude a pour objectif d'évaluer la valeur ajoutée de la version en mode « convection-permitting » de la sixième version du modèle régional de climat (MRCC6) développé au centre ESCER de l'UQAM dans la simulation des vents intenses et les rafales de vent. Les rafales sont définies comme des épisodes de vents extrêmes d'une durée d'environ 3 s et dont la vitesse surpasse les vents moyens d'au moins 5 m/s. Différentes configurations du MRCC6 sont utilisées pour produire les simulations à 12, 2,5 et 1 km de résolution, dans lesquelles le module de rafales de vent est activé (utilisant la méthode de Brasseur). Ce module permet de diagnostiquer les rafales à l'aide de l'énergie cinétique turbulente, la stabilité statique ainsi que les caractéristiques de la couche limite. L'analyse de deux tempêtes, l'une synoptique survenue en décembre 2022 et l'autre de méso-échelle en mai 2022, met en évidence les différences observées dans les résultats. Une représentation précise des variables météorologiques est essentielle pour obtenir des estimations fiables des rafales de vent. Dans le cas de la tempête synoptique de décembre, le modèle offre de meilleures performances pour estimer les rafales, car les vents continus y sont bien représentés. De plus, le modèle tend à être plus précis sur la mer que sur la terre, ainsi que dans les situations où les vents continus sont plus forts

Session: 5010 Deep understanding of weather and climate extremes through regional climate modeling Approfondir la compréhension des extrêmes météorologiques et climatiques grâce à la modélisation climatique régionale	**28/05/2025 16:00**

ID: 12452 Contributed abstract

Simulating extratropical cyclones and associated surface fields using the convection permitting version of the Canadian Regional Climate Model

Maxine Cloutier-Gervais [1] , *Alejandro Di Luca* [2] , *Dominic Matte* [3] , *Philippe Roy* [4]

[1] Université du Québec à Montréal
[2] Université du Québec à Montréal
[3] Ouranos
[4] Hydro-Québec

Presented by / Présenté par: *Maxine Cloutier-Gervais*
Contact: cloutier-gervais.maxine@courrier.uqam.ca

Accurately representing extratropical cyclones (ETCs) in climate models is essential for understanding how climate change may affect their frequency, intensity and associated impacts. This study evaluates the ability of the sixth version of the Canadian Regional Climate Model (CRCM6-GEM5) using two horizontal grid meshes (~12 and ~2.5 km) to simulate key ETC characteristics such as intensity and lifetime, along with associated near-surface fields, including precipitation and 10-m winds. First, a storm tracking algorithm is applied to identify ETCs over North America, and the results are compared to the ERA5 reanalysis. Then, simulated ETC-associated hourly near-surface winds and precipitation fields are compared with in situ, satellite and radar observations for selected locations over a common northeastern United States region. Over northeast North America, our results show that the model generates slightly more (2-7%) ETC storms, that are slightly longer (6-13%) than observed in ERA5, with the largest differences occurring in summer. In addition, the two model configurations simulate a distribution of ETC intensity that is in good agreement with the ERA5 results in all seasons. To conclude, preliminary results regarding the comparison of simulated and observed near-surface fields associated with ETCs will be presented and discussed.

Session: 5010 Deep understanding of weather and climate extremes through regional climate modeling Approfondir la compréhension des extrêmes météorologiques et climatiques grâce à la modélisation climatique régionale **28/05/2025 16:15**

ID: 12434 Contributed abstract

Virtual

A Methodological Framework for Identifying Extreme Extratropical Cyclones in Regional Climate Model Simulations

Victorien De Meyer [1] , *Alejandro Di Luca* [2] , *Philippe Gachon* [3] , *Ting-Chen Chen* [4]

[1]

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Presented by / Présenté par: *Victorien De Meyer*

Contact: de_meyer.victorien@uqam.ca

Extratropical cyclones (ETCs) are primary drivers of extreme weather events in northeastern North America (NNA), accounting for over 60% of all hourly precipitation extremes and nearly 80% of wind events. These atmospheric phenomena can severely impact critical infrastructure, power distribution networks, property, and populations. Understanding their characteristics and projected evolution under climate change is therefore crucial for informed adaptation strategies. This study investigates the characteristics of the most severe ETCs affecting the NNA region through a comparative analysis of ERA5 reanalysis data and multiple simulations from the Canadian Regional Climate Model (CRCM6/GEM5). We employ a Lagrangian tracking algorithm and develop novel metrics to identify ETCs that produce local near-surface wind-precipitation compound hourly extremes. The methodology is applied to an ensemble of

CRCM6/GEM5 simulations driven by reanalysis and CMIP6 global climate models simulations. Our methodological framework yields distinct results, providing insights into the seasonal variations, intensity patterns, and duration of these events. The implications of different metrics and methodologies are thoroughly examined, highlighting the complexity in characterizing extreme ETCs and their impacts on the NNA region.

Session: 5010 Deep understanding of weather and climate extremes through regional climate modeling Approfondir la compréhension des extrêmes météorologiques et climatiques grâce à la modélisation climatique régionale **28/05/2025 16:30**

ID: 12395 Contributed abstract

Climatology of cloud and precipitation distribution across the Continental Divide in the Canadian Rockies

Jade Seguin [1] , *Julie Thériault* [2]

[1]

[2] UQAM

Presented by / Présenté par: *Jade Seguin*
Contact: de291026@ens.uqam.ca

Precipitation falling in the Canadian Rockies can flow in the Arctic, Pacific, and Atlantic basins. The region is prone to extreme flooding events driven by complex interactions between large-scale atmospheric systems, orography, and precipitation phases. Rain-on-snow events during the spring can cause significant damage to infrastructure. Furthermore, the Storm and Precipitation Across the Continental Divide Experiment (SPADE) found that deeper precipitation layer moving westward tend to produce precipitation on both sides of the divided simultaneously while most of other atmospheric condition patterns mainly lead to precipitation on one side. This study aims to quantify the climatology of cloud and precipitation distribution across the Continental Divide in the Canadian Rockies under both current and warmer climate conditions. To do so, a 11-year high-resolution regional climate simulation using the Canadian Regional Climate Model version 6 (CRCM6/GEM5) was used in this study. The pseudo-global warming (PGW) method was used to simulate the warmer climate conditions. The amount and phase of precipitation as well as the moisture and condensate fluxes are compared across the Continental Divide in the historical and warmer climate conditions. Higher precipitation amounts occur on the western side of the Continental Divide during colder months while higher precipitation amounts are observed on the eastern side during summer. Furthermore, a case study of a precipitation event during the 2019 spring compared to the PGW simulations suggest a shift in precipitation distribution, with more precipitation occurring near the Continental Divide compared to the historical simulations. Overall, this study will lead to a better understanding of precipitation distribution on regional to continental scale to better predict extreme events and improve flood risks management.

Session: 5010 Deep understanding of weather and climate extremes through regional climate modeling Approfondir la compréhension des extrêmes météorologiques et climatiques grâce à la modélisation climatique régionale **28/05/2025 16:45**

ID: 12303 Contributed abstract

Quantification of the impact of latent heat associated with the freezing of supercooled drops at the surface during freezing rain

Sujan Basnet [1] , *Julie Thériault* [2]

[1] UQAM
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Presented by / Présenté par: *Sujan Basnet*
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Freezing rain poses significant social, environmental, and economic challenges. The accumulation of ice can lead to power outages, disrupt transportation, and create hazardous driving conditions, increasing the risk of traffic accidents. When supercooled droplets freeze upon contact with a subfreezing surface, the latent heat released warms the near-surface atmosphere. This study aims to investigate how this latent heat release influences the type of precipitation reaching the surface during freezing rain events. To achieve this, we use the Global Environmental Multiscale (GEM) 5.1.1 model, coupled with the Predicted Particle Properties (P3) bulk microphysics scheme and the Canadian Land Surface Scheme (CLASS). The impact of latent heat release was examined by simulating the April 2023 ice storm with and without this process. The released latent heat was divided between the surface and the atmosphere, with modifications to the model to account for both effects. At the surface, it was integrated into the surface energy balance within CLASS, while in the atmosphere, it was represented by an increase in air temperature at lower model levels. Results show that the median cumulative freezing rain decreased by 34.4%, and the time required for the median temperature to reach 0°C was reduced by 2.5 hours. The simulations suggest that temperature advection played a role in balancing the phase transition of precipitation. This study enhances our understanding of the mechanisms that sustain or terminate freezing rain and contributes to improved hazard mitigation strategies.

Day 4 – 29 May 2025

Session: 1005 Plenary - Thirty-Five Years of Atmospheric Remote Sensing from Satellite Platforms – A University of Saskatchewan Perspective Plénière - Trente-cinq ans de télédétection atmosphérique à partir de plates-formes satellitaires - Une perspective de l'Université de Saskatchewan **29/05/2025 09:00**

ID: 12577 Invited plenary speaker

Thirty-Five Years of Atmospheric Remote Sensing from Satellite Platforms – A University of Saskatchewan Perspective

Doug Degenstein [1]

[1] University of Saskatchewan

BIO

Dr. Doug Degenstein
Department of Physics and Engineering Physics,
University of Saskatchewan

Dr. Degenstein has been a member of the U of S faculty since the autumn of 1999 and specializes in the remote sensing of the atmosphere through optical means with a primary focus on satellite based optical instrumentation. Dr. Degenstein is the Principal Investigator (PI) of OSIRIS, the Optical Spectrograph and InfraRed Imager System. OSIRIS is the Canadian Space Agency (CSA) contribution to the multi-national, Swedish led, Odin mission. This mission has a fundamental goal to better understand the photochemistry and dynamics associated with arctic ozone and its depletion. Dr. Degenstein is currently an executive member of the Atmospheric Science Advisory Committee (ASAC), which has a mandate to advise the CSA with respect to atmospheric science. He is also the Principal Investigator of the Spatial Heterodyne Observations of Water (SHOW) instrument that will fly as part the Canadian High-altitude, Aerosol, Water vapour and Cloud (HAWC) mission that is part of the international Atmosphere Observing System (AOS) led by NASA.

Presented by / Présenté par: ***Doug Degenstein***
Contact: doug.degenstein@usask.ca

In the early 1990s Professor Ted Llewellyn at the University of Saskatchewan was part of a Canadian team involved with a Wind Imagining Interferometer (WINDII) that was launched as part of NASA's Upper Atmosphere Research Satellite. This began a long-lasting relationship between researchers at the University of Saskatchewan (within the Institute of Space and Atmospheric Studies (ISAS) that is part of the Department of Physics and Engineering Physics); the Canadian Space Agency; the European Space agency; NASA and the study of the atmosphere from space using optical remote sensing techniques. This talk will hit many of the highlights related to University of Saskatchewan involvement in: the Optical Spectrograph and InfraRed Imaging System (OSIRIS) that operates to this day on the Swedish spacecraft Odin; the SASKTRAN radiative transfer model used to infer geophysical information from optical remote sensing measurements; the Canadian SciSat-1; an almost infinite list of remote sensing instrument and concept studies; the NASA Ozone Mapping and Profiler Suite (OMPS) and the European Space Agency ALTIUS mission.

The end of the talk will focus on the now fully funded High-altitude Aerosol, Cloud and Water vapour (HAWC) mission. The discussion will be centred upon the development of many atmospheric remote sensing prototype optical instruments designed and built by the University of Saskatchewan group and how these prototypes eventually led to the Aerosol Limb Imager (ALI) and the Spatial Heterodyne Observations of Water (SHOW) instruments that will fly on the Canadian HAWCsat that is a significant part of the much larger internation Atmosphere Observing System (AOS) that will launch early next decade. Included will be the tales of the not yet successfully manifested Canadian Atmospheric Tomography System (CATS), the Limb Imaging Fourier transform spectroscopy Experiment (LIFE), the Acousto-Optical Tuneable Filter (AOTF) version of ALI and OSIRIS-3, a CubeSat version of the original OSIRIS. Altogether these stories of instrument design, build, test, re-design and re-build (along with serious environmental testing on high ude stratospheric balloons and the NASE high flying ER-2 aircraft) will lay out our path from WINDII to HAWC and hopefully into MicroSpace (or new Space or Space 2.0) with existing concepts such as OSIRIS-3 and others we haven't thought up yet.

Session: 1006 Plenary - Maybe we can't solve this one: Eutrophication, harmful algal blooms, and a conversation on the place of water science in environmental problem solving Plénière - Nous ne pouvons peut-être pas résoudre ce problème : L'eutrophisation, les efflorescences algales nuisibles et une conversation sur la place de la science de l'eau dans la résolution des problèmes environnementaux.	**29/05/2025 09:00**

ID: 12575 Invited plenary speaker

Maybe we can't solve this one: Eutrophication, harmful algal blooms, and a conversation on the place of water science in environmental problem solving

Helen Baulch **[1]**

[1] University of Saskatchewan

BIO:

Helen is a biogeochemist and limnologist whose work focusses on water security and water quality, spanning land management and water management. Her group works to help identify pragmatic options to manage agricultural nutrients, and support research on cold regions processes, including BMPs suited to the prairie context. Her work also spans to aquatic ecosystems impacted by high nutrients and changing climate, studying the cycling of nutrients within lakes, impacts of blooms within lakes, and adaptation and mitigation needs. She lives in Saskatoon, working as a professor and Centennial

Enhancement Chair at the University of Saskatchewan School of Environment and Sustainability and Global Institute for Water Security. Helen has received several honours through her career for her teaching and research, including a recent appointment to the Royal Society of Canada College of New Scholars.

Presented by / Présenté par: ***Helen Baulch***
Contact: helen.baulch@usask.ca

Eutrophication is an old problem: a crisis in the 1960s and 70s, it was thought to be solved in the 90s, only to resurge with widespread occurrence of cyanobacterial harmful algal blooms (cHABs) that continue to this day, exacerbated by climate change. It is a problem that is not just 'hard', but 'wicked', because of its place-based nature, connected, multicausal, and multiscale attributes, and impacts of multiple stakeholders. Discussing topics spanning crop management to agricultural drainage, water treatment and limnology in a search for solutions (or band aids), I'll discuss where we are on eutrophication management, and where we might go for solutions to this and other water problems. Urban and industrial effluents and agricultural change will continue to drive important changes for water and water quality. While agricultural solutions for water quality are feasible - they are challenged by needs for better communications across scientific disciplines, and economic sectors. Limnological connections to drinking water are inherently stronger, and I will share benefits of a long-term research partnership on drinking water that have helped adapt, plan, and implement solutions. Adapting to poor water quality, while working to mitigate the drivers remains urgent. As we see across water sciences and beyond, this creates the need to enhance capacity, better coordinate science, and perhaps most of all, support trust in science. Lessons from sustainability science, and a high apparent 'willingness to pay' for improved water quality provide options to act, and support optimism, while highlighting the types of work ahead to find solutions to water problems old, and new.

Session: 5030 ClimatEx: Downscaling for Weather and Climate Extremes
ClimatEx : Réduction d'échelle pour les extrêmes météorologiques et climatiques

Convenors:

Alex Cannon (ECCC)
Colin Mahony (BC Ministry of Forests)
Adam Monahan (UVic)

High-resolution representation of weather and climate variability in a changing climate is essential for planning. This need is particularly acute with regards to extreme events, such as heatwaves, droughts, floods, and hazardous fire weather conditions. Funded by the BC Ministry of Forests, the ClimatEx project in partnership with Environment and Climate Change Canada, University of Victoria, and University of British Columbia explored dynamical and artificial intelligence downscaling approaches to generating high-resolution climate information in British Columbia, with particular emphasis on extremes. This session invites submissions from participants in ClimatEx as well as other studies considering dynamical, statistical, or AI based downscaling. Submissions addressing extreme events are particularly welcome.

Session: 5030 ClimatEx: Downscaling for Weather and Climate Extremes ClimatEx : Réduction d'échelle pour les extrêmes météorologiques et climatiques **29/05/2025 10:30**

ID: 12357 Contributed abstract

WRF-ClimatEx: A Multi-Decadal, High-Resolution, Dynamically Downscaled Dataset Over British Columbia

Timothy Chui [1] , *Colin Mahony* [2] , *Alex Cannon* [3] , *Nicolas Duboc* [4] , *Nat Scott* [5] , *Roland Stull* [6]

[1] University of British Columbia
[2] BC Ministry of Forests
[3] Environment and Climate Change Canada
[4] University of British Columbia
[5] University of British Columbia
[6] University of British Columbia

Presented by / Présenté par: *Timothy Chui*
Contact: tchui@eoas.ubc.ca

As part of the ClimatEx project, the Weather Forecast Research Team at the University of British Columbia (UBC) is creating a multi-decadal, high-resolution gridded dataset for climate, fire weather, and hydrometeorological research in BC. This dataset involves the use of the Weather Research and Forecasting (WRF) model to dynamically downscale the European Centre for Medium-Range Weather Forecasts Reanalysis version 5 (ERA5) to 3-km grid spacing over the entire province, for water years 1999-2023. The downscaled dataset is able to better resolve terrain and convective features compared to the base reanalysis, and is more skillful when verified against surface observations for the extreme heat and precipitation events of 2021. A parallel dataset that downscales climate-perturbed ERA5 data using a pseudo-global warming (PGW) approach is also being produced. Reanalysis data are adjusted with perturbations derived from an ensemble of Coupled Model Intercomparison Project Phase 6 (CMIP6) models, corresponding to fixed levels of global warming (e.g., +2°C and +3°C relative to preindustrial levels). The resulting PGW-based simulations retain the meteorological structures of the reference dataset but reflect shifts in overall statistics and changes in the magnitudes of extreme events due to the imposed perturbations. This dataset provides an estimate of how historical weather events might have differed under a climate with higher global temperatures. An interactive website to access and display the data from both datasets is being developed, to provide researchers and policy-makers a resource for future research into the climate of the province.

Session: 5030 ClimatEx: Downscaling for Weather and Climate **29/05/2025**

ID: 12399 Contributed abstract

Improving Stochastic Deep Learning Downscaling of Climate Variables to Convection Permitting Scales

Kiri Daust [1] , *Adam Monahan* [2] , *Nic Annau* [3] , *Colin Mahony* [4]

[1] Future Forests Ecosystem Centre, BC Ministry of Forests, University of Victoria
[2] University of Victoria
[3] ECCC
[4] BC Ministry of Forests

Presented by / Présenté par: *Kiri Daust*
Contact: kiridaust@uvic.ca

Accurate local-scale climate information is important for ecological applications and climate adaptation strategies. Recently, deep learning has been successful at increasing the resolution of digital images, and it shows promise as a statistical downscaling method for highly non-Gaussian climate variables. Specifically, stochastic Generative Adversarial Networks (GANs), which can be trained on pairs of low- and high-resolution climate fields, can downscale by sampling from the high-resolution distribution conditional on low-resolution fields. Our work investigates some adaptations necessary for the application of GANs to practical downscaling problems. We will discuss two main areas of research: extension to large spatial regions and improving temporal consistency.
Training GANs requires substantial graphical processing unit (GPU) memory, and this memory demand increases quickly as the size of the region increases. We investigated spatial generalisability of GANs and show that a single network can successfully downscale multiple regions, if the GAN is provided with training data from each region. Based on these results, we introduce a tiling algorithm for stochastic GAN training that allows prediction over large areas with decreased memory requirements and no apparent tiling artifacts. We show that by using the same noise inputs for each tile, realisations are consistent across tiles.
While statistical consistency of consecutive realisations at large scales is inherited from low-resolution conditioning fields, most previous work using stochastic GANs does not enforce temporal consistency at fine scales, leading to unrealistic random movement of small-scale features. We investigate various methods for improving temporal consistency, including adding recurrent architectures to the networks, and enforcing dependence of noise inputs. Initial results show promise at improving consistency, and we will present results for various climate variables.

Session: 5030 ClimatEx: Downscaling for Weather and Climate Extremes ClimatEx : Réduction d'échelle pour les extrêmes météorologiques et climatiques

**29/05/2025
11:00**

ID: 12503 Contributed abstract

Deep Learning-Based Downscaling of Gridded Fire Weather Indices with

Generative Adversarial Networks

Robert Payne [1] , *Adam Monahan* [2] , *Derek Van Der Kamp* [3]

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Presented by / Présenté par: *Robert Payne*
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Wildfire behavior is known to be closely linked to local weather conditions. As such, an understanding of potential fire behaviour requires an understanding of its atmospheric drivers. In Canada, the relationship between meteorological conditions and potential fire behavior is commonly characterized by the Canadian Forest Fire Weather Index System, a set of indices derived from weather station observations. However, station observations are often scarce in large, complex regions such as BC and cannot be used directly for projections. High-resolution dynamical models are an alternative approach, but are computationally demanding and subject to their own limitations. Statistical downscaling has been explored as a compromise, and recent deep learning methods have shown promise in the field of climate downscaling. With support from the ClimatEx project led by the BC Ministry of Forests, we present preliminary results that demonstrate how generative adversarial networks—a prominent machine learning framework comprising a generative and discriminative model—can be used for downscaling of gridded fire weather indices across BC.

Session: 5030 ClimatEx: Downscaling for Weather and Climate Extremes ClimatEx : Réduction d'échelle pour les extrêmes météorologiques et climatiques

29/05/2025
11:15

ID: 12218 Contributed abstract

Improving Wind Downscaling with Generative Diffusion Models

Tianxia Jia [1]

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Presented by / Présenté par: *Tianxia Jia*
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Recently developed diffusion models have shown promise in generative modelling and image super-resolution, but their potential for atmospheric downscaling is still largely unexplored. This research assesses the use of diffusion models for generating high-resolution wind fields, providing ensemble forecasts, and capturing fine-scale features. We will test diffusion models on synthetic datasets and real-world applications, including downscaling ERA5 reanalysis data to WRF simulations over the region of coastal BC. We will evaluate the importance of a suite of meteorologically relevant conditioning variables and historical low-resolution wind speed data in improving downscaling performance. By improving downscaling techniques using generative models, this work aims to enhance wind forecasting accuracy, supporting more efficient wind farm

planning and energy estimation.

Session: 8050 Hydrometeorology of lakes and reservoirs Hydrométéorologie des lacs et des réservoirs

Convenors:

Warren Helgason1, Murray Mackay2, Daniel Nadeau3, Christopher Spence4
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Lakes and reservoirs occupy a substantial portion of the Canadian landscape. It is well known that the large heat capacity of water has a profound influence on local and regional climate. In addition, hydrological, meteorological and limnological processes control downstream flow regimes, which is crucial for water availability for cultural, domestic, industrial, hydroelectric and ecosystem purposes. However, these water bodies are highly sensitive to climate conditions. In particular, there remains uncertainty in how lakes and reservoirs will respond to climate warming and if water management systems are flexible enough to adapt. Therefore, there is an urgent need to improve our understanding of these systems. We therefore encourage contributions that address the interaction of lakes and reservoirs with climate and hydrology during both the open-water period as well as in the presence of ice and snow, but also more specifically on 1) novel measurements of lake and reservoir water and energy budgets; 2) lake and reservoir hydrological and hydrometeorological processes that control these budgets; 3) modelling of these systems.

ID: 12201 Contributed abstract **29/05/2025 10:30**

Large-Scale Analysis of Ice Phenology in 3702 Lakes and 1028 Reservoirs of the Northern Hemisphere from Sentinel-2 Data

Daniel Nadeau [1] , *Doris Domart* [2] , *Antoine Thiboult* [3] , *François Anctil* [4] , *Tadros Ghobrial* [5] , *Yves Prairie* [6] , *Alexis Bedard-Therrien* [7] , *Alain Tremblay* [8]

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Presented by / Présenté par: *Daniel Nadeau*
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Very few studies of ice phenology have combined both lakes and reservoirs of various sizes. On the one hand, global phenological studies on lake ice have mainly focused on rather large lakes (> 500 km2), while studies on reservoir ice have been limited to regional scales. This study characterizes the freeze-up and break-up dates of 3702 lakes and 1028 reservoirs ranging from 1 to 31,000 km2 throughout the Northern Hemisphere, and analyzes the spatial patterns that emerge, as well as the relationships between phenological dates and the geographical, morphometric and climatic characteristics of the water bodies. Freeze-up and melt dates were determined using a detection algorithm based on Sentinel-2 observations (spatial resolution: 10 m, temporal resolution: 5 days) and applied on a large scale on the Google Earth Engine platform from 2019 to 2023. The algorithm was validated by comparing phenological dates with an independent database constructed from passive microwave satellite observations, with a mean absolute error of 18 days for freeze-up and break-up dates. Using this new ice phenology database, a random forest model was employed to predict ice phenology dates. Although the performance of the predictive model was satisfactory (mean absolute error of 12 days for freeze-up and break-up), difficulties were encountered in certain high-altitude areas where cloudy conditions and black ice were observed. Among the variables included in the random forest model, latitude and accumulation of freezing degree-days were identified as the main drivers of ice phenology dates. Despite the difficulties associated with applying a single, simple method on a global scale, this study has enabled the creation of an extensive database on ice phenology that can be used by the community to further analyze lake models. Efforts in this direction will also be presented.

Session: 8050 Hydrometeorology of lakes and reservoirs
Hydrométéorologie des lacs et des réservoirs **29/05/2025 10:45**

ID: 12365 Contributed abstract

Virtual

The Lakes of North America in Regional Climate Simulations

Mani Mahdinia [1] , *Andre R. Erler* [2] , *Ka Hei Ng* [3] , *W. Richard Peltier* [4]

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[3] University of Toronto, Physics Department
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Presented by / Présenté par: *Mani Mahdinia*
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The hydro-climatic effect of the lakes of North America (NA) and their representation in regional climate simulations is examined, using the WRF model with three fully-coupled 1D column lake models. All lakes larger than the model grid resolution of 24 km are considered. The 3 column models used to simulate lake physics include the WRF default lake model, the Xiao et al. (2016) improved default lake model, and the widely-used

empirical model FLAKE. The lakes' ice-in and ice-out dates, mean ice fraction, ice temporal and spatial distributions, and surface temperature (LST) temporal and spatial distributions are investigated and validated again observations including IMS ice, NOAA GLERL ice, NASA MODIS LST and NOAA GLSEA LST. The effect of lake model choice on the variation of these quantities is investigated as well. Furthermore, the dependence of the ice-in and ice-out dates on the lake's surrounding temperature and latitude is studied. Furthermore, to quantify the effect of the lakes on the climate of the surrounding regions, a fourth simulation is considered, where the lakes have been removed entirely. Comparison with simulations with a lake model reveals that lakes often cool their surrounding environments by ~2.5K and result in an increase in precipitation by ~25%. For some larger lakes on the other hand, the inclusion of the lakes results in warmer winter temperatures and suppression of summer precipitation. The latter effect is found to be due to the stabilizing effect of the lakes' surfaces, as well as decreased evaporation in the presence of the lakes.

Session: 8050 Hydrometeorology of lakes and reservoirs
Hydrométéorologie des lacs et des réservoirs **29/05/2025 11:00**

ID: 12570 Contributed abstract

Preliminary Results from Ship-Borne Turbulent Flux Observations over the Laurentian Great Lakes

Christopher Spence [1] , *Newell Hedstrom* [2] , *Joe Gabrielle* [3] , *Peter Blanken* [4]

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Presented by / Présenté par: *Christopher Spence*
Contact: chris.spence@ec.gc.ca

Evaporation is significant to the water budget of the Laurentian Great Lakes, with commensurate influence on lake levels. Direct evaporation measurements are spatially limited to fixed sites on lighthouses with relatively small measurement footprints. To address this gap, eddy covariance equipment was deployed on the CCGS Limnos from 2016-2019. This presentation will summarize project planning, installation, operation, data retrieval, post-processing and quality control. Observations were made on four Great Lakes and connecting channels, providing a spatially diverse dataset of observed turbulent fluxes from these water bodies. Comparisons between ship-borne estimates and those from a lighthouse installation at Long Point on Lake Erie during concurrent periods when flux footprints overlapped demonstrate the comparability of observations and feasibility of using ships as evaporation observation network platforms. The comparisons also highlight issues associated with synthesizing time series from mobile platforms, and these will be discussed.

Session: 8050 Hydrometeorology of lakes and reservoirs
Hydrométéorologie des lacs et des réservoirs **29/05/2025 11:15**

ID: 12553 Contributed abstract

Evaporation Modelling at Qikiqtalik Lake, Iqaluit, Nunavut

Jakob Hadden [1]

[1] Carleton University

Presented by / Présenté par: *Jakob Hadden*
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Qikiqtalik Lake, a small arctic lake located approximately 5 km from Iqaluit, Nunavut, is a focal point for research on northern water systems. Although there is an increasing body of literature on small northern lakes, the remote nature of these systems complicates long-term data collection. Evaporation models provide a valuable tool for estimating water budgets in the absence of direct data collection. Lake evaporation is controlled by both the water and energy budgets of the lake. The water budget quantifies the mass or volume of water entering and exiting the reservoir, leading to changes in storage, whereas the energy budget describes the distribution of net radiation, heat fluxes, and the energetic processes that control evaporation rates. The energy budget includes both the incoming solar radiation and the heat exchanged between the lake and the atmosphere, with latent heat flux driving evaporation. A comprehensive understanding of water availability is critical for addressing both current and future water demand. Iqaluit has faced recurrent water shortages, largely due to the limitations of its existing water sources, such as Lake Geraldine and, in emergencies, water pumped from the Apex River. In response, the city is developing a larger water reservoir sourced from Qikiqtalik Lake. This study investigates the evaporation rates and their controlling factors at Qikiqtalik Lake to evaluate its viability as a long-term water supply. This research aims to assess the performance of six existing empirical evaporation models using eddy covariance measurements.

Session: 8050 Hydrometeorology of lakes and reservoirs
Hydrométéorologie des lacs et des réservoirs **29/05/2025 11:30**

ID: 12383 Contributed abstract

Lake Ice and Climate Perturbation: Numerical Experiments on a Small Boreal Lake

Murray Mackay [1] , *Evan Timusk* [2] , *Paul Blanchfield* [3]

[1] Environment and Climate Change Canada
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Presented by / Présenté par: *Murray Mackay*
Contact: murray.mackay@ec.gc.ca

Changes in lake ice cover resulting from systematic perturbations to individual meteorological forcing variables are examined here by way of numerical experimentation

with a 1-dimensional thermodynamic lake model. Examination of a simplified vertical energy budget suggests that wind speed, air temperature, precipitation, and incoming shortwave radiation are key variables governing the creation and evolution of ice. Synthetic 30-year meteorological forcing datasets over a small boreal lake are generated by replicating 1 year of detailed observations with added Gaussian noise or by a scaling factor to each of these forcing variables in turn, and the impact on lake ice phenology, quality, and maximum thickness analyzed.
For the wind speed experiments, changes in phenology were nonlinear. For the largest wind speed reductions ice-on was delayed but for increasing mean wind speed perturbations the ice-on date was essentially unchanged. For large wind speed perturbations of either sign the ice-off date was early, but smaller changes in mean wind speed of either sign had no effect. Thus any significant change in mean wind speed would lead to a reduction in ice cover duration.
Ice-on dates were only weakly affected by perturbations to any of the other forcing variables considered, including air temperature. Thus observational studies that link increasing air temperatures to delays in ice-on should also consider the impacts of wind speed if data are available.

Session: 8050 Hydrometeorology of lakes and reservoirs
Hydrométéorologie des lacs et des réservoirs **29/05/2025 11:45**

ID: 12494 Contributed abstract

Energy Dynamics of an Oil Sands Pit Lake in the Initial Years Following Construction

Nataša Popović [1] , *Austin Zabel* [2] , *Scott Ketcheson* [3] , *Richard Petrone* [4]

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[2]
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Presented by / Présenté par: *Nataša Popović*
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Lakes are an essential component of boreal landscapes as they influence regional hydrologic cycling and climate regulation. In recognition of their vital ecohydrological role, lakes have been integrated into the broader reclamation strategy in the Athabasca Oilsands Region. Constructed, end pit lakes serve as important reclamation tools as they restore disturbed landscapes and provide a means for the storage and recycling of mining by-products such as tailing sands. While pilot-scale ecosystems have been constructed in the region, upscaling to larger, commercial-scale systems is intended. Thus, determining key factors and potential design limitations is required to adequately create functioning reclaimed ecosystems. As such, understanding the energy dynamics of end pit lakes is critical for predicting the long-term stability, and applicability of these systems in post-mining landscapes. This study assesses the energy dynamics of Lake Miwasin, a pilot-scale end pit lake over two consecutive open-water seasons with varying climatic conditions. Here, heat storage, surface energy fluxes, and tailings heat fluxes were quantified to assess how lake size and climate influence constructed lake thermal dynamics. Results indicate the timing and magnitude of the maximum heat

content varied between the two years, with greater energy storage, enhanced latent heat flux, and reduced sensible heat flux compared in the warmer 2021 season compared to the cooler and wetter 2020 season. In both years, deposited tailings acted primarily as a heat sink during the open water season however the magnitude of the flux was responsive to elevated water temperatures. Furthermore, the lake’s relatively small surface area and surrounding topography contributed to lower wind-driven energy exchanges providing insight into the relationship between lake morphometry and hydroclimatic controls. These findings provide insight into the energetics of future oil sands pit lakes, informing their design and management in post-mining landscapes.

Session: 9020 Applications of AI and machine learning to the atmosphere/ocean/climate system - Part 1 Applications de l'IA et de l'apprentissage automatique au système atmosphère/océan/climat - Partie 1

Convenors:

Dr. Joe Fitzgerald, Dept. of Physics and Physical Oceanography, Memorial University of Newfoundland
Dr. Alex Bihlo, Dept. of Mathematics and Statistics, Memorial University of Newfoundland
Dr. Terrence Tricco, Dept. of Computer Science, Memorial University of Newfoundland

Global scientific interest in artificial intelligence (AI) and machine learning (ML) is exploding. The developments of the past 5-10 years in AI/ML applications to geophysical fluid dynamics and climate have shown that AI/ML has great potential to significantly advance our ability to model, predict, and understand our climate. This session aims to bring together researchers from all sub-domains of atmosphere/ocean/climate science to share what we have learned and are learning about this revolutionary new technology. We invite presentations on all topics related to AI/ML and climate, including but not limited to: 1) AI/ML approaches to the general problem of parameterization, including parameterizations of geophysical turbulence, 2) Practical and theoretical applications of AI/ML to prediction problems, such as weather forecasting, climate projection, ensemble forecasting, and the prediction of extreme and rare events, 3) AI/ML methods for regional prediction, including ML-facilitated downscaling, 4) AI/ML applications in remote sensing, and 5) AI/ML techniques analyzing atmosphere/ocean/climate data. New AI/ML tools are constantly being developed. We welcome presentations relating to all classes of AI/ML tools, including feed-forward/convolutional neural networks, transformers, physics-informed neural networks, neural operators, and many others.

Session: 9020 Applications of AI and machine learning to the atmosphere/ocean/climate system - Part 1 Applications de l'IA et de l'apprentissage automatique au système atmosphère/océan/climat - Partie 1 **29/05/2025 10:30**

ID: 12217 Contributed abstract

Virtual

Problems in the application of regression in the atmospheric, earth and

environmental sciences

Konrad Gajewski [1]

[1]

Presented by / Présenté par: *Konrad Gajewski*
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Linear regression is a simple, easily employed and routinely used statistical model. Observations of the peer-reviewed literature in the atmospheric, earth and environmental sciences show that, surprisingly, it is frequently inappropriately implemented. Although fitting a regression curve is a trivial operation (for example, can be implemented in Excel), if the assumptions of the linear regression model are fulfilled, then it becomes a useful tool for modelling. However, in many cases from the literature, the published models violate the assumptions of the methodology, leading to questionable results and models that are of limited use. I will show examples of problems of the use of linear regression from the literature. I will then use a detailed example to illustrate how problems can be easily avoided, leading to more usable models.

Session: 9020 Applications of AI and machine learning to the atmosphere/ocean/climate system - Part 1 Applications de l'IA et de l'apprentissage automatique au système atmosphère/océan/climat - Partie 1 **29/05/2025 10:45**

ID: 12362 Contributed abstract

Adaptive Wavelet Full Multigrid Method for Solving the Variational Data Assimilation Problem

Hamidreza Moazzami [1] , *Nicholas Kevlahan* [2]

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[2] McMaster University, Mathematics and Statistics, Hamilton, Canada

Presented by / Présenté par: *Hamidreza Moazzami*
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We propose non-adaptive and adaptive wavelet multigrid methods to solve the incremental 4DVAR data assimilation problem of numerical weather prediction. For simplicity, we have considered one space dimension and one time dimension (2DVAR). We assume sparse noisy observations are available in space and time and our goal is to efficiently approximate the Hessian of the space--time cost function. The methods are applied to the linear advection equation and the Burgers equation.

We investigate the impact of various parameters, such as the number of observations in space and time, spacing of observations, the correlation length scale of the background term, and the observation error variance on the properties of the Hessian. We are particularly interested in the condition number of the Hessian, which determines the convergence of the multigrid method. Additionally, we compare the efficiency of the V-cycle and full multigrid methods for faster convergence of data assimilation, both of

which are implemented using the wavelet collocation method. Standard multigrid and non-adaptive wavelet multigrid are also compared, showing identical results in terms of accuracy and efficiency.

Finally, we show that the adaptive multigrid method can efficiently solve the data assimilation problem. This approach significantly reduces the number of grid points by focusing computations in regions with localized structures. The solution is then interpolated to the remaining grid points with minimal loss of accuracy.

Session: 9020 Applications of AI and machine learning to the atmosphere/ocean/climate system - Part 1 Applications de l'IA et de l'apprentissage automatique au système atmosphère/océan/climat - Partie 1 **29/05/2025 11:00**

ID: 12322 Contributed abstract

Investigating the Use of Statistical, Machine-Learning and Semi-Empirical Lumped Models to Develop Water Temperature Prediction System (WTPS)

Behnoosh Roknaldini [1] , *Siraj ul Islam* [2] , *Bryce O'Connor* [3] , *Alexandre Bevington* [4] , *Eduardo G. Martins* [5]

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Presented by / Présenté par: *Behnoosh Roknaldini*
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The interaction between air and water is essential for regulating the latent heat fluxes of freshwater ecosystems. An increase in air temperatures results in higher water temperatures, affecting the freshwater habitats of various species, particularly cold-water fish. This study explored freshwater temperature relationships with key atmospheric variables to develop a comprehensive multi-model water temperature prediction system (WTPS) for lakes and rivers. We developed the WTPS using Multiple Linear Regression (MLR), Generalized Additive Model (GAM), Random Forest (RF), and Artificial Neural Network-Feedforward (ANN) statistical/machine-learning techniques, and the Air2Stream (A2S) and Air2Water (A2W) Semi-Empirical Lumped models. The WTPS is applied at both river and lake sites within British Columbia to validate its performance for diverse freshwater systems, home to several native fish. We tested its reliability by comparing models' performance, examining sensitivity to input variables, and predicting water temperature during warm months (May 1 - September 30). The WTPS calibration, validation, and prediction were analyzed for selected periods from 2000 to 2024 on a daily scale while considering a range of hydrometeorological variables.
The inter-model comparison showed that at river sites, the ANN model slightly outperformed other models, while the A2S model achieved comparable predictive performance, despite requiring fewer river inputs. Conversely, the GAM and A2W models emerged as the top performers at lakes, while at the Reservoir site, the RF and GAM models performed best. We found that the depth of the water temperature

monitoring sensor notably influences the Air2Water model's performance. However, statistical/machine-learning approaches can override such performance issues by incorporating additional predictors. The real-world evaluation of WTPS showed reliable water temperature predictions for both river and lake sites during the 2023 and 2024 summers (MAE 1.2-1.4°C and RMSE 1.4-1.5°C). This study leverages ongoing water temperature monitoring and prediction efforts to support environmental stewardship and fish conservation initiatives.

Session: 9020 Applications of AI and machine learning to the atmosphere/ocean/climate system - Part 1 Applications de l'IA et de l'apprentissage automatique au système atmosphère/océan/climat - Partie 1 **29/05/2025 11:15**

ID: 12323 Contributed abstract

Virtual

Temperature Prediction of the Pincher Creek Region Using an Adaptive Neuro-Fuzzy Inference System (ANFIS): A Case Study

Ali Hakimi [1] , *Jeff (Jafar) Sepehri* [2]

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Presented by / Présenté par: *Jeff Sepehri*
Contact: Jeff.Sepehri@gmail.com

This study aims to accurately forecast the air temperature in the Pincher Creek region of southern Alberta using an Adaptive Neuro-Fuzzy Inference System (ANFIS). Meteorological data—including temperature and relative humidity—were collected from 2011 to 2024 at hourly intervals from the Pincher Creek station. After data cleaning (removing incomplete records), a final dataset of 110,892 records was obtained. The last 1,000 records were reserved for extrapolation testing, while the remaining data were split into 70% training (76,924 records) and 30% testing (32,968 records) sets. Model performance was evaluated using RMSE, MAE, and the coefficient of determination (R^2). For the training data, the obtained metrics were RMSE = 1.2992 °C, MAE = 0.8798 °C, and R^2 = 0.9865. The test data yielded RMSE = 1.2871 °C, MAE = 0.8783 °C, and R^2 = 0.9869, while the extrapolation (prediction) set achieved RMSE = 1.2620 °C, MAE = 0.8283 °C, and R^2 = 0.9639. These results demonstrate that the ANFIS model, using temperature and relative humidity from three consecutive hourly time steps as inputs, effectively predicts temperature in the subsequent hour. The discussion highlights the synergy between neural network adaptability and fuzzy logic interpretability, addresses limitations, and proposes future enhancements.

Keywords: Temperature prediction, ANFIS, Subtractive clustering, Time series forecasting, Pincher Creek, Extrapolation

Session: 9020 Applications of AI and machine learning to the atmosphere/ocean/climate system - Part 1 Applications de l'IA et de l'apprentissage automatique au système atmosphère/océan/climat - Partie 1 **29/05/2025 11:45**

ID: 12479 Contributed abstract

Virtual

Physics-Informed Neural Networks for Scale-Aware Bias Correction of Temperature and Precipitation in Regional Climate Modeling

Zhenhua Li [1] , *Yanping Li* [2] , *Danqiong Dai* [3] , *Fei Huo* [4] , *Xiao Ma* [5]

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Presented by / Présenté par: *Zhenhua Li*

Contact: zhenhua.li@uwo.ca

We present a novel bias correction methodology that addresses critical scale mismatch challenges when using coarse-resolution reanalysis products as correction targets for high-resolution regional climate models. Our approach employs Physics-Informed Neural Networks (PINNs) that integrate physical constraints between temperature and precipitation fields while accounting for their distinct scaling properties across different spatial resolutions. The framework introduces a scale-bridging architecture that explicitly models the statistical relationships between point measurements, regional climate model outputs (4-km resolution), and coarser reanalysis products (25-km resolution). Physical constraints are incorporated through custom loss functions that enforce energy and moisture conservation principles, temperature-precipitation dependencies, and orographic effects. This ensures corrections maintain meteorological consistency while adapting to local topographic features that are inadequately represented in reanalysis products.The framework particularly excels in capturing precipitation extremes and temperature gradients in complex terrain, where traditional correction methods using reanalysis targets often introduce artificial biases. This work establishes a more robust foundation for generating reliable climate projections at scales relevant for impact studies by addressing the fundamental limitations in current bias correction methodologies while maintaining physical consistency between critical climate variables.

Session: 8032 General Hydrology - Part 3 Hydrologie générale - Partie 3

Convenors:

Dr. Barret Kurylyk, Dalhousie University
Dr. Lauren Somers, Dalhousie University

The general hydrology session invites a broad range of research contributions, including, but not limited to, field-, laboratory-, and/or modelling-based studies of the water cycle. Studies carried out at different spatial scales and situated in both pristine and disturbed landscapes are welcome.

Session: 8032 General Hydrology - Part 3 Hydrologie générale - Partie 3 **29/05/2025 10:30**

ID: 12373 Contributed abstract

A novel method for frequency analysis of high water temperatures using temperature duration curves in a partially regulated watershed

Mostafa Khorsandi [1] , *Stephen Déry* [2]

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Presented by / Présenté par: *Mostafa Khorsandi*
Contact: mostafa.khorsandi@unbc.ca

Water temperature is the key variable for aquatic environmental assessments, and in the absence of long-term observational records, simulations provide essential data for further environmental analysis. In this presentation, we will investigate the upper percentiles of a novel Temperature Duration Curve (TDC) as a proxy to characterize high water temperatures in a partially regulated watershed. The study area comprises the 47,200 km2 Nechako Watershed of British Columbia, Canada, where nine hydrometric stations measure streamflow and water temperature. Four sites represent regulated flows, while five sites are unregulated. Using daily streamflow and water temperature observations and ERA5-Land air temperature data, the Air2Stream model was calibrated for historical periods from 1950 to 2023. Simulations were also conducted using naturalized flows for the regulated Nechako River at Vanderhoof and Isle Pierre to reconstruct naturalized water temperatures. A frequency analysis was performed on observed, simulated, and naturalized water temperatures for different return periods and TDC percentiles. The analysis included exceedances of 0, 1, 5, and 10% for high temperatures and the 50th percentile (median) for mean temperatures. Results showed robust model performance with RMSE < 1.5°C (NSE > 0.9 and KGE > 0.8) for all stations during calibration. The frequency curves showed reduced high temperatures for the Nechako River at Vanderhoof due to ecological flow releases, but increased mean temperatures for return periods > 2 years. This novel approach suggests that thermal mandates should be related to Q_5 and Q_10, which had the best agreement between observations and simulations. The presentation will close with a discussion on how the method is applicable globally across various basin sizes and hydrological regimes, making it a valuable tool for assessing water temperature dynamics in diverse environments.

Session: 8032 General Hydrology - Part 3 Hydrologie générale - Partie 3 **29/05/2025 10:45**

ID: 12519 Contributed abstract

Energy conservative solutions for coupled heat-mass transport in frozen soils and snow

Andrew Ireson [1] , *Alana Muenchrath* [2] , *Simon Mathias* [3] , *Chris Spence* [4]

[1]
[2] University of Saskatchewan
[3] University of Durham
[4] Environment and Climate Change Canada

Presented by / Présenté par: *Andrew Ireson*
Contact: andrew.ireson@usask.ca

Physically based frozen soil models are essential for understanding hydrological processes in cold regions, particularly snowmelt infiltration into seasonally frozen soils and permafrost thaw. While significant progress has been made in modeling coupled heat and mass transport in frozen soils, and several sophisticated physically based models exist, practical applications require robust coupling between snow and soil models. Although we have well-developed physically based snow models, state-of-the-art soil models are typically not integrated with them. Notable exceptions include the Cold Regions Hydrological Model (CRHM) and various land surface models such as CLASS, CLASSIC, SVS, and SUMMA. However, these models are often applied with coarse vertical resolution and, in some cases, rely on oversimplified process representations.

The objective of this study is to develop a simple, point scale mass- and energy-conservative coupled snow-soil model that can be used to systematically evaluate the numerous implicit and explicit assumptions embedded in existing models. A particular focus is to evaluate various approaches for representing the upper boundary condition of the soil, which plays a critical role in governing heat and mass fluxes and, consequently, the thermal and hydrological behavior of the soil.

Session: 8032 General Hydrology - Part 3 Hydrologie générale - Partie 3 **29/05/2025 11:00**

ID: 12542 Contributed abstract

Runoff partitioning and controls within a nested catchment complex

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Presented by / Présenté par: *Scott Ketcheson*
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In Canada’s Western Boreal Plain, catchment runoff is typically low but spatially variable. Wetlands are abundant, covering up to 50% of the landscape, despite a regional sub-

humid climate. Local topographic highs, including Stony Mountain, appear to be water generation hotspots, with the goal of this research to evaluate the controls, partitioning, and importance of runoff from small headwater catchments on a local topographic high for water generation and availability in downgradient systems.

Isotope-based partitioning of streamflow and catchment runoff efficiencies were evaluated within a nested catchment complex in northern Alberta (The Stony Mountain Headwater Catchment Observatory; SMHCO). Water table configurations across forested hillslopes and adjacent wetlands represented an important control on the magnitude of runoff response to rainfall events. Rainfall is the main driver of short-term runoff generation but not the primary source, with surface and shallow wetland waters typically dominating streamflow. However, the nested catchment design revealed some scale-dependency of groundwater contributions, with an increasing contribution from groundwater with increasing catchment size in the smallest (<10 km2) headwater catchments, with landcover composition (especially wetland coverage) complicating these trends in the mesoscale (up to 200 km2) catchments. Regardless, groundwater contribution increased, and runoff efficiency decreased, during drier years when inputs from surface and shallow wetland water were reduced. The headwater catchments demonstrated highly variable runoff efficiencies, ranging from 10 to 90% (average 32%), with the larger mesoscale catchments demonstrating lower runoff efficiency (average = 21%; range 10 to 36%). The findings of this research demonstrates that smaller sub-catchments within headwater regions of larger catchments represent an important area for water supply and availability for down-gradient ecosystems and water courses.

Session: 8032 General Hydrology - Part 3 Hydrologie générale - Partie 3 **29/05/2025 11:15**

ID: 12351 Contributed abstract

Dynamic land use modeling to simulate the hydrological response of forest disturbances in Western Canada

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Presented by / Présenté par: *Krishna Kafle*
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Forest disturbances such as the Mountain Pine Beetle (MPB) and wildfires are claiming vast expanses of forests in western Canada. There is growing concern regarding how these disturbances affect regional hydrological processes amid changing climatic conditions. This study aims to quantify these hydrological changes using a hydrological model that utilizes forest disturbance scenarios to estimate the hydrological response in the Upper McLeod River Basin (UMRB) in Alberta and the Nautley River Basin (NRB) in British Columbia. We applied the Variable Infiltration Capacity (VIC) hydrological model across these testbed watersheds using 5 km horizontal resolution on a daily time scale. The VIC modeling framework includes a dynamic land use approach by varying the

forest cover in the model simulations. This is accomplished by generating multiple land use input files using spatial maps of wildfire-burnt areas and data on MPB-affected tree locations. The outputs are examined to quantify the estimated changes in snow water equivalent, soil moisture, evapotranspiration, base flow, runoff, and streamflow.

The forest loss simulations indicate an increase in annual streamflow compared to the baseline simulation without forest loss. This rise in streamflow is primarily due to reduced evapotranspiration and earlier snowmelt when forest cover is replaced by bare land in the model simulations. Additionally, the hydrological changes reveal noticeable variations in streamflow magnitude and timing caused by interannual climate variability. Furthermore, the experiments demonstrate that the natural regeneration process of the forest, with various species of trees, cannot fully restore the watershed's hydrology to the pre-disturbance state. Overall, this study offers new insights into how forest loss impacts hydrology, which can inform operational decisions in water management under the continued spread of MPB and increasing wildfires.

Session: 8032 General Hydrology - Part 3 Hydrologie générale - Partie 3 **29/05/2025 11:30**

ID: 12181 Contributed abstract

Virtual

Enhancing Flood and Drought Event Characterization Triggered by Landslides Using SWOT Data

Corinne Bourgault-Brunelle [1] , *Jessica Plante* [2] , *Omar Elasfar* [3]

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Presented by / Présenté par: *Corinne Bourgault-Brunelle*
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Globally, studies show the average annual frequency of landslides triggered by extreme precipitation, increasing under climate change, is projected to increase by 7% in the future 30-year periods of 2031–2060. Landslides result in large volumes of debris, such as rocks, soil, and vegetation, and can create a natural dam and block the water flow. This lowered the water level downstream leading to drought-like conditions and impact downstream regions, especially in river systems where water flows are critical for agriculture, drinking supplies, navigation, and ecosystems. When the dam breaks or overtops, the sudden release of water can lead to downstream flooding. Here, SWOT provides detailed information on river slopes, helping to define the river morphology and flow changes in a river impacted by a landslide event.

Session: 3010 Biogeochemistry of boreal ecosystems La biogéochimie des écosystèmes boréaux

Conveners:

Nora Casson1,
Colin Whitfield2,
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Temperatures are rising more rapidly at high latitudes than anywhere else on Earth. Boreal ecosystem processes are impacted by climate change, both directly through shorter winters and longer, warmer summers and indirectly, through increases in disturbances including wildfire, permafrost thaw and outbreaks of invasive insects. This sensitive region stores massive quantities of carbon in the soil and biomass, and thus climate driven changes to ecosystem processes may shift the carbon balance in important ways. There is a critical need to understand controls on boreal biogeochemical processes, in order to understand where systems are resilient to climate change and where systems may be shifting to a new regime. This session invites contributions in terrestrial and aquatic biogeochemistry that provide insight into boreal region ecosystem processes, particularly those with a focus on impacts of climate change and climate-related disturbances. We welcome studies that use field observation, experimental manipulation, long-term data analysis, remote sensing or models to provide new insight into biogeochemistry in the boreal region.

Session: 3010 Biogeochemistry of boreal ecosystems La biogéochimie des écosystèmes boréaux **29/05/2025 10:30**

ID: 12250 Contributed abstract

Evaluating the performance of the Carbon Budget Model of the Canadian Forest Sector against the observations in the boreal forest stands

Nicole Lau [1] , *Mihai Voicu* [2] , *Derek Sattler* [3] , *Oleksandra Hararuk* [4]

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Presented by / Présenté par: *Nicole Lau*
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Boreal forests cover approximately 270 million hectares of Canada’s land area and play a critical role in carbon (C) cycling, both in C storage and emissions. However, these ecosystems are also highly sensitive to the impacts of climate change. As climate change accelerates, patterns of C flux and storage in forest soils and vegetation may be disrupted, potentially altering overall C balance. The Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3) is a tool designed to simulate forest carbon dynamics at the stand and landscape levels. By incorporating stand-specific forest data

and ecological parameters from national databases, the model calculates carbon stocks and fluxes for monitoring and projection purposes, across different forest events and management scenarios. Ongoing model evaluation and calibration are essential to ensure accurate carbon monitoring, accounting, and reporting that reflect changing conditions and more effectively capture uncertainties. In this project, we evaluate the performance of CBM-CFS3 using independent ground plot data from 144 aspen-dominated sites, as part of the nation-wide Climate Change Impacts on the Productivity and Health of Aspen project, along with 40 lodgepole pine-dominated sites disturbed by mountain pine beetle in boreal forests of Alberta. We compared modelled and measured carbon stock values across several pools, including soil organic matter, mineral soil, aboveground biomass, snags, and deadwood. Additionally, we examined how different explanatory variables, such as disturbance severity, stand age, aboveground biomass, and soil texture, may affect model performance.

Session: 3010 Biogeochemistry of boreal ecosystems La biogéochimie des écosystèmes boréaux **29/05/2025 10:45**

ID: 12344 Contributed abstract

Wildfire-Induced Carbon Emissions in the Canadian Boreal Forest: Climate Drivers and Trends

Saba Asadolah [1] , *Peter Jackson* [2]

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Presented by / Présenté par: *Saba Asadolah*
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Understanding how wildfire activity affects carbon dynamics in the Canadian Boreal Forest is essential for assessing its role in the global carbon balance. Recent trends indicate a shift from a carbon sink to a carbon source, driven by changes in fire frequency, intensity, and emissions. In this study, we analyze wildfire patterns and their climatic drivers from 2003 to 2023, using fire emissions data from the Global Fire Emissions Database (GFED) and burned area estimates from MODIS and VIIRS.
This work explores seasonal and geographic wildfire hotspots, fire-climate relationships, and the role of lagged climatic conditions such as winter snowpack, spring soil moisture deficits, and drought. A particular focus is on extreme fire years, including 2023, to assess deviations from historical patterns and links to climatic events like heatwaves and precipitation anomalies. The study also considers shifts in wildfire-prone regions, including potential northward migration.
To quantify these relationships, we used Random Forest regression modeling to evaluate how wildfire activity, burned area, fire intensity, and carbon emissions respond to climate factors. These findings contribute to wildfire risk assessment, carbon budget evaluations, and scenario projections, providing insights for improved wildfire modeling, adaptation strategies, and climate mitigation planning.

Session: 3010 Biogeochemistry of boreal ecosystems La biogéochimie des écosystèmes boréaux **29/05/2025 11:00**

ID: 12446 Contributed abstract

Space-for-time documentation of future white spruce growth in the boreal forest

Bryan Mood [1] , *Colin Laroque* [2]

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Presented by / Présenté par: *Bryan Mood*
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Climate conditions throughout the 21st century across much of western Canada's boreal forest have been drier than normal leading to significant impacts on forest productivity and tree growth. Determining the limiting factors of radial growth in common boreal tree species under current and future conditions is crucial to reconcile how they will continue to respond to climate change. While modelling efforts provide understanding on potential future risks to forests throughout Canada, shelterbelts, and other agroforestry practices, provide additional insights using a space-for-substitution. In this study, we used white spruce shelterbelts growing up to 500km south of their natural range in warmer, drier climates to document their plasticity using dendroecological methods. Our research highlights that white spruce is sensitive to extreme droughts and radial growth requires up to three years to return to 'normal' growth conditions which is typically followed by compensatory growth. They were also more resilient than other common shelterbelt species. This information was augmented by applying a non-linear, process-based approach to model radial growth that shows white spruce is moisture limited throughout southern Saskatchewan. Model outcomes were much more sensitive to extreme droughts compared to actual tree-ring growth illustrating high plasticity to attendant environmental conditions. Our research shows that, although still sensitive to drought, white spruce in the boreal forest may be more resilient to hotter, drier conditions through phenotypic plasticity.

Session: 3010 Biogeochemistry of boreal ecosystems La biogéochimie des écosystèmes boréaux **29/05/2025 11:15**

ID: 12274 Contributed abstract

The Earth Keeps the Score – Insights on the long-term carbon accumulation history in heavily degraded peatlands from Sudbury, Ontario

Samantha Mitchell [1] , *Nathan Basiliko* [2] , *Peter Beckett* [3] , *Colin McCarter* [4] , *Ellie Goud* [5] , *Pete Whittington* [6] , *Florin Pendea* [7]

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Presented by / Présenté par: *Samantha Mitchell*
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Peatlands are generally considered carbon (C) sinks, however, changes to the peatland's chemistry, hydrological regime, and microbiome structure and composition, can transform these peatlands into net sources of greenhouse gases (GHG) to the atmosphere. Becoming a net GHG source is particularly exacerbated by large-scale processes such as pollution, forest fires, and increased evapotranspiration under the influence of climate change.
In this study, we evaluate the long-term soil C dynamics in four peatlands across a pollution gradient in the Greater Sudbury Area (ON), North America's largest point source pollutant of acidic sulfate and some heavy metals during mid 20th century. Using peat C, sulfur, nitrogen, base cations, metal, and metalloid geochemistry coupled with radiocarbon dating, we contrast pollutant loading with temporally constrained C stocks and accumulation rates to identify whether a relationship exists between smelter pollutant contamination of peatlands during the industrial isochron (1880 to 1975) and the fate of their C stores. Our results indicate that while contaminant accumulation had a deleterious effect on peat structure and quality, heavy pollutant loading (high S, Ni, Cu, Pb, and As) initiated an increase in the apparent C accumulation rates. This increase could have been driven by a number of processes, such as suppression of microbial decomposer activity and shifts in species composition from Sphagnum-dominated poor fen to Ericaceous shrub-graminoid fen, the latter producing more C-dense woody peat. However, our study also indicates that downward translocation of pollutants led to a substantial post-depositional loss of C from older (deeper) peats.

Session: 3010 Biogeochemistry of boreal ecosystems La biogéochimie des écosystèmes boréaux **29/05/2025 11:30**

ID: 12557 Contributed abstract

Impacts of changing drought regimes on dissolved organic matter transport to boreal headwater streams

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Presented by / Présenté par: *Nora Casson*
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Boreal forests store and process vast quantities of carbon, and one of the consequences of the rapid climate change in this region is an increase in the length and severity of summer droughts, which impact both the biogeochemical processing of C in catchment soils as well as the quantity and quality of dissolved organic carbon (DOC) that is hydrologically transported to streams. The impacts of droughts on dissolved organic

carbon (DOC) dynamics will be heterogeneous across landscapes, which contributes to uncertainty in predicting how a changing climate will affect the fate of C in these sensitive ecosystems. The objective of this project was to investigate the impact on DOC quantity and quality in soil and stream water in three headwater boreal catchments. We conducted a detailed examination of soil water and stream DOC export at the International Institute for Sustainable Development-Experimental Lakes Area site in northwestern Ontario, Canada. Long-term (1980 - 2020) stream discharge and DOC records were coupled with soil and soil leachate samples taken from 60 locations across the 320 ha boreal forested catchment. Analysis of the long-term records demonstrated that the monthly stream DOC concentrations could be predicted using the duration and severity of the drought, calculated using a standardized drought index. Much of this response is driven by the flush of DOC that occurs post-drought. During an intensive field campaign in 2021, we observed that soil water DOC quality (measured using absorbance and fluorescence indices) changes with flowpath. These changes in flowpath also predict post-drought stream DOC quantity and quality, when hydrological connectivity and landscape configuration are accounted for. As summer temperatures increase and droughts become longer and more intense, understanding hydrological transport of DOC is critical for predicting changes in stream dynamics.

Session: 3010 Biogeochemistry of boreal ecosystems La biogéochimie des écosystèmes boréaux **29/05/2025 11:45**

ID: 12235 Contributed abstract

DOC character and export dynamics from exposed bedrock in the Subarctic Taiga Shield

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Presented by / Présenté par: *Aram Jalali Bouraban*
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Climate change is rapidly transforming water and carbon cycles in Arctic and Subarctic regions, with potential shifts in precipitation patterns significantly affecting dissolved organic carbon (DOC) mobilization. This can be observed in flashy systems such as exposed bedrock units—the dominant landscape unit in the Taiga Shield ecoregion; however, the DOC response from bedrock units in this region, and how it might respond under future climate is poorly understood. At our study area located in the Baker Creek Research Watershed, Yellowknife, NWT, we explored how exposed bedrock produces distinct DOC characteristics in runoff. To achieve this, we selected three bedrock plots and collected data through a combination of high-frequency and discrete sampling from April to October 2024. Summer and autumn exported DOC is more recalcitrant and less microbially derived compared to that from the spring freshet. While maximum DOC concentrations were higher during rainfall events following dry periods than during snowmelt, the snowmelt period accounted for the largest DOC loads of the study period due to high runoff. This research highlights the critical influence of seasonality and landscape processes in shaping DOC dynamics, providing valuable insights into carbon

fluxes and enhancing water quality predictions for the Taiga Shield region.
Keywords: DOC characteristics, exposed bedrock, Taiga Shield, Subarctic region

Session: 5050 Weather, Climate, and Environmental Extremes Météo, climat et extrêmes environnementaux

Convenors:

Elizaveta Malinina, Environment and Climate Change Canada
Alex Cannon, Environment and Climate Change Canada
Alejandro Di Luca, Université du Québec à Montréal
Rachel White, University of British Columbia

Extreme events in weather, climate, and environmental systems pose significant risks to lives, ecosystems, and economies, often resulting in devastating losses and long-term impacts. Building a resilient future requires a comprehensive understanding of these events and their associated risks. This session invites contributions addressing all aspects of weather, climate, and environmental extremes, including interdisciplinary perspectives that explore connections between atmospheric, terrestrial, and marine systems and how these connections influence the occurrence and impact of events. We welcome submissions examining extremes across varying durations (from hours to months) and types, including but not limited to heatwaves, wildfires, extreme precipitation, wind-related events, hydrological extremes (e.g., floods and droughts), geomorphological extremes (e.g., landslides and avalanches), and oceanographic extremes (e.g., storm surges, coastal flooding, and marine heatwaves). Submissions may focus on historical changes, event attribution, future projections, or any other extremes related topic.

Session: 5050 Weather, Climate, and Environmental Extremes Météo, climat et extrêmes environnementaux **29/05/2025 13:30**

ID: 12392 Contributed abstract

Virtual

Canadian Rapid Extreme Weather Event Attribution system: a year of results

Elizaveta Malinina [1] , *Nathan Gillett* [2] , *Konstantinos Menelaou* [3] , *Megan Kirchmeier-Young* [4] , *Yongxiao Liang* [5] , *Karen Garcia Perdomo* [6] , *Robin Stevens* [7] , *Madalina Surcel* [8] , *Aaron Tamminga* [9]

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Presented by / Présenté par: *Elizaveta Malinina*
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To support Canada's National Adaptation Strategy, Environment and Climate Change Canada developed a pilot rapid extreme weather event attribution system, which allows us to assess how much human-caused climate change altered the probability of an extreme weather event shortly after it occurs. This system provides near-real-time analyses for temperature extremes in 17 regions covering the whole of Canada by comparing the current climate with pre-industrial conditions using a large multi-model ensemble of coupled simulations from the CMIP6 climate models. In this presentation, we outline the scientific methodology used in this system and the mechanics of running such analyses quasi-operationally. We also present the results from the first year of operations, including the analyses of the heatwaves from the summer of 2024 and the cold spells of winter 2024-2025. Finally, we will highlight the ongoing development of the system, including the future expansion to additional variables.

Session: 5050 Weather, Climate, and Environmental Extremes Météo, climat et extrêmes environnementaux **29/05/2025 13:45**

ID: 12435 Contributed abstract

Virtual

Development of an atmosphere model based rapid event attribution system for Canada

Nathan Gillett [1] , *Konstantinos Menelaou* [2] , *Megan Kirchmeier-Young* [3] , *Tsz-Kin Lai* [4] , *Yongxiao Liang* [5] , *Hai Lin* [6] , *Elizaveta Malinina* [7] , *Ryan Muncaster* [8] , *Robin Stevens* [9] , *Madalina Surcel* [10]

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Presented by / Présenté par: *Nathan Gillett*
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Quantification of the influence of human-induced climate change on the probability of observed extreme events can help inform climate change adaptation and public understanding of the effects of climate change. Simulating many of the extreme events which impact Canada, such as atmospheric rivers and post-tropical cylones, requires higher resolution than is typical of CMIP6 climate models. Environment and Climate

Change Canada is therefore developing a rapid event attribution system using ensembles of simulations from the Canadian Atmosphere Model (CanAM) and the Global Environmental Multiscale Model (GEM) at 100km and later 25km resolutions. Probabilities of observed extreme events will be compared between factual ensembles run with observed anthropogenic forcings, sea surface temperatures and sea ice, and counterfactual ensembles in which anthropogenic influence on forcings, sea surface temperatures and sea ice has been removed. This presentation will describe progress towards the development of such a system, and present initial results of the system for example events in Canada.

Session: 5050 Weather, Climate, and Environmental Extremes Météo, climat et extrêmes environnementaux **29/05/2025 14:15**

ID: 12258 Contributed abstract

Hydrometeorological Analysis of Flood Events in Quebec: The REX-PHY Project

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Presented by / Présenté par: *Romane Hamon*
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Floods are the primary natural disasters affecting Quebec. Since 1990, several major flooding events have occurred in 1996, 2011, 2017 and 2019. More recently, the Gouffre River overflow in May 2023 and the floods triggered by Tropical Storm Debby have underscored the growing challenges posed by flooding. Yet, there is no comprehensive database of flood events across Quebec. This project aims to fill this gap by creating a timeline of past floods and documenting the most significant ones.

Over the past decade, the Quebec government has sought to better understand flood-related risks. One tool in this effort is the “Experience Feedback” approach (“Retour d’experience” (REX) in French), which reviews the causes and consequences of extreme events. As part of disaster prevention, the Ministry of Public Security (MSP) funds the REX-PHY project, which documents the hydrometeorological conditions of damaging floods in Quebec over the past 30 years.

The project relies on MSP financial assistance data (1991-2020), as well as hydrological and meteorological databases from the MELCCFP. The cross-referencing of these two data sources allows for the precise dating of most identified flood events. Additionally, the analysis of all MELCCFP data enables the generation of hydrometeorological profiles of the floods. This work has already identified over 2,100 flood events at the

municipal level and will lead to the creation of around sixty reports outlining the hydrometeorological conditions causes of the most damaging floods across the southern regions of the province.

Ultimately, it will contribute to a better understanding of flood-related risks, both at a global and regional scale. For the most affected regions, analyzing multiple events will enhance the understanding of local flood dynamics. Meanwhile, characterizing all events since 1991 will provide a comprehensive overview of floods in the Quebec context.

Session: 5050 Weather, Climate, and Environmental Extremes Météo, climat et extrêmes environnementaux **29/05/2025 14:30**

ID: 12541 Contributed abstract

Virtual

Projecting Wind Extremes and Tornado Activity for Southern Canada through Convection-Permitting WRF Simulations

Xiao Ma [1] , *Yanping Li* [2] , *Fei Huo* [3] , *Zhenhua Li* [4]

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Presented by / Présenté par: *Xiao Ma*
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Near-surface extreme wind events, including strong winds and tornadoes, are significant meteorological phenomena with substantial destructive impacts. In the context of global climate change, the frequency and intensity of these extreme events have notably varied, drawing particular attention. This study employed a 4-km convection-permitting Weather Research Forecasting (WRF) model to simulate the current climate (2000-2013) and future climate (2100-2113) over Southern Canada. The high-resolution model better represents the orography and underlying surface that significantly affect boundary layer winds and convective systems. Our analysis elucidates the spatial distribution and annual variations of extreme winds. The results indicate that the frequency and intensity of future extreme winds over the Great Lakes region and central prairies will increase in the summer, while prairie regions may experience a significant decrease in wind extremes during the cold season. Furthermore, we also evaluate the tornado activity across Southern Canada, employing various tornado indices and diagnostic methods to quantify future tornado trends in warm seasons. This study offers the convection-permitting regional climate model projections in comprehensive extreme wind phenomena across Southern Canada, providing scientific evidence for disaster risk management in the context of climate change.

Session: 5050 Weather, Climate, and Environmental Extremes Météo, climat et extrêmes environnementaux **29/05/2025 14:45**

ID: 12230 Contributed abstract

Virtual

"The Billion-Dollar Question: A Comparative Analysis of Calgary's Costliest Hailstorms"

Caroline Floyd [1] , *Laura Twidle* [2]

1

2

Presented by / Présenté par: *Caroline Floyd*

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Calgary is no stranger to massively damaging hailstorms, but the storm of August 5, 2024, stands head and shoulders above its predecessors. Between 2013 and 2023, the city was impacted by more than a dozen hailstorm insurance catastrophes – that is, events which generated at least CAD 30 million in insured damage. All told, insured damage from these events cost more than CAD 3 billion, with the lion's share of that chalked up by the June hailstorm of 2020. The previous 'most damaging hailstorm' on record for Canada, the June 2020 storm carried an insurance price tag of CAD 1.1 billion. Affecting a similar part of the city, the August 5, 2024, hailstorm carries a cost of more than CAD 3 billion, all on its own, making it not only the most damaging hailstorm on record, but also the second-costliest event in Canadian history. This presentation examines the similarities and differences between this most recent Calgary hail catastrophe and those that came before it, including the major event of 2020. Explored are trends in insurance exposure, the size of average claims, and the relationship of hail size to damage.

Session: 9021 Applications of AI and machine learning to the atmosphere/ocean/climate system - Part 2 Applications de l'IA et de l'apprentissage automatique au système atmosphère/océan/climat - Partie 2

Convenors:

Dr. Joe Fitzgerald, Dept. of Physics and Physical Oceanography, Memorial University of Newfoundland
Dr. Alex Bihlo, Dept. of Mathematics and Statistics, Memorial University of Newfoundland
Dr. Terrence Tricco, Dept. of Computer Science, Memorial University of Newfoundland

Global scientific interest in artificial intelligence (AI) and machine learning (ML) is exploding. The developments of the past 5-10 years in AI/ML applications to geophysical fluid dynamics and climate have shown that AI/ML has great potential to significantly advance our ability to model, predict, and understand our climate. This session aims to bring together researchers from all sub-domains of atmosphere/ocean/climate science to share what we have learned and are learning about this revolutionary new technology. We invite presentations on all topics related to AI/ML and climate, including but not limited to: 1) AI/ML approaches to the general problem of parameterization, including parameterizations of geophysical turbulence, 2) Practical and theoretical applications of AI/ML to prediction problems, such as weather forecasting, climate projection, ensemble forecasting, and the prediction of extreme and rare events, 3) AI/ML methods for regional prediction, including ML-facilitated downscaling, 4) AI/ML applications in remote sensing, and 5) AI/ML techniques analyzing atmosphere/ocean/climate data. New AI/ML tools are constantly being developed. We welcome presentations relating to all classes of AI/ML tools, including feed-forward/convolutional neural networks, transformers, physics-informed neural networks, neural operators, and many others.

Session: 9021 Applications of AI and machine learning to the atmosphere/ocean/climate system - Part 2 Applications de l'IA et de l'apprentissage automatique au système atmosphère/océan/climat - Partie 2 **29/05/2025 13:30**

ID: 12474 Contributed abstract

High-Resolution Climate Projections for Western Canada Using WRF and a Pseudo-Global Warming Approach

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Presented by / Présenté par: *Yanping Li*
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Climate change threatens Western Canada’s ecosystems and socio-economic stability. This study employs the Weather Research and Forecasting (WRF) model at a convection-permitting 4 km resolution to downscale CMIP5 ensemble projections under the RCP8.5 scenario for late-century (2071–2100). A retrospective (2000–2015) and a pseudo-global warming (PGW) simulation assess future hydroclimatic risks. Results indicate seasonal shifts in precipitation, with increases in spring and autumn but negligible or decreased summer rainfall in key agricultural regions. Increased evapotranspiration may exacerbate water shortages. The PGW simulation also shows more high-intensity precipitation events, heightening flood risks. These high-resolution projections offer valuable insights for hydrology, agriculture, and ecosystem management.

Session: 9021 Applications of AI and machine learning to the atmosphere/ocean/climate system - Part 2 Applications de l'IA et de l'apprentissage automatique au système atmosphère/océan/climat - Partie 2 **29/05/2025 13:45**

ID: 12536 Contributed abstract

Clausius-Clapeyron Informed Deep Learning for Downscaling Precipitation

Pierre-Louis Lemaire [1] , *Julie Carreau* [2] , *Youssef Diouane* [3]

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Presented by / Présenté par: *Julie Carreau*
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Deep learning techniques have become promising cost-effective tools for climate downscaling, taking advantage of existing Regional Climate Models (RCMs) simulations and reanalysis data, and outperforming standard statistical downscaling methods. Nevertheless, neural networks suffer from well-known flaws, which greatly affect the potential end-usage of the downscaled simulations in climate impact research. First, due to shortcut learning and overfitting, deep learning models can learn physically incoherent features that won't hold outside of their training distribution, for instance in a climate under severe climate change. Another flaw is their failure to accurately predict extremes because of their low-frequency bias. One family of methods to overcome these challenges when working on physical phenomena such as climate science or astrophysics, is to encode physical priors into the model, in the form of physics-inspired architectures or constrained objective functions. A common assumption in atmospheric science is that extreme precipitation scales with air surface temperature at the same rate as water vapor saturation, following the Clausius-Clapeyron equation which states that the water vapor saturation increases by approximately 7%/K. However, downscaled simulations from deep learning RCM emulators show lower-than-expected temperature-precipitation scaling rates (TSPR). To address this, we propose a method to efficiently constrain neural networks using this physical a priori, enhancing their generalization to non-stationary climates and improving extreme value predictions. We implement a robust TSPR estimation technique tailored for mini-batch optimization, and leverage neural operators and surrogate gradient directions to overcome the constraint's non-differentiability. Preliminary results are promising and demonstrate the potential of incorporating domain-knowledge into deep learning models. We use climate simulations from the CRCM5 Large Ensemble (ClimEx) over Southern-Quebec to train our model and evaluate our approach.

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ID: 12567 Contributed abstract

Bridging Prediction and Mechanistic Understanding in Hydrology: A Physically-Informed Deep Learning Approach to Characterize Catchment Hydrologic Function

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Presented by / Présenté par: *Majid Bayati*
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Recent advances in the availability of hydrometeorological data have encouraged the use of data-driven modeling frameworks, yet most deep learning approaches still prioritize predictive accuracy rather than advancing process-based hydrological understanding. In this study, we introduce a physically-informed deep learning framework explicitly designed to uncover interpretable functional relationships that describe how catchments convert precipitation into streamflow without making a priori assumptions. Instead of relying on pre-specified equations, our model dynamically learns interpretable rainfall-runoff and storage-discharge relationships. These nonlinear and time-variant relationships directly show impulse response functions (or unit hydrographs) and indirectly show storage–discharge dynamics, providing a physically meaningful interpretation of how water input is filtered into streamflow by catchments. Applied to more than 1,000 catchments across North America, our framework identifies coherent spatial patterns of hydrologic behavior, classifies dominant functional regimes, and elucidates climate and physiographic controls on storage and release processes. Our findings highlight the potential of physically-guided, interpretable data-driven modeling to bridge the gap between hydrologic prediction and mechanistic understanding in large-sample hydrology.

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ID: 12568 Contributed abstract

Depressional Wetland Inundation Regulates Annual Runoff Dynamics in Prairie Pothole Catchments

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Presented by / Présenté par: *Javad Rahmani*
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Understanding interannual variability in the water cycle is essential for managing water resources, assessing ecosystem health, and evaluating flood and drought risks. While this variability is typically attributed to climatic drivers—such as precipitation, temperature, and radiation—and often analyzed using the Budyko framework, wetland-dominated landscapes like the Prairie Pothole Region (PPR) present unique hydrologic challenges. The dense presence of depressional wetlands in the PPR introduces dynamic inundation patterns that may strongly influence catchment-scale runoff

generation, yet their role on interannual variability in the water cycle remains underexplored.
In this study, we integrate 38 years of streamflow data, climate variables, and satellite-derived inundation and snow presence observations to investigate the controls on interannual variability of the runoff ratio (ROR) across 109 catchments in the PPR. Results reveal that 76 catchments are primarily dominated by wetland inundation dynamics, 13 by aridity, 5 by both, and 15 by neither. We also find that climatic factors such as snow persistence and antecedent-year aridity play secondary, indirect roles by modulating wetland inundation extent. Notably, years with high snow persistence and low prior-year aridity appear to be associated with elevated flood risk in the region. Further analysis shows that catchments with large extent of inundation (inundation-dominated catchments) often exhibit a power-law—most commonly exponential—relationship between inundation extent and ROR. This indicates that, after a threshold of inundation, even small increases in wetland inundation can lead to disproportionately large increases in annual runoff. These findings underscore the nonlinear buffering role of wetlands in hydrologic regulation and suggest that wetland drainage could shift catchment behavior toward a more linear, flood-prone response. Together, our results highlight the critical role of wetland inundation in shaping the annual water balance in the PPR and call for its explicit consideration in hydrologic modeling and water management strategies.

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ID: 12398 Contributed abstract

HySIMUv2.0: A Hyperspectral Remote Sensing Toolkit for Geoscience Applications

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Presented by / Présenté par: *Fadhli Atarita*
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Hyperspectral remote sensing (HRS) has diverse applications in geoscience, including precision agriculture, soil science, mineral exploration, and carbon monitoring, to name a few. However, the success of HRS imaging depends on optimizing survey geometries to account for sun illumination and minimize atmospheric and geometric effects, while maintaining the required spatial and spectral resolutions. Additionally, the growing variety of public and commercial hyperspectral platforms and sensors adds complexity to mission planning. To address this challenge, we developed HySIMUv2.0 (Hyperspectral SIMUlator version 2.0), a forward modelling toolkit that offers a cost-effective approach to evaluating the performance of a planned HRS survey. The toolkit is designed to simulate hyperspectral imagery based on user-defined parameters with several key features: a ground truth data cube builder for customizable input parameters, filters for spatial mixing, a terrain-based solar geometry calculator for illumination modelling, and

an integrated radiative transfer models (6S and libRadtran) for atmospheric effects. HySIMUv2.0 is scale-independent and supports parallelization on High-Performance Computing (HPC) clusters, making it well-suited for the extensive computational demands of hyperspectral datasets. In this study, we demonstrate HySIMUv2.0's capabilities through several case studies in geoscience, evaluating the impacts of different survey configurations including satellite, aircraft, and drone missions. As remote sensing technologies continue to advance, forward modelling toolkits such as HySIMUv2.0 play a crucial role in refining mission designs and assessing survey feasibility. The scalability for arbitrary hyperspectral sensors, platforms, and spectral libraries ensures broad applicability and allows for optimizing survey planning and mitigating risks of HRS campaigns pre-flight.

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ID: 12498 Contributed abstract

Assessing Image-to-Image Passive Microwave Satellite Retrievals over Polar Surfaces using Artificial Neural Network Architectures

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Presented by / Présenté par: *Colleen Henschel*
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Artificial Neural Networks (ANNs) have proven effective in capturing complex non-linear relationships within large datasets, making them a valuable tool for analyzing high-dimensional and non-linear satellite data. This study investigates the application of image-to-image ANN retrievals for passive microwave satellite measurements, evaluating whether they provide comparable or superior performance to single-pixel retrievals. The polar regions serve as a case study due to their critical role in the global climate system and the challenges they present for remote sensing, including highly variable surface emissivities and atmospheric conditions. Image-to-image retrievals incorporate spatial context, which may improve consistency over heterogeneous surfaces such as snow and sea ice and may prove more effective than single-pixel retrievals.

Image retrievals of various geophysical parameters are performed for observations from the Advanced Technology Microwave Sounder (ATMS) using the following ANN architectures: UNet, Swin Transformers, and Swin Transformers with skip connections. Performance is evaluated against single-pixel ANN retrievals and validated using ground-based observations from the Baseline Surface Radiation Network (BSRN), the NOAA Global Monitoring Laboratory (GML), and the Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC) expedition. Additionally, single-pixel ANN retrievals are compared to those obtained using physics-based Optimal Estimation (OE) retrievals, which remains constrained to one-dimensional retrievals due

to computational demands. While ANN-based retrievals offer significant efficiency gains, potential trade-offs in accuracy and robustness are examined.

By exploring the strengths and limitations of image-to-image ANNs, this talk will provide insight into their potential for large-scale operational retrievals in passive microwave remote sensing.

Session: 8033 General Hydrology - Part 4 Hydrologie générale - Partie 4

Convenors:

Dr. Barret Kurylyk, Dalhousie University
Dr. Lauren Somers, Dalhousie University

The general hydrology session invites a broad range of research contributions, including, but not limited to, field-, laboratory-, and/or modelling-based studies of the water cycle. Studies carried out at different spatial scales and situated in both pristine and disturbed landscapes are welcome.

Session: 8033 General Hydrology - Part 4 Hydrologie générale - Partie 4 **29/05/2025 13:30**

ID: 12233 Contributed abstract

Virtual

Hydrologic Modelling for Regional, Fine-scale Projections of Future Fresh Water Hazards

Arelia Schoeneberg [1] , *Samah Larabi* [2] , *Jingwen Wu* [3] , *Markus Schnorbus* [4]

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Presented by / Présenté par: *Arelia Schoeneberg*
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In the freshwater environment, warm temperatures, increased high-flow magnitudes and extended low-flow periods can pose a threat to the survival of Pacific Salmon, and future climate change is expected to increase exposure to these hazards. To support sustainable management and conservation efforts, fisheries experts need improved information on projected hazards across a diversity of freshwater habitats and a variety of species. Climate, hydrologic, and water temperature models can be used to make such quantitative projections. In recent years, the approach to modelling streamflow and water temperature has evolved and a range of approaches and tools are available. This study assesses three approaches to streamflow and water temperature modelling: (1) the Raven hydrologic modelling platform combined with the Air2Stream water temperature model, (2) VICGL hydrologic model and the DynWat streamflow and water

temperature model, and (3) VICGL hydrologic model combined with Raven for streamflow and thermal modelling. Results are compared in three watersheds located in British Columbia, Canada, the Stuart, Chilko and Quesnel watersheds, for five flow and thermal hazard indicators: (1) monthly flow, (2) annual frequency of high flow days, (3) annual frequency of summer low flow days, (4) mean monthly water temperature and (5) annual frequency of days with water temperature in excess of 19°C. Each are driven with the same 6 GCMs run under RCP 4.5 and 8.5 from the fifth Coupled Modelling Inter-comparison Project (CMIP5). Uncertainty in future low-flows, high-flows and water temperatures due to the differing hydrologic / water temperature model structures will be quantified and contrasted to those caused by GCMs and emissions scenarios.

Session: 8033 General Hydrology - Part 4 Hydrologie générale - Partie 4 **29/05/2025 13:45**

ID: 12360 Contributed abstract

Fully integrated groundwater-surface water modelling in Southern Alberta

Stephanie Bringeland [1] , *Steven K. Frey* [2] , *Georgia Fotopoulos* [3] , *John Crowley* [4] , *Bruce Xu* [5] , *Omar Khader* [6] , *Hyung Eum* [7] , *Babak Farjad* [8] , *Andre Erler* [9] , *Anil Gupta* [10]

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Presented by / Présenté par: *Stephanie Bringeland*
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In this study, a fully integrated groundwater (GW) – surface water (SW) model of the South Saskatchewan River Basin (SSRB) in Southern Alberta is compared with two decades of satellite gravity data from the Gravity Recovery and Climate Experiment (GRACE) and its follow-on mission (GRACE-FO). The HydroGeoSphere (HGS) model is calibrated with hydrologic conditions at locations associated with GW wells and SW flow gauges and the GRACE/GRACE-FO observations provide transient terrestrial water storage anomaly information within the SSRB. Results indicate that the HGS model produces similar interannual trends to those observed by GRACE/GRACE-FO, however the amplitudes of the seasonal signal differ between HGS and GRACE/GRACE-FO by approximately +/- 2.3 cm equivalent water height. A detailed investigation into the differences is conducted using HGS-derived water storage fluctuations in surface water,

soil moisture, and groundwater flow systems, and by evaluating interannual snowpack variability. The results show a moderate negative correlation between ENSO cyclicity and water storage levels in the SSRB. HGS modelling allows for an analysis of the GRACE results compartmentalized into surface water, soil moisture, and groundwater components. Overall, this approach demonstrates the utility of fully integrated groundwater-surface water modelling in complex regions such as the SSRB.

Session: 8033 General Hydrology - Part 4 Hydrologie générale - Partie 4 **29/05/2025 14:00**

ID: 12556 Contributed abstract

St Mary and Milk Rivers Study – Modelling Results and Initial Findings

Bruce Davison [1] , *Beau Hawkings* [2] , *Sandrina Rodrigues* [3] , *Alain Pietroniro* [4]

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Presented by / Présenté par: *Bruce Davison*
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The International Joint Commission's (IJC) International St. Mary and Milk Rivers Study, launched in November 2021, is exploring options to improve access to apportioned waters by each country, in recognition of climate change and challenges to apportionment since the original 1921 Order was issued. The effort includes a desire to achieve long-term resilience in accessing the shared waters of the St. Mary and Milk Rivers.
The modelling effort within the Study involves running hydrologic models, water management models, and developing performance indicators to examine how potential changes to water management in the basin would impact what people consider to be important. This presentation will describe the progress that has been made in the study and the initial findings.

Session: 3060 Potential of Canadian peatlands as nature-based climate solutions Le potentiel des tourbières canadiennes en tant que solutions climatiques basées sur la nature

Convenors:

Maria Strack, University of Waterloo
Kelly Bona, ECCC
Megan Schmidt, University of Waterloo
Melanie Bird, University of Waterloo

Canada contains over one quarter of the world's peatland area. These ecosystems represent dense soil carbon stocks such that peatland disturbance results in greenhouse gas emissions, largely as carbon dioxide. Therefore, protection of peatland carbon stocks, through conservation, better land-use practices and ecological restoration, has been identified as an opportunity for greenhouse gas emissions reductions. To evaluate the potential emission reductions arising from peatland management in Canada, evidence-based information is needed on the state of Canadian peatlands alongside quantification of their carbon stock and greenhouse gas exchange under various land-uses and future climates. Opportunities for future peatland management scenarios also rely on policy decisions related to wetland management. In this session we invite studies using a range of methods to investigate peatland area, disturbance status, carbon stocks, and greenhouse gas exchange. Studies making direct field measurements, modelling past and future conditions, compiling datasets to advance mapping and modelling efforts, and/or exploring policy and decision-making around peatland management are all welcome.

Session: 3060 Potential of Canadian peatlands as nature-based climate solutions Le potentiel des tourbières canadiennes en tant que solutions climatiques basées sur la nature **29/05/2025 13:30**

ID: 12288 Contributed abstract

Temporal Coherence of Peatlands in the Northern Hemisphere: Insights for InSAR-Based Studies

Nicholas Pontone [1] , *Koreen Millard* [2]

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Presented by / Présenté par: *Nicholas Pontone*
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Interferometric Synthetic Aperture Radar (InSAR) is a remote sensing technique that analyzes phase differences in radar signals between satellite passes. While traditionally used to measure ground deformation, recent studies suggest that InSAR time series can also assess peatland health, degradation, and restoration status due to their sensitivity to ecohydrological dynamics. Wide-area monitoring of peatland status has the potential to support peatland-related policies, greenhouse gas estimates, and large-scale biogeochemical models. However, for InSAR results to be accurate, the phase of each pixel must be correlated between satellite passes (coherence). While many peatlands exhibit low coherence due to temporal variations in vegetation, soil moisture, and seasonal oscillations of the peatland surface, some peatlands meet the coherence threshold necessary for InSAR. Despite this, little research has been conducted to understand the factors influencing peatland coherence.

In this study, we analyzed a global dataset of Sentinel-1 seasonal interferometric coherence alongside peatland maps from Canada, Europe, Russia, Scandinavia, the United Kingdom, and Ireland to investigate coherence patterns across a variety of landscapes. To determine the controls on coherence, we examined relationships between coherence and peatland type, vegetation height, and bioclimatic variables. The results showed that ombrotrophic peatlands were more coherent than their minerotrophic counterparts. Additionally, coherence decreased as vegetation height increased. Several bioclimatic variables were correlated with coherence, which indicated

that peatlands in more temperate climates exhibited higher phase stability. This research demonstrates that if InSAR is to be widely used for peatland health and condition assessment, geographic and site-specific factors must be considered. In regions where peatlands lack sufficient coherence, extracting meaningful ecohydrological parameters from InSAR data is challenging. Understanding the conditions that promote coherence is necessary to optimizing InSAR-based peatland monitoring and improve its integration into existing greenhouse gas and biogeochemical frameworks.

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29/05/2025 13:45

ID: 12497 Contributed abstract

Missing the wetland for the trees: Quantification of soil carbon fluxes in temperate swamps to advance process-based understanding

Megan Schmidt [1] , *Maria Strack* [2]

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Presented by / Présenté par: *Megan Schmidt*
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Swamps are forested wetlands that account for a large portion of the wetland area of Canada and up to 87% of total wetland spatial extent in southern Ontario. Trees in swamps store large amounts of carbon and swamps have the potential to store significant amounts of carbon in soils that range from mineral to meters-deep peat. Despite their prevalence and potential as natural climate solutions, swamps are under-represented in carbon accounting and modeling due to difficult access and unclear classification relative to other wetland types. Currently, most data on swamps comes from subtropical and tropical sites rather than the temperate and boreal regions found in Canada. Four swamps in southern Ontario, Canada were selected to quantify and compare the net exchange of carbon dioxide (CO2) and methane (CH4) between soil and the atmosphere. We considered differences among sites due to the physical and biological characteristics of hydrogeomorphic settings and canopy types that drive carbon cycling and the resulting fluxes. Soil respiration of CO2 over the growing season was three times that of the non-growing season. Wet soil conditions during the growing season resulted in similar net CO2 efflux across the sites regardless of hydrogeomorphic setting (position in landscape) or canopy composition. Water table and soil temperature had a significant impact on net CO2 exchange, with fluxes generally decreasing as moisture increased and increasing with rising temperature. Methane emissions during the growing season were twice that of the non-growing season and varied significantly between sites in both; one riverine site acted as a small sink over the growing season. Fluxes were highest from basin sites and increased with increasing proportion of deciduous trees. Generally, CH4 emission increased with higher water tables, warmer soils, and longer periods of inundation. Better understanding of these processes can help improve carbon modelling and climate change predictions.

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ID: 12221 Contributed abstract

CO_2 and CH_4 dynamics in Sphagnum peatlands recovering from industrial atmospheric pollution

Megan Montgomery [1] , *Colin McCarter* [2]

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Presented by / Présenté par: *Megan Montgomery*
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Peatlands are globally significant atmospheric sinks of carbon that are under pressure from current and historical land use changes, as well as climate change. However, many peatlands globally are contaminated with toxic trace metals, potentially disrupting the processes that support peatlands net cooling effect on the global climate. The peatlands surrounding Sudbury ON have been impacted by historical atmospheric deposition of trace metals (chiefly nickel and copper). In the decades since emissions reductions have occurred, the peatlands are slowly recovering along a vegetation recovery gradient, characterized by Sphagnum spp. dominance, in relation to historical nickel and copper deposition intensity patterns. However, it is unknown if such contaminated and recovering peatlands are net atmospheric carbon sinks, or significant methane emitters. We used a non-steady state chamber paired with an infrared gas analyser to quantify net CO_2 and CH_4 exchange from three peatlands with increasing degrees of Sphagnum moss recovery. Preliminary results suggest that all peatlands regardless of recovery status are net atmospheric CO_2 sinks with the least recovered (most contaminated) having the highest mean net ecosystem exchange (NEE) (-16 ± 15 $CO_2/m^2/d$) and the most recovered (least contaminated) the lowest mean NEE (-7 ± 14 $CO_2/m^2/d$). Higher ecosystem respiration (ER) at the least recovered peatland (14 ± 10 $CO_2/m^2/d$) was offset by higher gross ecosystem productivity (GEP) (-31 ± 20 $CO_2/m^2/d$), while ER (11 ± 10 $CO_2/m^2/d$) and GEP (-18 ± 18 $CO_2/m^2/d$) was lowest at the most recovered peatland. However, at both the lowest (443 ± 1290 mg $CH_4/m^2/d$) and middle (315 ± 892 mg $CH_4/m^2/d$) recovery status peatlands the mean CH_4 fluxes offset the CO_2 uptake, resulting in these peatlands being net climate warming ecosystems.

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ID: 12428 Contributed abstract

Restoring GHG Function to Horticulturally Extracted Peatlands: How Much Can Be Achieved and When?

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Ecological restoration is necessary to re-establish the normal carbon (C) sequestration and storage functions of peatlands degraded by industrial disturbance. However, the resulting quantity and timing of typical greenhouse gas exchange (GHG) function returned to disturbed areas remains ambiguous. This is due to variability in restoration strategies and site-specific conditions from case studies in the literature. It is therefore necessary to reduce this uncertainty, and provide easy-to-implement, scaleable techniques to estimate when C sink function is returned and estimate total GHG emissions from a site during its recovery lifecycle. The results will be valuable to restoration planners, policy makers, and climate scenario modellers wanting to account for restored peatlands as potential nature-based climate solutions.

To address these objectives, we compiled historical chamber based GHG fluxes from published and unpublished datasets from restoration trials across Canada. Beginning with formerly extracted peatlands, we investigated the effectiveness of different restoration strategies, compared them to fluxes from unrestored and natural peatlands, and examined the environmental drivers controlling GHG response. We will discuss how vegetation development stage and microform variability (e.g., former extraction fields, closed ditches, and unintended pools) influenced GHG response and propose a scalable, indirect tool for estimating when C sink function has returned based on water table position and vegetation cover. We will also highlight our plan to validate the returned C sink predictor and calculate estimated total site GHG emissions at a new case study during the 2025 field season as an example for industry.

Session: 3060 Potential of Canadian peatlands as nature-based climate solutions Le potentiel des tourbières canadiennes en tant que solutions climatiques basées sur la nature **29/05/2025 14:30**

ID: 12257 Contributed abstract

Peatland Net Ecosystem CO2 and Methane Exchange Following the Acrotelm Harvesting Method

Ian Strachan [1] , *Maria Strack* [2] , *Katherine Bot* [3] , *Declan Roche* [4]

1 Queen's University
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Presented by / Présenté par: *Ian Strachan*
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Currently, horticultural peat harvesting requires vegetation to be removed and the peatland partially drained. The acrotelm harvesting method (ACM) has been developed to permit sphagnum harvesting without requiring such alterations to the ecosystem. A strip of surface vegetation is cut, lifted and replaced after a layer of sphagnum is removed. How the ecosystem will respond to the disturbance and whether the system remains a net sink for carbon (C) following harvesting is unknown and thus the goal of our research is to evaluate the impact of the ACM on net ecosystem C function. The net ecosystem exchange (NEE) of CO2 and CH4 flux were measured May-October, 2024 using eddy covariance (EC) at an undisturbed area (UNH) and an area that had been harvested using ACM three years previously (H21). At the plant community scale, in each of UNH and H21, triplicate collars were installed at each of hummock, hollow and lawn positions. Chamber-based CO2 and CH4 exchange were repeatedly measured throughout the period using a portable infrared gas analyzer. From EC measurements, daytime Bowen ratio was lower at H21 indicating higher rates of evapotranspiration consistent with the surface now being closer to the water table. A net uptake of CO2 at H21 (albeit smaller than at UNH) was observed. Methane flux was higher at H21 than UNH consistent with the wetter conditions. Similar patterns were seen with the chamber data, however, hollows at H21 were consistent sources of CO2. A chronosequence of chamber data across 2022-24 for H21 showed that hollows remained sources after harvest, lawns were sinks and hummocks transitioned from sources to sinks through the period. All communities were net sinks at UNH over the three-year period. A significant reduction in greenhouse gas emissions over the current practices may be achievable, mitigating climate change.

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ID: 12411 Contributed abstract

Plant community and biomass accumulation as indicators of carbon accumulation rate in restored Canadian peatlands

Maria Strack [1] , *Line Rochefort* [2] , *Mélina Guêné-Nanchen* [3] , *Marissa Davies* [4]

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Presented by / Présenté par: *Maria Strack*
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Peatland restoration leads to large reductions in ecosystem greenhouse gas (GHG) emissions and has been highlighted as an important nature-based climate solution. However, since measurement of GHG and ecosystem carbon balance outcomes can be time consuming and/or require expensive equipment and specialized expertise, quantification of actual climate benefits arising from restoration remains challenging. While plant cover, community composition and hydrological conditions have been used to estimate GHG emissions in wetlands and peatlands, these methods lack site-specific validation of GHG outcomes. In peatlands, measurement of biomass and litter

accumulation post-restoration provides a direct measurement of recent rates of peat accumulation but is still not a direct measure of ecosystem carbon balance as continued carbon emission arising from organic matter decomposition in the remnant peat layer is not included. Here we use over 1300 measurements of plant community composition, biomass and new peat accumulation across 135 restoration trials spanning 3-30 years post-restoration, alongside measurements of remnant peat respiration, to assess the potential of easy to measure indicators (e.g., plant community type, moss layer thickness) to estimate post-restoration carbon accumulation function. Plant communities with moss dominance had higher rates of new peat layer and biomass accumulation than those with minimal moss cover, yet variation within each plant community type was high. Mass of litter/new peat accumulated was only weakly correlated to the thickness of this layer due to large differences in density. Changes in new peat mass over time at sites 15-20 years post-restoration had consistent trends with chamber-based measurement of net CO_2 exchange, suggesting this could be a robust indicator of carbon accumulation function. Our results illustrate that while simple indicators, such as broad plant community classes, provide some information about carbon storage function, estimates will remain uncertain if not combined with more direct measures of changes in soil carbon stock.

Poster Session

Day 2 - 27 May 2025

Special Note

There were about 69 poster abstracts submitted, all included below.

22 poster images were uploaded in pdf or jpg format.

Links to high resolution copies of the uploaded posters are seen in blue from the Poster Order line in the abstract.

When viewing some poster images, please reduce the view to match your device screen. High resolution has been maintained.

Session: 14010 POSTER SESSION AFFICHES

27/05/2025 15:30

ID: 12355 Contributed abstract

Poster Order: 10020P01

Surface Water CO2 in Hudson Bay and James Bay

Nicholas Decker [1] , *Tim Papakyriakou* [2] , *Dave Capelle* [3] , *Zou Zou Kuzyk* [4] , *C.J. Mundy* [5] , *Kristina Brown* [6]

1

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Presented by / Présenté par: *Nicholas Decker*
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Anthropogenic carbon dioxide (CO2) emissions have led to a global increase in atmospheric CO2 concentrations since the pre-industrial era, with the concentration of CO2 in the surface ocean increasing in response. Physical, biological, and biogeochemical processes lead to regionally variable surface water CO2 exchanges with the atmosphere. Field observations provide the opportunity to integrate knowledge on factors that underpin this variability into models, ultimately leading to improved regional and global CO2 flux estimates. The distinctly cold temperatures and relatively fresh waters of the Arctic Ocean, including Southern Hudson Bay and James Bay (SHB-JB), contribute to additional oceanic CO2 uptake capacity relative to other regions, influencing their potential to be globally important atmospheric CO2 sinks. Despite this, SHB-JB remain understudied with respect to the carbonate system.
To address this gap, we measured SHB-JB surface water CO2 partial pressure (pCO2), salinity, and temperature for three-week periods in August 2021-2023. Surface water pCO2 varied within and between years. Mean pCO2 across the three seasons (457, 453, 477 µatm) were marginally

above atmospheric CO2 concentrations (~416 µatm) in each year sampled. The mean calculated CO2 flux from the ocean to the atmosphere were 2.75 ±3.78, 1.48 ±3.33, and 3.67 ±3.74 mmol CO2 m-2 day-1 for 2021-2023, respectively. The surface water of SHB-JB acted as a weak source of CO2 to the atmosphere during the late summer, contrary to what has been observed in Hudson Bay. Throughout the Hudson Bay Complex, temperature described the major variability in pCO2, however, the region's surface water pCO2 distribution is complex and dominated by independent events. Physical processes such as upwelling and tidal mixing contribute to areas of heightened surface water pCO2, while biological processes achieve the opposite. This work highlights the need for small scale carbonate system measurements in coastal environments due to their high degrees of variability.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12358 Contributed abstract

Poster Order: 10020P02

Low Oxygen Utilization Rate below the mixed layer using BGC-Argo float data in Northeast Pacific Ocean

Simin Kheradmand [1] , *Roberta Hamme* [2]

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Presented by / Présenté par: *Simin Kheradmand*

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The ocean plays a key role in the global carbon cycle by absorbing atmospheric CO_2 through the biological carbon pump. This process moves carbon from the surface to deeper waters, where it is isolated from the atmosphere, until ocean circulation eventually brings it back to the surface. Oxygen consumption in the water column due to the respiration of sinking organic matter serves as an indicator of organic carbon export, as oxygen is depleted when this material breaks down. To study carbon export, we

estimated summertime respiration rates (Oxygen Utilization Rate or OUR) in the Northeast Pacific Ocean using high-resolution oxygen data from BGC-Argo floats (2004–2022). At each isopycnal, we calculated OUR by fitting a trendline to the O2 concentration change during the summer. Then, by identifying the average depth of each isopycnal, we integrated OUR over depth for each year. We limit our estimate of OUR to an interval of 20 meters below the mixed layer to 200 m in order to minimize the impact of surface gas exchange and photosynthesis from above and quantify OUR values indistinguishable from noise at greater depths. We plan to compare OUR near the coast and farther offshore to determine if there are differences between the two regions. Future work will compare OUR-based carbon export estimates from this study with satellite-derived data used to estimate primary production using an empirical export fraction ratio. Since satellites do not directly measure export production and often miss deep primary production and dissolved organic carbon export, our findings will improve estimates of biological carbon sequestration and enhance the accuracy of global carbon cycle estimates.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12464 Contributed abstract

Poster Order: 10020P03

Ocean Optics: Development of Glider-Based Productivity Analysis in BC Waters Using Backscatter

Emily Koopmans [1] , *Roberta Hamme* [2]

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Presented by / Présenté par: *Emily Koopmans*

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The ocean plays a crucial role in regulating atmospheric carbon dioxide, yet quantifying the processes that govern its carbon storage remains a challenge. The biological pump, which converts dissolved carbon dioxide

into organic particles through biological processes, is a key component of this cycle. Some of these particles remain suspended in the upper ocean, while others sink, either individually or as larger aggregates, contributing to long-term carbon sequestration in the subsurface ocean. Understanding the distribution of these particles is essential, but representative measurements are difficult to obtain since particle concentration and size fluctuates with biological activity, ocean currents, and seasonal changes. Optical backscatter provides a valuable tool to address this challenge. We developed a method to process backscatter sensor data from autonomous ocean gliders, adapting a technique originally designed for Argo floats. Our approach partitions raw backscatter data into three components: scattering from large aggregates, smaller particles, and instrument noise. We applied a two-filter method to isolate scattering from small particles and estimated instrument noise using the deepest backscatter measurements collected. The remaining signal corresponded to large aggregates. Using data collected in offshore British Columbia waters by a Canadian-Pacific Robotic Ocean Observing Facility (C-PROOF) glider deployment, we mapped particulate concentrations alongside chlorophyll measurements. The patterns in the filtered backscatter mirror those in the chlorophyll data, suggesting its success as a measurement of productivity. We also observed areas of high productivity that lacked large aggregates and were dominated by smaller particles. The opposite was also visible, a high chlorophyll region dominated by larger aggregates. Our method enhances the application of gliders in carbon cycle research. With broader applications across additional glider missions, we hope this method can be used to refine our understanding of particulate size and distribution and explore how these variations correlate with productivity and carbon cycling.

Submitted to 10020 Biological, physical, and chemical oceanographic research to enhance and support resilient and healthy marine ecosystems

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12312 Contributed abstract

Poster Order: 10030P01

The dynamics of the Hudson Bay Complex revealed using a coupled ocean sea-ice biogeochemical model

Inge Deschepper [1] , *Tim Papakyriakou* [2] , *Diane Lavoie* [3] , *Zou Zou*

Kuzyk [4] , *Frederic Maps* [5] , *Paul Myers* [6]

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Presented by / Présenté par: *Inge Deschepper*
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The Hudson Bay Complex (HBC), a vast sub-Arctic inland sea, stands out for its unique biogeochemical productivity shaped by seasonal sea ice, abundant riverine inputs, and nutrient limitation (primarily nitrogen). Historically, the HBC ecosystem has been considered a low-productive system. However, recent research indicates higher primary production levels than previously thought, with a portion of this productivity attributed to sea ice-related (sympagic) biological processes. Using a biogeochemical model with a sympagic-included module can provide insight into these areas that are hard to observe. The BioGeoChemical Ice Incorporated Model (BiGCIIM), coupled to a 3-D numerical physical ocean (NEMO v3.6) and ice model (LIM2), was used to assess the chlorophyll-a concentration dynamics in the HBC and the reliant carbon chemistry from 2002 to 2023. Compared to satellite-derived chlorophyll-a concentration, BiGCIIM produces spring blooms related to the sea-ice retreat and along-shore blooms downstream of the largest rivers. James Bay at the south of the HBC shows the characteristic lower dissolved inorganic carbon associated with waters highly influenced by river runoff compared to higher concentrations in the centre of the Hudson Bay and Foxe Basin.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12454 Contributed abstract

Poster Order: 10030P02

Representing Iceberg Melt Plumes in Ocean Models

Gabriela Amaral Wasielesky [1] , *Juliana Marson* [2] , *Paul Myers* [3]

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Presented by / Présenté par: *Gabriela Amaral Wasielesky*
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The mass loss from the Greenland Ice Sheet (GrIS) has been accelerating in response to a warmer climate. Approximately half of the mass loss of the GrIS is in the form of solid discharge, mainly through the calving of icebergs. The icebergs released to the ocean travel while distributing freshwater away from their sources, changing local physical properties and, potentially, regional and large-scale ocean processes. Considering the limited number of observations, numerical models enable us to better understand iceberg freshwater distribution. However, the representation of those processes in GCMs is still very simplified. In particular, the melting of icebergs results in a freshwater input at the surface in ocean models, even though observations suggest that this is not always the case. In this sense, this research aims to analyze different parameterizations of iceberg melt plumes in the ocean model NEMO (Nucleus for European Modelling of the Ocean). The analysis consists in assessing the impacts of representing the freshwater input from icebergs at ocean surface or through depth (along the iceberg's keel). For this comparison, passive tracers, temperature, salinity, convective resistance and mixed layer depth were evaluated. This comparison shows that different forms of parameterizing iceberg melt plumes lead to distinct patterns of meltwater spread, and dynamics of the water column. Results indicate that the intrusion of meltwater at the surface leads to its accumulation in shallower regions, while the intrusion through depth results in accumulation in Baffin Bay and in the interior of the subpolar gyre. Moreover, the depth of intrusion of the freshwater from icebergs can impact the water column stability, affecting physical properties and mixed layer depth. In summary, the results suggest that the parameterization of iceberg melt plumes may influence large-scale ocean properties and physical processes differently.

Session: 14010 POSTER SESSION AFFICHES

27/05/2025
15:30

ID: 12454 Contributed abstract

Poster Order: 10030P02

Representing Iceberg Melt Plumes in Ocean Models

Gabriela Amaral Wasielesky [1] , *Juliana Marson* [2] , *Paul Myers* [3]

[1] University of Manitoba
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[3] University of Alberta

Presented by / Présenté par: *Gabriela Amaral Wasielesky*
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The mass loss from the Greenland Ice Sheet (GrIS) has been accelerating in response to a warmer climate. Approximately half of the mass loss of the GrIS is in the form of solid discharge, mainly through the calving of icebergs. The icebergs released to the ocean travel while distributing freshwater away from their sources, changing local physical properties and, potentially, regional and large-scale ocean processes. Considering the limited number of observations, numerical models enable us to better understand iceberg freshwater distribution. However, the representation of those processes in GCMs is still very simplified. In particular, the melting of icebergs results in a freshwater input at the surface in ocean models, even though observations suggest that this is not always the case. In this sense, this research aims to analyze different parameterizations of iceberg melt plumes in the ocean model NEMO (Nucleus for European Modelling of the Ocean). The analysis consists in assessing the impacts of representing the freshwater input from icebergs at ocean surface or through depth (along the iceberg's keel). For this comparison, passive tracers, temperature, salinity, convective resistance and mixed layer depth were evaluated. This comparison shows that different forms of parameterizing iceberg melt plumes lead to distinct patterns of meltwater spread, and dynamics of the water column. Results indicate that the intrusion of meltwater at the surface leads to its accumulation in shallower regions, while the intrusion through depth results in accumulation in Baffin Bay and in the interior of the subpolar gyre. Moreover, the depth of intrusion of the freshwater from icebergs can impact the water column stability, affecting physical properties and mixed layer depth. In summary, the results suggest that the parameterization of iceberg melt plumes may influence large-scale ocean properties and physical processes differently.

Session: 14010 POSTER SESSION AFFICHES

27/05/2025 15:30

ID: 12515 Contributed abstract

Poster Order: 10030P03

Exploring the environmental factors controlling the iceberg season severity along the east coast of Canada.

Madhurima Chakraborty [1] , *Juliana Marson* [2] , *Paul Myers* [3]

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Presented by / Présenté par: *Madhurima Chakraborty*

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As the Arctic warms, discharge from the Greenland ice sheet in the form of icebergs has increased in the last decades. Some of these icebergs drift to Canada's east coast where they become significant hazards to ships and other offshore structures. The yearly number of icebergs crossing 48°N is widely accepted as a measure of iceberg severity on the east Canadian coast. This number has fluctuated widely from year to year in recent decades, making the iceberg season unpredictable, and causing concern for marine industries. Former studies have attributed this variability to different environmental factors, such as ice conditions encountered by iceberg enroute, calving rates from Greenland glaciers, and the ocean temperature over the Labrador shelf. However, scientists do not agree upon which of these factors plays the key role in determining the severity of the iceberg season. Moreover, scarcity of information about icebergs' behavior outside of the region monitored by International Ice Patrol in collaboration with Canadian Ice Service, makes the understanding of what governs the icebergs' drift in the upstream portions of their trajectories challenging. To gain deeper insight into this matter, we analyzed observations and outputs from Nucleus for European Modelling of the Ocean (NEMO version 3.6), an ocean model that treats icebergs as Lagrangian particles and is coupled with a sea ice model. Iceberg count south of 48°N showed stronger correlations with Labrador shelf temperature and sea ice area than with Greenland calving rates. Moreover, model outputs suggest that another important driver affecting the number of icebergs reaching 48°N has not yet been considered in the literature: variations in the ocean circulation in Baffin Bay. Most likely, the main factor driving the iceberg season severity off Canada's east coast changes in different periods, depending on the environment's mean state.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12294 Contributed abstract

Poster Order: 13030P01

An Analysis of Syllabi from Geoscience Departments Across Canada

Maria Chadid [1] , *Akalya Kandiah* [2] , *Ulaş Taştekin* [3] , *Nathan Andrews* [4] , *Malinda Smith* [5] , *Annie Duchesne* [6] , *Joseph Shea* [7]

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Presented by / Présenté par: *Joseph Shea*
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Racism and whiteness are ingrained in higher education within the geosciences, where structural advantages benefit white scientists and researchers over racialized scholars. One way this manifests is through the disproportional values placed on the knowledge production of different groups. Understanding these dynamics in academia is important to propose and implement changes that aim to increase diversity and equity within geoscience departments. Through quantitative and qualitative syllabi analyses, our research explores how issues of whiteness manifest in undergrad and graduate schools. We analyzed curricula from twenty-five Canadian universities, which allowed us to identify themes and statistics about the sources used in teaching. We retrieved 355 readings from seventy-two anonymized syllabi, and found that at least 80% of the lead author's country of affiliation comes from the Global North (USA, Canada and UK). In addition, over 40% of the publications in geoscience syllabi were led by white males. Less than 30% come from white females and approximately 20% come from racialized scholars. Qualitatively, most syllabi use discipline-specific language promoting discussion on classic subjects, but we identify key differences between undergraduate and graduate programs. Lower level courses aim for more critical thinking in themes such as climate change or environmental justice, while courses at a graduate level tend to be more research-specific and reference technical

and conventional texts. These results highlight that diversity is not reflected in the Canadian geosciences curricula, and efforts need to be made to diversify the contents of course syllabi.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12205 Contributed abstract

Poster Order: 2010P01

Historical Simulation and Future Projection of Arctic-Boreal Fire Carbon Emissions and Related Surface Climate by CMIP6 Models

Xiao Dong [1]

1

Presented by / Présenté par: *Xiao Dong*

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Warming in the Arctic receives much attentions since it has been warming much faster than in the rest of the world, known as Arctic amplification. Along with rising temperature the climate system also changes substantially, for example, rapid retreating of the Arctic sea ice and more boreal fires. In this study, the historical simulation and future projection of the Arctic-boreal fire carbon emissions and associated surface climate conditions (surface air temperature, precipitation, relative humidity and surface wind speed) are examined using available CMIP6 models. We found that more than half (11 out of 17 models with available fire carbon emissions) of the models underestimate ~40% of the observed annual mean fire carbon emissions in the Arctic-boreal region (0.20 PgC/yr) due to a wetter bias in the Arctic-boreal regions. There is common underestimation of the fire centers in the eastern part of the Eurasian continent and overestimation of that in Europe. For future projection, the fire carbon

emissions in the Arctic-boreal region is projected to exceed 100% (0.5 PgC/yr until the end of the 21st century compared with ~0.2 PgC/yr at present), along with projected increase in precipitation and temperature. Although all models show upward trend, the spread among models are large.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12241 Contributed abstract

Poster Order: 2010P04

Association of spring thermal forcing anomalies in the Tibetan Plateau with dust aerosol changes over the Taklamakan Desert

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Presented by / Présenté par: *Lu Meng*

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The Tibetan Plateau (TP) is significantly influencing the climate and environmental evolution regionally and globally. Adjacent to the northwestern TP, the Taklimakan Desert (TD) experiences the unique pattern of dust aerosol variations due to the deep basin terrain. However, systematic studies on how TP climate change affects TD dust aerosol variations are lacking. This study employs MERRA-2 and ERA5 reanalysis data (1991-2020) to investigate the impact of springtime TP thermal forcing on TD dust aerosol. Results indicate that the interannual variation of dust column mass densities over the TD showed an increasing trend over 1991–2020, with a significant increase in the northern TD, where the maximum value exceeded 9.51 mg m-2 per year. Thermal forcing strengthening on the northwestern TP are positively correlated with dust column mass density variations in the northern TD, while negatively correlated in the southern TD. Further comprehensive analyses indicate that strong northwestern TP thermal forcing has increased dust aerosol concentrations in northern TD, with a maximum 14 mg m-3 increase at 700 hPa, while decreasing them in the southern part. During strong SNTP-Q1 years, anticyclonic anomalies, strong updrafts, and the blocking effect of the Tian Shan Mountains, combined with high temperatures, result in dust aerosols suspended in the atmosphere over the northern TD. In contrast, during weak SNTP-Q1 years, cyclonic anomalies, strong downdrafts, and the large topography of the TP, along with inversion temperatures, contribute to dust aerosol accumulation in the southern TD. This study elucidates the mechanism of TP thermal forcing on TD dust aerosol variations, enhancing understanding of its effects on environmental and climatic changes in the TD and Central Asia.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12364 Contributed abstract

Poster Order: 2010P05

Analysis of Gap Winds in Bute Inlet, British Columbia, Using ERA5 Reanalysis and WRF Modelling

Ehsan Taghizadeh [1] , *Jennifer Jackson* [2] , *Charles Hannah* [3] , *Peter Jackson* [4]

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Presented by / Présenté par: *Ehsan Taghizadeh*

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Gap winds are channelized airflows that accelerate through sea-level gaps due to pressure gradients aligned with the channel's axis. Along the northern Pacific coast of North America, the coastal mountain ranges act as a barrier between cold continental arctic (cA) air and warmer maritime air, creating ideal conditions for gap winds. With over 50 inlets along the BC coast, several act as natural conduits for these winds which flow from the interior toward the coast.

This study investigates four arctic outflow wind events in Bute Inlet, BC, during February 2019 using weather station observations, the ERA5 reanalysis dataset, and the Weather Research and Forecasting (WRF) model. At Tatlayoko Lake on the upwind side of the coastal mountains, notable low temperatures associated with cA air were recorded including -27.7°C on February 4 and -31.2°C on February 10, with other instances falling below -22°C. These times were accompanied by higher wind speeds, indicating the probability of strong gap winds in Bute Inlet.

Using the ERA5 reanalysis, synoptic conditions during these outflow events were analyzed. At upper levels, a 500 hPa ridge over Alaska and a trough over the interior continent, were associated with strong outflows. In certain instances, an omega blocking pattern at 500 hPa was noted. At the surface, a low-pressure system near southwest BC or stretching from east of North Pacific Ocean and an anticyclone over interior Canada facilitated cA air movement along the valley and inlet. Outflow ended as the surface pressure gradient weakened.

To improve spatial resolution, WRF model simulations with nested domains

(with an innermost grid resolution of 1 km) were carried out. The simulations successfully captured the expected wind patterns, indicating its ability to resolve strong along-channel outflow winds in Bute Inlet. These findings emphasize the importance of high-resolution modelling in understanding complex atmospheric dynamics in fjord environments.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12463 Contributed abstract

Poster Order: 2010P06

Biogeochemical budgets and fluxes for the Arctic Ocean and northern Atlantic Ocean: an analysis of deoxygenation and the physical influences on oxygen patterns.

Fiona Davidson [1] , *Inge Deschepper* [2] , *Paul Myers* [3]

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Presented by / Présenté par: *Fiona Davidson*
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In the coming decades and centuries, oceanic biogeochemical cycles will be increasingly stressed by rising temperatures, ocean acidification, and ocean deoxygenation. Increasing atmospheric CO2 and associated global warming is leading to a decline in global ocean oxygen concentrations. This decline is predicted to continue under future climate change. These changes will be particularly pronounced in the Arctic, which is warming at a rate almost four times faster than the rest of the world. In order to better understand how the oceans will change due to these factors, biogeochemical models can be coupled with ocean and sea ice models. Biogeochemical budgets for oxygen, phosphate, iron, and chlorophyll A will be calculated for basins in the Arctic Ocean and northern Atlantic Ocean, as well as fluxes through the following gateway straits: Bering Strait, Fram Strait, Davis Strait, Nares Strait, Barents Strait, and Barrow Strait. This research will provide a baseline biogeochemical budget for the Arctic Ocean and will be based on several existing high-resolution model simulations

using NEMO (Nucleus for European Modelling of the Ocean) and BLING (Biogeochemistry with Light, Iron, Nutrients and Gas). These budgets will allow us to study oxygen dynamics in the Labrador Sea, where deep convection and mixing brings oxygen to deep layers of the North Atlantic and has important impacts on ecosystems and marine species. While many studies still suggest that the principal oxygen source for the Labrador Sea is the air-sea flux, lateral advective fluxes from the west Greenland Current and the Baffin Island Current have been identified as significantly important as well. Finally, the budget of biogeochemical fluxes in the Arctic will allow us to investigate whether these nutrients sink in these waters, or if they are carried in and out of the Arctic by larger oceanic circulation.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12538 Contributed abstract

Poster Order: 2010P07

Characterizing Nocturnal Boundary Layer Regimes in Complex Terrain Using Hidden Markov Models

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Presented by / Présenté par: *Fateme Salehi*
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The stable nature of the atmospheric nocturnal boundary layer plays a key role in determining turbulence intensity and atmosphere exchanges of energy, mass, and momentum with the surface. The nocturnal boundary layer is often classified into two distinct regimes: the weakly stable (wSBL) and very stable boundary layer (vSBL), associated with sustained and intermittent turbulent fluxes, respectively. In many observational tower locations, the SBL has been observed to transition frequently between these two regimes, but little is known about the spatial size of SBL regime patches nor their propagation.
To understand properties of the spatial scale and spatial relationships of SBL regimes across a complex terrain, we analyze data from the Perdigão field campaign in Portugal which consisted of 18 towers closely spaced across an area of 4 km2. Based on the regime clustering of a Hidden

Markov Model timeseries analysis of stratification and wind information, we present regime statistics at each individual tower site and how they relate to the local terrain and dominant wind patterns. Given the spatial resolution of the tower network, we can also understand typical propagation patterns of SBL regimes or how they relate to the local wind fields.

Keywords: Stable Boundary Layer, Hidden Markov Model, Stratification, Wind Speed, Complex Terrain, Spatial Structure, Statistics

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12224 Contributed abstract

Poster Order: 2020P01

Enhancing WETMETH Wetland Module in UVic ESCM for Peatland-Specific Simulations

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Presented by / Présenté par: *Xiaolong Guo*
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Peatlands store approximately 30% of the world's soil carbon and play a dual role as both carbon sinks and methane sources in the global climate system. However, current Earth system models lack detailed representation of peatland-specific processes in their wetland modules, particularly the unique characteristics of peat soils and their associated biogeochemical cycles. Here we enhance the WETMETH module in UVic ESCM through two main developments: (i) integration of high-resolution peatland distribution datasets, and (ii) updating of the soil module to better account for thermal and hydraulic properties specific to peat soils. Building upon UVic ESCM's existing multi-layer soil model with representations of permafrost carbon and soil anoxia-methane processes, the enhanced model will be used to assess climate change impacts on Canada's peatlands and evaluate potential restoration strategies through modifications of soil drainage parameters. Initial development suggests that incorporating peatland-specific processes could substantially alter projections of regional carbon cycling and methane emissions, particularly

in high-latitude regions where climate warming is most pronounced. This research aims to improve our understanding of peatland-climate feedbacks and their role in future climate mitigation strategies, with particular focus on regions where peatland conservation and restoration efforts may be most effective.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12456 Contributed abstract

Poster Order: 2020P02

The Potential of Ocean Thermal Energy Conversion and Carbon Sequestration

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Presented by / Présenté par: *Leslie Moffat*

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The Intergovernmental Panel on Climate Change has identified the need for negative emission technologies to limit the increase in global mean surface air temperature to 2 °C above pre-industrial levels. Carbon sequestration is a form of negative emission technology which includes carbon dioxide being injected into depleted oil and gas fields, saline aquifers, or basalt reservoirs for permanent storage. Carbon sequestration is an energy intensive process and Ocean Thermal Energy Conversion (OTEC) could act as a renewable energy source powering marine carbon sequestration. OTEC harnesses solar energy stored in the vertical thermal water column by using the thermal gradient between the surface and deep ocean to drive a heat engine. OTEC is non-polluting and independent of season or time of day, rendering it a consistent and safe form of electricity generation. Over the past three decades, research has determined the potential magnitude of energy that can be drawn from OTEC to replace the use of fossil fuels and its potential environmental effects. However, there has been little investigation into the use of OTEC as a renewable energy source to power negative emission technology. This research now attempts to determine the magnitude of atmospheric carbon dioxide concentration reduction associated with coupled marine carbon sequestration and OTEC

considering the co-located resources. Upon estimating the carbon dioxide storage capacity of marine sequestration sites within proximity to suitable OTEC marine conditions, the UVic Earth System Climate Model is used to project the atmospheric carbon dioxide concentration reduction associated with identified carbon dioxide capture and storage.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12516 Contributed abstract

Poster Order: 2020P03

Assessing the effectiveness of ocean alkalinity enhancement on carbon sequestration and ocean acidification

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Over the past decade, OAE (Ocean Alkalinity Enhancement) has drawn the scientific community's attention, as a natural form of carbon capture and a hopeful solution to the excess carbon dioxide in our atmosphere. This paper will focus on limestone and lime as an OAE solution, and the upper-boundary condition of total global mining needed to utilize this process as a reliable green technology and carbon capture development. Here we used the University of Victoria's earth system climate model (UVic ESCM) to model several variables for 4 representative concentration pathways (RCPs). Within those, we compared three inputs: calcium carbonate with a DIC (Dissolved inorganic carbon) flux, lime with the addition of CO_2 emissions and the direct input of lime under the assumption of sequestered or stored CO_2. Although lime and limestone OAE have been put forward as major solutions for carbon dioxide emissions, our results show that the change is minuscule despite slightly raising pH, lowering CO_2

concentrations and lowering air surface temperatures. Albeit showing slight potential, our input of total global limestone mining suggests OAE is unable to make an impactful difference on CO2 emissions as it would require a massive upscale in mining or the transference of all current limestone mining to OAE solely. Though research into these solutions should be continued, it's of insurmountable value to understand that OAE does not show large-scale climate-saving potential and should only be considered as one of many solutions needed for climate mitigation.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12283 Contributed abstract

Poster Order: 3020P01

Using Soil and Plant C:N and ^{13}C to Assess Ecosystem Health of "Restored" Sand & Gravel Pits

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Ecological restoration aims to facilitate the transition from a heavily degraded ecosystem to a "climax" ecosystem. Currently, the success of ecological restoration is primarily based on plant species richness and diversity at a site rather than quantifying plant or ecosystem health. To investigate how ecosystem health can be used in restoration assessments, we collected plant and bulk soil samples at five previously "restored" and one unrestored aggregate pits across southern Ontario and analyzed them for C, ^{13}C, and N concentrations. The five "restored" sites were restored in 2001, 2006, 2013, 2014, and 2019. The most visually abundant graminoid and forb species were collected at each site during peak biomass of the 2024 growing season. An additional plant common to all sites, great mullein (Verbascum thapsus), was sampled to directly compare plant health between sites. Total soil C varied by a factor of 10, between 0.56% (± 0.05) at the 2014 site and 4.79% (± 0.54) at the unrestored site. Total soil N varied between 0.04% (± 0.00) at the 2014 site and 0.23% (± 0.05) at the 2001 site. Grass and forb leaf C:N were significantly different from each other at each site and were not correlated with time since restoration. These

results suggest soil nutrients and resultant plant health are greatly impacted by site-specific characteristics such as parent material, not age post-restoration. Mullein leaf ^{13}C concentrations differed significantly between sites, ranging from most depleted at the oldest, 2001 site (-30.61 ± 0.13‰) to least depleted at the unrestored site (-28.25 ± 0.12‰), implying site-specific effects on water use efficiency (WUE). While species richness may indicate restoration "success", plant health assessed through nutrient ratios and WUE can reveal poor ecosystem health. Future restoration assessments should consider soil and plant nutrient chemistry rather than focusing solely on plant biodiversity.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12506 Contributed abstract
Poster Order: 3020P02

Carbon, Water, and Energy Exchanges in a Sweet Potato Agricultural Field in the Great Lakes Region

Liam Kreibich [1] , *M. Altaf Arain* [2]

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Presented by / Présenté par: *Liam Kreibich*
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Carbon, water, and energy exchanges were measured in an agricultural field in the Great Lakes region near Turkey Point in southeastern Ontario. The site is part of Turkey Point Environmental Observatory and associated with the Global Water Future Observatories and Global Centre for Transboundary Waters initiatives. It is know as CA-TPAg in Ameriflux and global Fluxnet. In this study energy, water and carbon fluxes as well as meteorological and hydrological variables were measured in Sweet Potato

(Ipomoea batatas) crop for two years (2022 and 2024). An open-path eddy covariance system and an automatic weather station were used for this purpose. The field was planted with a cover crop (rye grass and winter wheat) in both years during the winter months which was mowed into the soil in April. Sweet potato was planted in June and harvested in October with crop yield of about 25 to 30 tons/ha. The study results showed that on an annual basis the field was a net source of carbon in both 2022 and 2024 with net ecosystem productivity (NEP) of -120 and -25 gC/m2/year, respectively. Respective annual evapotranspiration (ET) values were 715 and 708 mm/year. This Sweet Potato focused study is aimed to fill a current gap in research, as it's a crop that's rarely observed for its carbon, water and energy dynamics in North America, not just the Great Lakes Region. It also underscores the necessity of studying and incorporating diverse crop types when evaluating agricultural fields as potential nature-based carbon sequestration solutions.

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Poster Order: 3020P02

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Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12286 Contributed abstract
Poster Order: 3030P01

Evaluating the Impacts of Episodic Events on Salinization and Greenhouse Gas Emissions in Salt Marshes

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Salt marshes play a critical role in carbon sequestration but are increasingly vulnerable to episodic events such as tropical storms, heavy rainfall, and tidal surges. This study examines the hydrological and biogeochemical dynamics of two salt marshes—Rainbow Heaven Beach (Cow Bay, Nova Scotia) and Rushton's Beach (Tatamagouche, Nova Scotia)—with a focus on salinization and carbon fluxes (CO_2 and CH_4) in response to these disturbances. At each site, shallow monitoring wells were installed along a salinity gradient, with gas flux collars placed at and between well sites. Hydrological data, including water level, temperature and conductivity, was recorded continuously using piezometers. Greenhouse gas fluxes were measured using a dynamic chamber technique with a Trace Gas Analyzer for high-precision CH_4, CO_2, and H_2O measurements. Additionally, a multiparameter water quality probe was used to assess porewater temperature, dissolved oxygen, pH, specific conductivity, and oxidation-reduction potential. Initial measurements from the multiparameter water quality probe indicate that at Rainbow Haven the well in a non-tidally inundated plot had lower dissolved oxygen and specific conductance but higher pH and oxidation-reduction potential compared to a tidally inundated plot. Furthermore, carbon flux data collected in October 2024 show that methane emissions at both well sites are lower than carbon dioxide emissions. Preliminary results will characterize variations in water level and salinity across the marsh from December 2024 to April 2025. Furthermore, we will establish baseline gas flux measurements for spring 2025 with which to compare future episodic events. This research will improve our understanding of how the salt marsh carbon sink will be impacted by increasing intensity and frequency of storm events compounded by sea level rise.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12432 Contributed abstract

Poster Order: 3030P02

Testing the Application of a Novel Technology for Assessing Vine Health Using Spectrometry

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Wine producing regions in Canada are already experiencing the effects of climate change, and more extreme weather events are expected. It is predicted that the changing climate will result in significant consequences for overall vine health. Continuous monitoring of vine health will help support vines by allowing for real-time decision on interventions (e.g., irrigation and pesticide application), which will translate into higher quality wine and improved environmental protection.
Recent advancements in compact and inexpensive technology for monitoring individual woody plant health and growth conditions, called TreeTalker, have been adapted to vines (TreeTalker Wine; TTW). TTWs have the ability to monitor changes in canopy spectral signatures in real-time and hourly. In 2023, we tested the use of TTW sensors to monitor vine health using these spectral signatures. TTWs were deployed under the canopy of Cabernet Franc in two commercial vineyards in Niagara, Ontario, Canada. Spectral data collected by the TTWs was used to calculate the daily Normalized Difference Vegetation Index (NDVIT) based on transmitted light. The resulting NDVIT values were consistent with expected ranges, aligned with both viticultural management practices and weather events, and provided more detailed insights compared to standard satellite monitoring methods.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12472 Contributed abstract

Poster Order: 3030P03

Prairie wetland drying and its effects on mercury emission patterns

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Wetland ponds in the Prairie Pothole Region naturally fill up with spring run off and slowly dry over the course of the open-water season. However, under a warming climate, these systems are drying out at a faster rate. This study will investigate the effects of climate change-based wetland drying on mercury emission patterns to determine whether prairie wetland ponds become atmospheric mercury sources. Using specifically designed flux chambers and Tekran 2537A machines, we will measure the amount of mercury released from the wetland throughout the drying process. Understanding the effects on mercury release rates as ponds dry out will provide critical insights to the potential environmental as well as human health risks associated with climate change-driven wetland drying. These findings could help with the development of future wetland protection strategies by demonstrating the consequences of allowing them to dry.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12219 Contributed abstract

Poster Order: 3040P01

Advancing Methane Emissions Quantification in Dairy Cattle: Integrating Genomic and Sensor-Based Approaches for Climate-Smart Agriculture

Christine Baes [1] , *Rachel Gervais* [2] , *Paul Stothard* [3] , *Flavio Schramm Schenkel* [4] , *Caeli Richardson* [5] , *Francesca Malchiodi* [6] , *Tom Wright* [7] , *Jennifer Ellis* [8] , *Ricarda Jahnel* [9] , *Filippo Miglior* [10]

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Presented by / Présenté par: *Ricarda Jahnel*
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Over the past decade, joint investments from industry and government in Canada have advanced dairy cattle genomics, enabling new genomic tools for selecting animals with improved health. Traits such as hoof health, fertility disorders, feed efficiency, body maintenance requirement, and methane efficiency represent the newest contributions to Canadian dairy cattle selection indices. These developments provide a strong foundation for further integrating both genetic and nutritional strategies to reduce greenhouse gas (GHG) emissions in the dairy sector.

This project focuses on measuring methane produced by individual dairy cows using both flux (sniffer) and flow (GreenFeed) methods. By combining genomic selection, nutritional interventions, and methane monitoring, we aim to develop a roadmap for GHG management in dairy cattle. This roadmap will equip dairy producers with tools to track and reduce emissions, while ensuring reliable data for policy development and national inventories. The roadmap targets a 55% reduction in methane emissions from dairy cattle (30-40% of from nutrition and 30% through genomic strategies). This systems-level approach will provide precise animal, herd and industry-level methane emission estimates, and will identify further areas for improved efficiency.

Key objectives include developing protocols to quantify methane mitigation strategies, estimating individual and herd-level emissions, consolidating methane emissions data (including that collected on beef animals), further enhancing genomic evaluations for methane efficiency, and identifying structural genomic variants associated with emissions variation.

Beyond emission reductions, this project will be used to assess public attitudes, stakeholder engagement, and value chain barriers to adoption of genomic selection programs. The ultimate goal is to deliver practical tools for producers, industry leaders, and policymakers, supporting a sustainable, climate-resilient future for the livestock sector.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12256 Contributed abstract

Poster Order: 3040P02

Evaluation of a New Trace-Gas Analyzer Designed for Eddy Covariance Flux Measurements of Methane (CH4) and Nitrous Oxide (N2O)

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Presented by / Présenté par: *Adam Green*
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The Eddy Covariance (EC) Flux technique is a broadly accepted method to measure the exchange of greenhouse gasses between surface ecosystems and the atmosphere. The primary elements of an EC system are a 3D anemometer and a fast-response collocated gas analyzer for the species of interest. As greenhouse gas research has expanded to include the trace gasses Methane (CH4) and Nitrous Oxide (N2O), there is a need for suitable gas analyzers with a small physical size, low power, low cost, sufficient frequency response, and proven field ruggedness. The TGA300 series, developed by Campbell Scientific, are closed-path trace-gas analyzers for CH4 and N2O tailored to specifically meet the requirements of EC flux measurements.

The newly developed TGA300 trace-gas analyzers are built on the principles of tunable diode laser absorption spectroscopy (TDLAS) and leverage technologies from the TGA200A with a long track-record in the field. A tunable mid-infrared distributed feedback inter-cascade laser provides the light source for the measurement. The analyzer employs a 1 m single-pass sample cell with a small volume allowing the use of a low-power integrated vacuum pump system that maintains 30 kPa sample pressure to clarify the spectral absorption lines. The source laser beam is simultaneously split into a parallel reference gas cell fed by a constant concentration pressurized gas. The reference cell is maintained at the same pressure and temperature as the sample cell and the ratio of these signals cancels out the spectroscopic effects of pressure and temperature. This eliminates additional corrections and calibrations improving the spectral line tracking and stability of the instrument. The sample intake uses a vortex particle separator to clean the sample air and prolong the service life of filtration components. The intake also includes an integrated Nafion membrane and counterflow to stabilize water vapor fluctuations and

eliminate the need for water vapor line broadening corrections. The intake components are designed to function without compromising the frequency response of the instrument and provide closed-loop control of sample flow and pressure.

In this study, we examine the sensor-level and system-level performance of the TGA300 instruments during field and laboratory trials. The sensor-level analysis considers the frequency response, noise performance, and accuracy of the analyzers. The instrument is shown to measure frequency response of verifiable atmospheric variation out to several Hertz. Instrument noise is low enough to accurately capture real agricultural flux events and differentiate those from periods without flux. Allan variance analysis shows system stability matching the short-term noise out to approximately 30 minutes. A system-level analysis of the TGA instrument looks at total data availability, power requirements, synchronization, maintenance routines, and logistics of a complete EC station. The conclusions of the analysis are framed from the perspective of practical field application and the specific data requirements of EC flux measurements.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12324 Contributed abstract

Poster Order: 3040P03

Drivers of Spatial Variation in Methane Emissions and the Role of Vegetation in Methane Oxidation from Capped Landfills in Southern Ontario

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Landfills are a major source of atmospheric methane (CH_4), which accounted for 24% of Canada’s total CH_4 emissions. Understanding the effect from vegetation in landfill cover and environmental variables on CH_4 flux is crucial to develop mitigation strategies. This study examines CH_4 flux variation, soil moisture, soil temperature, soil physiochemical properties of

vegetated and non-vegetated treatments in two capped landfill sections in Waterloo, ON: the Original Landfill Area (OLA), capped in 2001, and the Northern Expansion Area (NEA), capped in 2016 with six pairs of vegetated and non-vegetated plots in each section. Methane emissions were measured bi-weekly from April 2024 to March 2025 using a closed acrylic chamber, and gas concentrations were analyzed with a LI-7810 $CH_4/CO_2/H_2O$ Trace Gas Analyzer. In general, capped landfill soils were a sink for CH4. At the NEA, CH4 flux was -0.80 ± 1.13 mg $CH_4/m^2/d$ in vegetated plots and -1.14 ± 1.38 mg $CH_4/m^2/d$ in non-vegetated plots whereas in OLA, flux was -0.56 ± 1.38 mg $CH_4/m^2/d$ and -0.88 ± 1.22 mg $CH_4/m^2/d$, respectively. Methane uptake was significantly higher at non-vegetated plots at NEA, but not OLA. A multiple linear regression analysis showed that CH4 uptake was significantly greater under drier soil conditions ($p = 0.0107$), while soil temperature had no significant effect ($p = 0.3609$). Vegetated plots had higher soil moisture and extractable dissolved organic carbon concentration (DOC), suggesting a potential link to increased CH4 production. This study highlights soil moisture as the primary driver of CH4 consumption in capped landfill soils, while soil temperature had no significant effect. Vegetation influenced methane flux, but its effect varied by landfill section. These findings emphasize the importance of moisture regulation in landfill management.
Keywords: Methane flux, Soil moisture, Vegetation, Capped landfills, Greenhouse gas

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12367 Contributed abstract

Poster Order: 3040P04

Integrating Ground and Aircraft Measurements to Characterize Urban Methane Emissions in Montreal

Regina Gonzalez Moguel [1] , *Peter Douglas* [2] , *Djordje Romanic* [3] , *Yi Huang* [4] , *John Stix* [5] , *Felix Vogel* [6] , *Sebastien Ars* [7] , *Lawson Gillespie* [8] , *Gustavo Villarruel* [9] , *Keyvan Ranjbar* [10] , *Jacob Asomaning* [11] , *Lei Liu* [12]

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Urban centers are significant sources of anthropogenic methane (CH_4), yet emission distributions and source contributions remain uncertain. This study integrates mobile ground-based surveys and aircraft measurements to map CH_4 enhancements in Montreal, Canada, quantify emissions, and assess atmospheric transport dynamics. Over four years, mobile surveys covering 3,300 km detected 3,045 CH_4 hotspots, with >85% exhibiting enhancements below 1 ppm. Larger hotspots (>1 ppm) were primarily associated with landfills, with estimated emissions of 10,064–36,410 kg CH_4 day^{-1}. Leak indications—localized CH4 hotspots unrelated to major sources—were concentrated in densely populated areas, contributing 250–507 kg CH_4 day^{-1}.
Complementary aircraft measurements conducted on February 21, 2024, provided vertical CH_4 and CO_2 profiles across the city. Morning flights captured elevated CH_4 concentrations near the surface under stable atmospheric conditions, while afternoon flights revealed greater vertical mixing and dispersion. Ground-based instruments confirmed significant CO2 urban enhancements compared to rural background levels. All together, our integrated results enhance our understanding of the spatial distribution of CH4 emissions in Montreal, provide estimates for the contributions of major sources, and give a deeper understanding of how meteorological factors influence CH4 distribution.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12410 Contributed abstract

Poster Order: 3040P05

Quantification of Greenhouse Gas emissions in Urban Wetlands and Stormwater Ponds in Southern Ontario

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Urban wetlands and stormwater ponds are widely incorporated in developments for stormwater management integrated with green infrastructure elements with the main aim to serve as receptacles for the stormwater runoff and mitigate the adverse impact of urbanization on water quality and quantity. Urban wetlands and stormwater ponds may also provide essential ecosystem services, including sequestration of carbon and preservation of biodiversity while enhancing the aesthetic value of the surrounding environment. Despite these services, these small water bodies accumulate organic matter and nutrients that can contribute to the release of significant amounts of greenhouse gases (GHGs) such as methane (CH4), carbon dioxide (CO2) and nitrous oxide (N2O). However, few studies have quantified emissions from urban wetlands and stormwater ponds in Canada, limiting our ability to account for and manage these GHG emissions. Hence, we monitored CO2, CH4 and N2O fluxes at 24 distinct stormwater ponds and urban wetlands in the Kitchener-Waterloo region, Southern Ontario, over a seven-month period from May to November, 2024 aiming to quantify GHG emissions and assess the impact of selected physical and chemical parameters on these GHG emissions. CH4 emissions peaked in July at an average of 236 mg m-2 d-1 declining to lowest average emissions in November at 52 mg m-2 d-1, mirroring the pattern of air and water temperature over this period. In contrast, CO2 emissions, ranging from 0.16 to 2.25 g m-2 d-1 showed an opposite trend, decreasing with increasing temperature likely associated with greater productivity in the ponds in midsummer. The significant influence of chemical parameters including pH, dissolved oxygen, nutrient concentration, specific conductance and pond physical characteristics on measured GHG will be assessed. This understanding will help facilitate the inclusion GHG emissions from urban wetlands and ponds in planning decisions and GHG reporting.

Key words: urban wetlands, stormwater ponds, greenhouse gas emissions

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12458 Contributed abstract

Poster Order: 3040P06

High Arctic Tundra as a Methane Sink: Effects of Snow and Warming on Soil Methane at an International Tundra Experiment (ITEX) Site on Melville Island, NU

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Accelerated environmental changes like warming and intensifying precipitation regimes in the High Arctic may enable carbon (C) feedback processes shifting ecosystem C source-sink status, which could increase atmospheric C concentrations. The response of moisture-sensitive microorganisms that produce or consume CH4, however, remains poorly understood. This response is critical to future climate change, as CH4 is a more potent greenhouse gas than carbon dioxide. While wetlands have dominated Northern research due to their significant CH4 production, drier ecosystems have proven to be strong CH4 sinks. My work addresses the impacts of environmental change on tundra soil CH4 dynamics by exploring their key environmental controls both in the field and the lab. During the summer 2024 field season, I collected data at an International Tundra Experiment (ITEX) site at the Cape Bounty Arctic Watershed Observatory on Melville Island, Nunavut. This 16-year field experiment manipulates winter snow accumulation and air temperature using snow fences and open-top plexiglass chambers. Surface flux measurements throughout the growing season derived from static chambers show that the site is an overall CH4 sink. Warming did not affect CH4 fluxes ($p=0.4$), however, those receiving enhanced snow cover were stronger CH4 sinks despite becoming snow-free later in the season. Future soil incubation studies will explore the effects of depth and treatment on CH4 oxidation potential. Soils collected at varying depths during from ITEX treatments will be incubated at both ambient and elevated CH4 conditions to assess the potential for both high and low affinity CH_4 oxidation. This work demonstrates the important role of dry tundra ecosystems as net summer CH_4 sinks, and the impact that enhanced snow cover may have in strengthening this growing season sink, a critical component in understanding both local and regional impacts of climate change in Arctic environments.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12462 Contributed abstract

Poster Order: 3040P06

Canadian Peatland Methane Synthesis: Improving CaMP Model Predictions

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Peatlands are an important land cover in Canada, and act as a source of methane (CH_4), a powerful greenhouse gas. The Canadian Model for Peatlands (CaMP, v 2.0) contains a module that aims to model annual CH_4 fluxes from Canadian peatlands. Due to a lack of Canada specific data, the Gaussian CH_4–WTD relationships are based on boreal region data for only three peatland classes: bogs, poor fens and rich fens. Additionally, these environmental relationships were built using plot scale daily fluxes, while the model uses annual WTD to predict ecosystem scale CH_4 fluxes. It is unclear if the form and relative importance of these CH_4–WTD relationships is appropriate at the annual ecosystem scale. The objective of this study was therefore to improve the modelling of CH_4 emissions in CaMP by assessing how the drivers of CH_4 emissions vary spatially and temporally.

To do this, we compiled plot and ecosystem scale CH4 fluxes from over 40 research sites across Canada spanning six peatland classes: bog, forested swamp, open poor fen, open rich fen, treed poor fen and treed rich fen. Significant interactions between WTD and air temperature suggest that future modelling work should consider a coupled water table and temperature response to improve CH4 predictions. This work will further our understanding of environmental controls of CH4 emissions from different peatland types in Canada, and support modelling efforts to better predict CH4 emissions under future climate change and disturbance scenarios.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

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Poster Order: 3040P07

Spatio-temporal variability of CO2 and CH4 fluxes in wetlands across the Prairie Pothole Region, Canada

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Wetlands are vital to the global carbon cycle, functioning as both carbon sinks and sources of greenhouse gas (GHG) emissions. They contribute to carbon sequestration and storage while also releasing methane (CH4), influencing overall atmospheric carbon dynamics. Wetlands in the Prairie Pothole Region (PPR) of Canada store large amounts of soil organic carbon but are among the most threatened ecosystems due to extensive land conversion and historical drainage. The spatial variability and temporal dynamics of GHG emissions from PPR wetlands remain poorly understood, limiting our ability to assess their contributions to regional and global carbon budgets. This study examines the spatial and interannual variability (2021–

2024) in net ecosystem exchange (NEE), methane flux (FCH_4), and total GHG balance across three distinct wetland sites in the PPR, Canada: an isolated cropland marsh (CA-EM1), an isolated grassland marsh (CA-EM2), and a restored marsh (CA-EM3), using eddy covariance measurements. The results indicate significant differences in NEE, FCH_4, and GHG balance among the three wetlands. CA-EM2 exhibited the highest carbon sequestration (maximum NEE: -225.8 gC m^{-2} $year^{-1}$) and the lowest FCH_4 emissions (0.3 gC m^{-2} $year^{-1}$), making it a strong GHG sink (−806.7 gCO_2-eq m^{-2} $year^{-1}$). In contrast, CA-EM1 functioned as a moderate carbon sink (maximum NEE: -75.0 gC m^{-2} $year^{-1}$) but had higher CH_4 emissions (maximum FCH_4: 6.1 gC m^{-2} $year^{-1}$), resulting in a net GHG balance of −312.9 gCO_2-eq m^{-2} $year^{-1}$. Despite increasing carbon sequestration (maximum NEE: -199 gC m^{-2} $year^{-1}$), CA-EM3 emerged as a net GHG source (272.6 gCO_2-eq m^{-2} $year^{-1}$) due to its high methane emissions (maximum FCH_4: 15.7 gC m^{-2} $year^{-1}$). The spatial and interannual variability in GHG emissions is likely influenced by water chemistry, vegetation dynamics, and climate variability, highlighting the need for site-specific wetland management strategies to enhance carbon sequestration while minimizing CH_4 emissions.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12554 Contributed abstract

Poster Order: 3040P08

Hyperspectral Imaging for Measurement of Diffuse Methane from Wetlands

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Presented by / Présenté par: *Avery Opalka*
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Methane emissions from wetlands may be enhanced through urban or agricultural development via an influx of nutrients and biomass. It is therefore important to measure and include these anthropogenic effects in

national greenhouse gas inventories. Wetland methane emissions are traditionally measured with flux chambers, which are inherently localized, and the results require significant interpolation for an overall emissions estimate of a wetland. In this regard, optical techniques that can image methane over larger areas could potentially provide a more complete emission estimate.
This study examines two optical techniques: longwave infrared (LWIR) hyperspectral imaging, and open-path tunable diode laser absorption spectroscopy (TDLAS). Hyperspectral imaging allows simultaneous visualization and measurement of methane and water vapor column densities within the camera's field of view. The TDLAS also measures column density over a path defined by the transceiver at one end, and a retroreflector at the other. The TDLAS has a much higher sensitivity and temporal resolution compared to the hyperspectral camera, but the latter can image an entire scene, rather than a single path. Using these instruments simultaneously realizes a synergy between the two measurement modalities.
We evaluate this dual approach in a range of wetlands and compare their results with the traditional flux-chamber measurements taken over a transect. Optical measurements are made over two seasons to compare differences in measurement effectiveness. Field trials indicate that the use of hyperspectral imaging and TDLAS can prove effective in providing highly detailed data for diffuse methane environments.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12339 Contributed abstract
Poster Order: 3060P01

Wetland Conservation from a Carbon Offset Perspective: The Shaubac Wetlands, Nova Scotia, Canada

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Presented by / Présenté par: *Kobi Shapero*
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Freshwater wetlands play a crucial role in global carbon sequestration. When these ecosystems remain undisturbed, they can act as carbon sinks that mitigate climate change by storing atmospheric carbon within their soils. Wetland loss, or disruption due to human activities, threatens this sequestration ability. The Canadian government has committed to achieving “net zero” carbon emissions by 2050, presenting opportunities for the conservation of wetlands based on their ability to sequester carbon. Using a carbon budget of 3 wetland classes confined within the Shaubac Wetlands in Nova Scotia, Canada (Forested Swamp, Shrub Swamp, and Open Bog/Fen), we (1) review the potential of integrating wetland restoration into carbon market frameworks by evaluating the functional equivalence of restored wetland and discussing the carbon market potential of wetland compensation programs, and (2) quantify the carbon sequestration capacity of the Shaubac wetlands, and 3) evaluate the current state of wetland functioning with respect to restoration opportunities by framing potential means of conservation within offset markets. Methods will involve monthly dynamic chamber CH_4 and CO_2 flux surveys using both opaque and transparent chambers, allowing us to differentiate between total ecosystem respiration and net ecosystem exchange. These measurements will take place during the growing season of May – October 2024-2025. Soil core samples will also be collected to quantify carbon storage and radiocarbon dating. Preliminary findings show an average peat depth of 0.55 m, with deeper peat (up to 1.5 m) in the fen areas compared to the swamps. Soil CO_2 fluxes in the shrub swamp were 24% higher than the bog/fen and 80.7% higher than the treed swamp. Upon completion of the carbon budget, we will be able to discuss the carbon storage potential of our wetland

alongside the review of Canada's "net-zero" policies to contribute new insight on the potential future synthesis of these offset policies.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12420 Contributed abstract
Poster Order: 3060P02

Assessment of Nitrogen and Carbon Dynamics of Peat Cores from a Constructed Fen Watershed.

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Presented by / Présenté par: *Yimeng Wang*
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Natural resource extraction in the region of Alberta sometimes coincides with swaths of forest ecosystems and wetlands including peatlands. Evolving sustainable land use practices currently compel industry to functionally restore disturbed landscapes. The Nikanotee Fen Watershed was therefore constructed as a pilot scale reclaimed fen peatland – forest upland system from a decommissioned surface mine. However, ongoing oil sands extraction in the vicinity could result in continuous nitrogen (N) deposition into the reclaimed fen impacting local ecology and biogeochemistry. Consequently, this study assessed the availability of N under varying water table regimes to determine variation in N2O exchange alongside methane (CH4) and carbon dioxide (CO2) exchange in the constructed fen.

A column experiment using 26 peat cores was setup in a greenhouse where C and N fluxes were measured alongside water table depth, and pore water chemistry. Replicate peat cores were extracted from dominant plant communities in the reclaimed fen and two regional undisturbed reference fens. At the end of the study peat cores were sectioned for total carbon content and bulk density determination.
Preliminary results indicate potential N enrichment in sections of the constructed fen although N2O emissions remained low. CH4 emissions increased with increasing water table depth as hypothesised. Higher CH4 fluxes in the constructed fen were positively correlated with increasing graminoid cover. Findings from this study provide a better understanding of N deposition and availability, and C cycling in the constructed fen further supporting on going reclamation assessment and ecosystem functionality.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12504 Contributed abstract
Poster Order: 3060P03

Assessing the impact of climate warming on peatland water table dynamics

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Presented by / Présenté par: *Erwin Don Racasa*
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Peatlands are the world's largest terrestrial carbon stores, where their ability to uptake atmospheric carbon relies on a host of interacting physical, hydrological, biological, and geochemical feedbacks. Water table variability and its response to precipitation and drying is a critical feedback on atmospheric carbon uptake, as net carbon sequestration relies on specific peat moisture conditions that are regulated by the water table feedback. However, the response in the water table feedback under a rapidly warming climate remains unclear. We examined the impact of climate warming on water table feedbacks in the Spruce and Peatland Responses Under Changing Environments (SPRUCE) whole-ecosystem warming within open-topped enclosures experiments at the Marcell Experimental Forest, Minnesota, USA. Since 2015, 10 bogs were subjected to temperature (+0, +2.25, +4.5, +6.75, +9°C) and atmospheric CO_2 (ambient or elevated) treatments. Decreasing ground surface elevations were observed in the warmest plots starting from 2017 with the largest decrease the +9°C treatment (~16 cm). Annual mean water table depths were close to ground surface (up to 0.1 m below ground surface) across all plots except in the 2021 drought year (all treatments) and 2023 (+6.75°C, +9°C). Specific yield (Sy), estimated by the water table rise method, generally declined across all plots from 2015 to 2023, with no significant difference between the ambient and elevated CO_2 treatments. Initially, there were no significant differences between warming treatments, but by later years (2021, 2023), Sy significantly differed ($p < 0.05$) in the +4.5°C, +6.75°C, +9°C treatments. The higher temperatures led to a decrease in water tables, resulting in a decline in Sy relative to the water table at the start of a given precipitation event. These findings highlight the effect of increasing temperatures on peatland hydrology that leads to autogenic positive feedbacks during

drought conditions.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12389 Contributed abstract

Poster Order: 3060P04

Overview of Data Cleaning Pipeline for Standardizing Eddy-Covariance Data

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Presented by / Présenté par: *Rosie Howard*

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The production of reliable eddy covariance (EC) data presents many challenges, such as site and instrumentation selection, manipulating and post-processing large datasets, and implementing quality control. Varying approaches to deal with these issues can result in diverse, non-standardized datasets, hindering cross-site comparisons. We present our approach for standardizing EC data post-processing, which includes QA/QC, gap-filling, and CO_2 flux partitioning, using a data-cleaning pipeline

scripted mainly in Matlab and R. The pipeline methodology is designed to be simple to implement, with minimal programming required. It incorporates resources and algorithms based on FLUXNET and other regional networks, as well as the REddyProc R-package. The intended result is to standardize datasets, allow reproducibility, and improve consistency across sites. Overall, the pipeline, combined with the efforts of projects such as Can-Peat and CARBONIQUE, will enable standardized EC data within larger regional and global networks. The goal is to enhance reliability and expand usability of these datasets, e.g., for improving estimates of carbon budgets in Canada, or validating remote-sensing based estimates of ecosystem carbon budgets. The pipeline code is freely available via a Git repository: https://github.com/CANFLUX/Biomet.net.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12281 Contributed abstract

Poster Order: 4060P01

Assessing the impacts of shifting planting dates on crop yields and irrigation demand under warming scenarios in Alberta, Canada

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Presented by / Présenté par: *Qi Zhao*

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Understanding the impacts of climate change on crop production and irrigation water demand is crucial for adapting to global warming. This study evaluated the effects of shifting planting dates on irrigated and rainfed crop yields and irrigation water demand under the latest Shared Socio-economic Pathways (SSPs) climate scenarios using the AquaCrop-OS model in Alberta, Canada. The results indicate: (1) climate change generally benefits irrigated crop yields while reducing rainfed yields under low mitigation scenarios (SSP585 and SSP370). (2) The impacts of planting date shifts on crop yields vary spatially and temporally across different SSPs. Early planting improves both rainfed and irrigated crop yields and reduces irrigation water demand under SSP585 in the latter half of the 21st Century, suggesting it is a viable strategy for mitigating heat and water stress in agricultural systems. However, this strategy does not guarantee yield increases under other SSPs. (3) The irrigated yields of spring wheat and canola are expected to increase under all scenarios, while rainfed yields decline under SSP585 and SSP370, with only marginal increases under SSP126. Annual irrigation demand will increase in the future, with the monthly irrigation peak occurring earlier. The most irrigation demand is under SSP585, followed by SSP370 and SSP126. (4) Early planting results in reduced irrigation water demand.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12304 Contributed abstract
Poster Order: 5010P01

Characterizing the changes in near-0°C temperature pathways and peaks in a warmer future climate in Eastern Canada

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Presented by / Présenté par: *Sujan Basnet*
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In cold regions like Canada, many hydrological and meteorological processes are strongly influenced by near-0°C temperatures (−2°C ≤ T ≤ 2°C). Recent studies indicate that these conditions are expected to persist in southern Canada under a warming climate. Previous research suggests that near-0°C temperatures are driven by factors such as snowpack melting and freezing, heat exchanges from precipitation, and temperature fluctuations caused by cloud cover. This study aims to examine changes in near-0°C temperature pathways and peaks in a warmer future climate across Eastern Canada. To achieve this, we utilized high-resolution (2.5 km) CRCM6/GEM5 model simulations over a 10-year period for both the current climate (CTRL) and a projected future climate (Pseudo-Global Warming, PGW) across Eastern Canada and the United States. Four near-0°C temperature pathways, classified based on warming and cooling transitions at the onset and cessation of near-0°C events where characterized. The temperature distribution was analyzed to identify near-0°C peaks in the current and future climate. Model results show a high frequency of near-0°C hours, reaching 1,500 in Newfoundland and Nova Scotia under CTRL run and 2,600 in Northern Quebec under PGW run. Pathway 3 (P3), which transitions from an above near-0°C temperature condition to another above near-0°C temperature condition, increases by 64.9% in Newfoundland. Meanwhile, Pathway 4 (P4), which moves from a below near-0°C temperature condition back to a below near-0°C temperature condition, rises by 200% in Northern Quebec. P3 is more common in southern regions, whereas P4 is dominant in the north, with the

P3/P4 boundary shifting northward in PGW. Peaks persist in the PGW scenario, with primary peaks increasing and secondary peaks decreasing. A deeper understanding of near-0°C conditions will enhance the ability to predict and manage their impacts on hydrological and meteorological processes.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12524 Contributed abstract
Poster Order: 5030P01

Modelling extreme climate events with machine learning downscaling techniques

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As extreme climate events grow in severity and frequency with climate change, research aims to improve modelling capabilities. To understand the relationship between large-scale climate change and local extreme events, low-resolution climate models must be downscaled to high-resolution weather fields relevant to regional scales. Due to the high computational expense of physics-based downscaling models, new approaches, including machine learning techniques, are being employed. Under the ClimatEx project, this research uses machine learning downscaling models to study extreme climate events. A stochastic Generative Adversarial Network (GAN) generates an ensemble of downscaled climate fields conditioned on low-resolution climate models, aiming to gain insight into the spatial dependence of these extremes and to evaluate the GAN's ability to reproduce them. The focus is on the tails and near-tails of the distributions of variables important to extreme events, such as temperatures and precipitation, as well as their dependence across space. Additionally, high-impact concurrent extreme events, where two variables are in their extremes, are analyzed with multivariate statistics. Model hyperparameters of the training process have been found to influence the quality of spatial features on small scales. Highly variable weather variables including precipitation benefit from the stochastic nature of these GANs, as do their tails. This work aims to develop operational products that can inform local adaptation strategies as well as address scientific questions about the dependence of extreme climate events.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12267 Contributed abstract
Poster Order: 5050P02

Distinct structures of interannual variations in stratosphere-to-troposphere ozone transport induced by the Tibetan Plateau thermal forcing

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Stratosphere-to-troposphere transport (STT) is an essential natural source of tropospheric ozone. Focusing on the STT variations in late spring and early summer with frequent ozone STT over the Asian region, this study investigated the Tibetan Plateau (TP) thermal effect on the interannual STT variations with the meteorological data over 1980–2014. The distinct structures of interannual STT anomalies with the key areas of TP thermal forcing are identified through the 35-year climatological statistics. Positive anomalies of thermal forcing over the central and eastern TP exert opposing impacts on the increasing and decreasing ozone STT respectively along northern and southern branches of the westerly jet around the TP. Such the stronger TP thermal forcing induces anticyclonic anomalies in the upper troposphere over the TP and the surroundings, which strengthens and attenuates the northern and southern branches of the westerly jet, intensifying and weakening the westerly trough for more (less) tropopause folds of ozone STT over East Asian region. Furthermore, the positive anomalies of thermal forcing over the western TP are related to the western enhancing and eastern declining STT over the Asian region. This study reveals a unique driver of the TP thermal forcing on the interannual variations in ozone STT with diverse structures, providing a new prospect for the TP effect on the atmospheric environment.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12466 Contributed abstract

Poster Order: 5080P01

A Collaborative Canadian Prairies and U.S. High Plains Binational Seasonal Climate Bulletin

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Presented by / Présenté par: *Erica Tetlock*

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The Prairies and High Plains binational seasonal climate bulletin is the latest addition to a collaborative series of quarterly climate impacts and outlook bulletins between Environment and Climate Change Canada (ECCC) and the National Oceanic Atmospheric Administration (NOAA), which cover the shared border regions of Canada and the U.S. The new Prairies and High Plains climate bulletin is produced each season, collectively between ECCC, Agriculture and Agri-Food Canada (AAFC), NOAA, and the U.S. Department of Agriculture (USDA). This new climate

bulletin summarizes the past season's significant weather and climate events, highlights regional impacts to communities over the Prairies and High Plains region, and includes an outlook for the upcoming season. Its geographical scope spans southern Alberta, southern Saskatchewan, southern Manitoba, Montana, North Dakota, South Dakota, western Minnesota, parts of Wyoming, and northern Nebraska. Unique to this bulletin is a section dedicated to drought monitoring and any agricultural impacts relevant to the region in each edition. The Prairies and High Plains region represents an area in both countries where agriculture is an important economic driver, and thus is sensitive to changing climatic conditions, especially those that may lead to increased risk of drought conditions. The bulletin utilizes information from AAFC's Canadian Drought Monitor, as well as the joint U.S. and Canadian North American Drought Monitor, which informs users of drought risks in both countries and plays an important role in informing policy and program development. AAFC and ECCC work closely together each season to review and produce this bulletin collectively with the U.S. partners, publishing it in March, June, September, and December, covering winter (Dec-Feb), spring (Mar-May), summer (Jun-Aug), and fall (Sep-Nov).

Session: 14010 POSTER SESSION AFFICHES

27/05/2025 15:30

ID: 12196 Contributed abstract

Poster Order: 6010P01

Climate Change Impacts to Groundwater Recharge & Hydrology in a Low-Mountain Area, Eskasoni, Nova Scotia.

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Presented by / Présenté par: *Julia Gillette*
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In cold regions, snowmelt is a prominent source of groundwater recharge and spring streamflow. However, as the climate warms, it is predicted there will be less snow falling and accumulating and more rain. Thus, the amount and timing of groundwater recharge may be significantly altered in a warmer climate through changes in temperature and changes in precipitation amount, timing, intensity, and phase. While declining snowpacks have been linked to declines in summertime low flows, the impact of a precipitation phase shift on groundwater resources is not well understood. The study purpose was to determine if snowmelt is more efficient than rain at recharging groundwater in a warming climate. The study was conducted in the Christmas Brook watershed located in Eskasoni, Nova Scotia. This watershed is one of eleven mountainous water towers in the region. Thus, study findings can be extrapolated to these other watersheds and aid the region's sustainable economic development goals. We monitored precipitation, snow depth, groundwater level, soil moisture and temperature, and streamflow across three landscape types at differing topographic positions. The Simultaneous Heat and Water (SHAW) model was applied over two years from July 2022 to July 2024 to quantify differences in rain versus snow recharge events. The baseline simulations were then compared to simulations of recharge in a warmer climate. Preliminary results indicate that historically, snowmelt makes up an important proportion of groundwater recharge, however large recharge events occur year-round from a combination of snowmelt and rainfall events. As anticipated, snowpack depth declined significantly with warmer temperatures. Additionally, soil ice content and snowmelt patterns changed, shifting recharge dynamics. The study results illustrate the complex mechanisms that control groundwater recharge in cold regions and the utility of modelling to understand how less snow and more rain will impact groundwater resources.

Session: 14010 POSTER SESSION AFFICHES

27/05/2025 15:30

ID: 12282 Contributed abstract

Poster Order: 6010P02

Field Observations of Snowpack Energy and Mass Balance During Rain-on-Snow (ROS) Events in Eastern Canada

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Presented by / Présenté par: *Dmitry Pershin*
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Rain-on-snow (ROS) events can cause severe flooding and alter snow accumulation dynamics. The hydrological impact of ROS events depends on two key elements: snowpack resistance factors, such as cold content and retention capacity, and amplifying factors, including available melt energy and rainfall amount. Despite advances in modeling, field studies quantifying snowpack mass and energy parameters during ROS events remain limited, particularly in boreal environments.
This study analyzes snowpack mass and energy dynamics during ROS events in Montmorency Forest (47°N, 71°W), Quebec, Canada. Our study sites span diverse boreal forest environments, from clear-cut areas to dense forest stands. The setup integrates manual snowpit observations with automated measurements of snow depth, snow water equivalent (SWE), and outflow via snow lysimeters. The energy balance is evaluated using measurements of shortwave and longwave radiation, vertical snowpack temperature profiles, and turbulent fluxes via Eddy Covariance.
During the 2023–2024 winter, eight ROS events were recorded, with rainfall exceeding 5 mm on an established snowpack. Two major events in December and April surpassed 70 mm of rainfall each. Early-season ROS typically occurred under cold snowpack conditions, while late-season events were linked to an isothermal snowpack. During early-season ROS events, water percolated through the snowpack and reached the snow base before the snowpack became isothermal, suggesting that rainfall percolation, rather than snowmelt, drove the outflow. Preferential flow pathways likely accelerated water transport through the snowpack with limited energy exchange.
Future analyses will explore how snow accumulation and energy flux variations across boreal environments shape snowpack response to ROS. Higher SWE and energy inputs in open areas may enhance snowmelt response, while lower SWE and reduced energy under forest canopies could limit melt but accelerate percolation. Understanding these interactions, also influenced by ROS intensity and seasonality, will clarify

spatial variability in snowpack response across the catchment.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12285 Contributed abstract

Poster Order: 6010P03

Towards a better representation of snow interception by forest canopies in cold, wet climates

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Presented by / Présenté par: *Emmanuelle Barrette*
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Snow is an essential component of the Canadian hydrological landscape. However, its spatial distribution is highly heterogeneous. In forested areas, snow interception by the canopy modulates snow water equivalent on the ground and affects surface albedo, which indirectly influences net radiation balance, surface temperature and heat exchange. Sublimation of intercepted snow also returns moisture to the atmosphere. Given the predominance of forested areas across Canada, accurate representation of this process is crucial in climate, meteorological, and hydrological models. However, snow interception remains poorly documented in the field, especially in eastern Canada’s cold, wet climate.

The objective of this research project is to analyze snow interception by the forest canopy using innovative experimental measurements to support the representation of interception within numerical models used in hydrometeorological forecasting.

Snow interception is monitored on nine trees (balsam firs, white spruces, and black spruces) located in three study sites: Laval University Campus (46.8°N, 71.3°W), Montmorency Forest (47.3°N, 71.1°W), and Romaine River valley (51°N, 63°W). Hourly time-lapse photography is used for qualitative observations of interception, while two quantitative methods are implemented at tree level. We use accelerometers to monitor wind-induced

tree sway and correlate changes in sway frequency with variations in intercepted snow mass. Each tree is calibrated with known weights and manual swaying to establish the relationship between changes in sway frequency and mass. Drone photogrammetry and terrestrial LiDAR techniques are used to measure the volume of intercepted snow. These methods aim at reconstructing time series of intercepted snow and linking them to the meteorological conditions responsible for its evolution. This presentation will detail the experimental setup and overview the first results obtained during winter 2024/25. Data will also be collected during winter 2025/26 to build an extensive evaluation dataset for the SVS2-Crocus land surface model used by Environment and Climate Change Canada.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12444 Contributed abstract

Poster Order: 6010P04

On the Comparison Between Observations and Idealized Simulations of Liquid Core Pellets During a Winter Storm

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Near 0°C winter precipitations are difficult to forecast because they strongly depend on environmental conditions and microphysical processes. For example, both freezing rain and ice pellets form when falling through a melting layer (T>0°C) aloft and a subfreezing layer (T<0°C) below it. These atmospheric conditions can also produce liquid core pellets, particles composed of a liquid water core surrounded by an ice shell. Liquid core pellets can form by the partial refreezing of liquid or mixed phase particles in the subfreezing layer. If these particles break upon impact with the surface, their liquid core might produce a coat of ice, which can lead to hazardous conditions. The goal of this study is to compare observations and idealized simulations of liquid core pellets during a winter storm. To do so, data from the 2022 Winter Precipitation Type Research Multiscale Experiment

(WINTRE-MIX) field campaign were used. Theoretical calculations based on the freezing time equation and observed vertical temperature profiles were also conducted. During this 22-23 February 2022 event, the thickness of the refreezing layer varied from 448 m to 599 m, which is lower than the climatology (770 m). The average diameter of the observed liquid core pellets was 0.8 mm, with a range of 0.31 mm to 2.88 mm. Given the measurements of the particles' diameter and ice shell thickness, the liquid water available for icing on structure corresponds, on average, to 48% of the particles' volume. The theoretical calculations also suggested that the refreezing of supercooled drops was initiated at elevations close to the surface, i.e. lower than 100 m above the surface. These results highlight the importance of precisely measuring and simulating the refreezing layer and the microphysical processes during winter storms to improve the representation of near 0°C winter precipitation types in atmospheric models.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12475 Contributed abstract

Poster Order: 6010P05

Determining the Impact of Alpine Terrain Roughness on Snow Redistribution by Wind

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Presented by / Présenté par: *Qingping Yu*

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In mountainous regions, snowmelt is the primary contributor to streamflow, influencing water availability for ecosystems, agriculture, industry, hydropower and community water supplies. However, accurate prediction of mountain snowmelt remains challenging due to uncertainties in snow redistribution by wind in alpine terrain. This research addresses a critical

gap in blowing snow modelling by integrating alpine terrain roughness parameters into physically based blowing snow redistribution models. The research uses observations of digital surface models (DSM) from drone-borne Light Detection and Ranging (LiDAR), in-situ rock measurements, and a ridgetop eddy covariance (EC) system at the Fortress Mountain Research Basin (FMRB) in the Canadian Rockies to derive terrain roughness parameters. LiDAR-derived DSM and EC turbulence measurements were used to estimate aerodynamic roughness length modification by rocky terrain and snowcover using DSM analysis algorithms developed for Martian dust-storms. Roughness length controls the partitioning of shear stress during snow saltation and hence the transport rate of blowing snow. The new roughness parameterisation was incorporated into the saltation equation of the Prairie Blowing Snow Model 3D (PBSM-3D), a physically based snow transport model designed to simulate wind-driven snow redistribution in complex terrain. The methodological framework involves data collection, roughness parameterisation, model integration, validation and sensitivity analysis. Findings suggest that rocky terrain roughness significantly alters alpine snow redistribution dynamics by affecting snow erosion and deposition patterns. Roughness from rocks also interact with roughness from alpine vegetation. Integrating locally parameterized roughness data into snow redistribution models enhances snow depth predictive accuracy, reducing uncertainty in snow accumulation estimates. This research provides a framework for refining snow hydrology models in alpine environments.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12226 Contributed abstract
Poster Order: 6020P01

Evidence of historical and contemporary permafrost degradation near Yellowknife, Northwest Territories

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Presented by / Présenté par: *Alana Muenchrath*
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Due to unprecedented warming of subarctic regions, rising permafrost temperatures are leading to widespread thaw. Of particular concern is the expansion of thermokarst terrain, which refers to landforms and processes associated with ground collapse due to the thawing of ice-rich permafrost. Thermokarst terrain can alter hydrogeologic connectivity and hydrologic pathways due to the loss of ground ice and formation of surface depressions. Vegetation and geomorphologic change associated with thermokarst processes allows for the detection of permafrost thaw using aerial imagery. The objective of this study was to identify locations of lithalsa degradation in the Baker Creek Research Watershed (BCRW) located near Yellowknife, NWT by combining field observations and high-resolution imagery. Recent and historical high-resolution aerial imagery acquired over a 2.0 km2 region was used to identify landscape features such as thermokarst ponds, flooded vegetation, and lithalsa remnants. Within the study area, 14 thermokarst ponds and one intact lithalsa were identified. Imagery suggests landscape change associated with thaw began between 1989–1994, while thermokarst terrain was evident by 2004. Further, LiDAR surveys conducted in 2007 and 2024 provide evidence of the degree of subsidence over the last 17 years, which was as high as 0.75 m. This study provides valuable insight on the rates of permafrost thaw and thermokarst development and identifies regions susceptible to associated

hydrological changes. It also highlights the advantage of fine-scale observations and imagery to detect landscape change and how they could complement extensive coarse-scale remote sensing methodologies, which may underestimate small-scale thermokarst occurrence.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12413 Contributed abstract

Poster Order: 7010P01

Relevance of the National Standards in MSC's Surface Network in Building Resilience

Jonathan Kwong [1] , *Gary Tsim* [2] , *Summer Warren* [3]

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Presented by / Présenté par: *Gary Tsim*

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As a Canada-wide network operator, the development and adherence to network standards are critical for consistency in the collection and exchange of meteorological data. This presentation will delve into the development and implementation of standardized protocols within the Meteorological Service of Canada's Surface Network that ensure the reliability, accuracy, and the interchange of weather data across various platforms and systems. We will explore the key components of these network standards in connection with data, communication protocols, and with an emphasis on site infrastructure.

The presentation will also address the challenges faced in standardizing network operations, such as the integration of aging legacy systems and the need for continuous updates to accommodate new technologies and client needs. As this presentation will be focused on the ongoing development of standards over the last decade, case studies will be presented to illustrate the successful application of these standards within the network, highlighting improvements in data consistency, data monitoring and the overall health and dependability of the network.
Furthermore, we will discuss what is needed in developing and maintaining these standards, ensuring that meteorological data can be effectively shared and utilized on a global scale. By adhering to these standards, we aim to support the meteorological community in providing more accurate and timely weather information, while contributing to better decision-making and public safety.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12418 Contributed abstract

Poster Order: 7010P02

Citizen Science Contributions to Enhancing Precipitation Observations on the Prairies: Insights from a Volunteer Community Collaborative Rain Hail and Snow (CoCoRaHS) Observer

Charmaine Hrynkiw [1]

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Presented by / Présenté par: *Charmaine Hrynkiw*
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The Community Collaborative Rain Hail and Snow (CoCoRaHS) network is a volunteer-based program of over 26,000 active precipitation observers who use manual methods to measure precipitation across the United States, Canada and the Caribbean. This presentation will explore the motivation, commitment and valuable insights gained from being engaged as a volunteer observer supplementing the official weather observation network with daily precipitation measurements. It will specifically highlight

the challenges of providing accurate observations in the Prairie environment, particularly for snowfall. The linkages between this volunteer data and products/services provided by Environment and Climate Change Canada will also be discussed. The presentation will highlight the value of citizen science, emphasizing the intrinsic rewards and continuous learning opportunities provided by participation in this network, as well as the associated benefits to the broader community, both now and in the future.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12416 Contributed abstract

Poster Order: 7010P03

Network operators experience using GIS to improve weather station resilience against forest fires

Kim Hsu [1] , *Gary Tsim* [2] , *Olivier Gagnon* [3]

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Presented by / Présenté par: *Kim Hsu*
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Wildfires pose significant threats to both natural and built environments, often exacerbated by changing climatic conditions. By incorporating (near)real-time fire data into our network, we can monitor fire activity and its potential impacts on weather station operations. GIS technology allows us to visualize and analyze spatial data, providing a comprehensive understanding of fire spread, affected areas, and critical infrastructure at risk.
Early warning systems are crucial in mitigating the adverse effects of wildfires. By integrating fire data with our network monitoring tools, we can issue timely alerts to our staff, enabling proactive measures to safeguard lives and property.
This presentation/poster will delve into case studies examining the application of these technologies, highlighting the collaborative efforts between network management, network operations and, developers. We will discuss the challenges faced, lessons learned, and future directions for enhancing network resilience in the face of increasing wildfire incidents.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12185 Contributed abstract
Poster Order: 8010P01

Is forest change altering streamflow across Canada?

Jason Leach [1] , *Danielle Hudson* [2] , *Annie Gray* [3] , *Joanne White* [4] , *Txomin Hermosilla* [5] , *Michael Wulder* [6]

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Presented by / Présenté par: *Jason Leach*
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Climate and forest change can alter the timing and magnitude of streamflow with potential consequences for downstream water supply and aquatic ecosystems. National-scale research from Canada has largely focused on streamflow response to climate effects, such as changes in precipitation and temperature. The influence of forest change on streamflow has received less attention despite detailed local- and regional-focused studies showing that forest change, due to harvesting, wildfire, or return of vegetation and trees following disturbance (forest recovery), can significantly alter catchment hydrology. We analyzed long-term (1984 to 2019) trends in annual streamflow, climate, and forest cover for 454 gauged watersheds across Canada’s forests. Results indicated that changes in climate explained variability in streamflow trends for most watersheds, but streamflow trends for 15% of the watersheds appeared to be strongly influenced by forest change. Watersheds that experienced a loss of forest cover due to disturbance tended to be associated with increased streamflow trends, likely caused by a reduction in canopy interception and evapotranspiration. Watersheds with increased forest cover trends, often due to the return of forests following harvesting, especially before the study baseline in 1984, were associated with decreased streamflow trends at 15 sites and insignificant streamflow trends at 36 sites. Many of these 36 watersheds with insignificant streamflow trends are in Atlantic Canada which has experienced increased precipitation inputs during the study period. We hypothesize that forest recovery may have offset the effect of increased precipitation on streamflow for these watersheds. Our results highlight that forest cover is more dynamic than previously thought for many gauged watersheds across Canada and that these changes in forest cover can alter streamflow and have interacting effects with climate change.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12197 Contributed abstract
Poster Order: 8010P02

Effects of afforestation on hydrologic signatures in a humid, snow-dominated system: A case study from Sudbury, Ontario

Danielle Hudson [1] , *Jason Leach* [2] , *Magali Nehemy* [3]

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Presented by / Présenté par: *Danielle Hudson*
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Many jurisdictions champion afforestation as an effective nature-based solution for sequestering carbon to help mitigate anthropogenic climate change. While we know that afforestation can alter hydrologic processes, we lack research from diverse climates and geologic settings to reliably predict the effects of increased forest cover on hydrology. Most studies on hydrologic response to afforestation are from arid or semi-arid landscapes. In contrast, we have few studies from humid environments that are influenced by snow. In this study, we examine the hydrologic response to afforestation in a snow-dominated system by focusing on the Sudbury region of central Ontario. This area has undergone considerable afforestation efforts over the past few decades following a century of deforestation associated with historic mining activities. We analyzed streamflow data collected at six Water Survey of Canada catchments located in the Sudbury region, three of which have had increasing forest cover from afforestation since the early 1980s, and three reference catchments which have had relatively stable forest cover over the same period. By considering a range of hydrologic signatures representing different aspects of the streamflow regime, such as water yield, peak flows, low flows, timing, and flashiness, we investigate the effect of afforestation on hydrologic responses. While most hydrologic signatures appeared to be insensitive to increases in forest cover, flashiness decreased and summer low flows increased slightly in the afforested catchments compared to the reference catchments. The robustness of our findings is limited by available data and confounding differences between afforested and reference catchments. Further research focused on underlying hydrologic processes associated with afforestation is needed to rigorously constrain predictions around the possible hydrologic effects of afforestation for Canadian

watersheds influenced by snow.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12361 Contributed abstract
Poster Order: 8010P03

Summer and winter variations in transpiration source water and ecohydrological connectivity with streamflow sources in the Maimai M8 Catchment

Cerra Simmons [1] , *Bruce Dudley* [2] , *Jeffrey McDonnell* [3] , *Magali Nehemy* [4]

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Presented by / Présenté par: *Cerra Simmons*
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Transpiration is responsible for transporting the largest volume of terrestrial subsurface water stores to the atmosphere and plays a crucial role in the hydrological cycle. While extensive research has been conducted in the Maimai M8 catchment (New Zealand) and across many catchments on streamflow generation processes and streamflow sources, we still know little about the sources of transpiration, the periods when transpiration and streamflow sources are hydrologically connected and the mechanisms that drive this connectivity. Here we investigated transpiration source water and transpiration source connectivity with streamflow sources at M8, a long-term studied catchment with well-described streamflow generation processes. We combined monthly observations of isotopic signatures (δ18O and δ2H) of xylem, bulk soil water, mobile water, subsurface flow, and stream water with continuous monitoring of tree water stress across a hillslope to answer the questions: (1) What is the source of transpiration at Maimai in the summer and winter? And (2) how and when does transpiration source water connect with streamflow sources? Our data showed similar tree isotopic signatures, suggesting that tree water sources were homogenous across the hillslope and showed seasonal changes in these sources. During summer, when trees displayed greater periods of water stress, trees relied on shallow soil water. In contrast, during the winter, trees' isotopic signatures plotted along the local meteoric water line (LMWL), overlapping with mobile soil water, subsurface flow and stream isotopic signatures. Xylem isotopic signatures were not statistically distinct from stream signatures in the winter, contrasting with distinct isotopic signatures during the summer. Our results showed that transpiration source water in the Maimai M8 catchment changes seasonally, influenced by tree water stress and wetness conditions. Overall, our findings suggest that transpiration and streamflow sources are ecohydrologically connected during winter months in this wet temperate climate.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12525 Contributed abstract
Poster Order: 8010P05

The pulse of forested watersheds: Stem and stream diel cycles reveal hydrologic connectivity between transpiration and streamflow

Kaleb Martin [1] , *Danielle Hudson* [2] , *Brianna Townsend* [3] , *Matthew Dimitroff* [4] , *Jason Leach* [5] , *Magali Nehemy* [6]

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[2] Trent University; Canadian Forest Service -- Natural Resources Canada

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Presented by / Présenté par: *Kaleb Martin*

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Subsurface water storage critically supports both transpiration and streamflow in forested environments. However, the subsurface processes that mediate the connectivity between transpiration and streamflow for forested hillslopes remain poorly understood. This study focuses on the diel cycles of tree water storage, streamflow, and groundwater to better understand the connectivity between transpiration and streamflow on forested hillslopes. Unlike previous research that primarily utilized proxies such as air temperature and solar radiation to study evapotranspiration-driven stream diel cycles, this study directly observes the diel cycles in tree water storage alongside streamflow. Diel cycles in tree water storage can directly reveal tree water use and reflect the balance between root water uptake and transpiration. Here we examined the diel cycles of maple tree stems (Acer saccharum), correlating these with patterns in streamflow and groundwater across two hillslopes with shallow soils over the 2023 and 2024 growing seasons at the Turkey Lakes Watersheds in Ontario. Our results revealed a strong positive correlation between tree stem diel cycles and streamflow under dry conditions, particularly toward the end of the growing season when tree water deficits were pronounced. Conversely, during wet periods, particularly in spring and after rainfall events, correlations were weaker, and tree water deficits were minimal. There was

no specific pattern of negative correlation related to rainfall intensity or event size. These findings indicate that transpiration-driven diel fluctuations in streamflow are primarily evident under drier conditions in the studied catchment, suggesting tighter hydraulic connectivity when subsurface water storage is not abundant. We hypothesize that under wet conditions, the existence of distinct subsurface flowpaths that feed transpiration and streamflow (preferential vs matrix flow, respectively) disrupt the transmission of root-generated tension during water uptake to subsurface storages that feed streamflow. Conversely, during drier conditions, root-generated tension significantly impacts the matrix, and subsurface water storages, effectively propagating transpiration-driven tension to streamflow. Further research is needed to delineate the drier threshold conditions under which this relationship diminishes. Our study highlights the value of direct measurements of tree stem diel cycles in understanding the impact of transpiration on streamflow dynamics, emphasizing the need for integrated ecohydrological measurements that account for direct changes in tree water use.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12183 Contributed abstract

Poster Order: 8020P01

Biophysicochemical characterization of wells and borehole waters along weathered crystalline aquifers, Mfou, centre region Cameroon

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[1]

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Presented by / Présenté par: *NANJE MOSERE FELICIA*
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The physicochemical properties of ground water from various locations in Mfou were analysed. Sampling was done July 2023 which marks the first short dry season in the climatic regime. Water samples were collected from 20 different locations constituting 8 major quarters and four main sources (open wells, closed wells, boreholes and spring). Samples were collected and clearly labeled in polythene bottles (1.5l) capacity, amba bottles and small white bottles which had be washed thoroughly and rinsed severally with distilled water. An analytical grade reagent was used to prepare reagents for calibration. For the alkalinity test, acid titrator was used with a bromomethyl indicator whereas a photo spectrometer was used for test for nitrates and dissolved oxygen. Physical test was done insitu using a multi parameter probe which was calibrated for pH of 4-7 and 11. Well depth ranged between 12-36m. Results of the physico-chemical parameters was within the following range: pH (4.01-6.81), temperature (24.04-27.4), conductivity (24-361), dissolved oxygen mg/l (4.2-7.4), percentage dissolved oxygen (27.1-61.9), dissolved oxygen ppm (2.04-27.1), oxygen reduction potential ORP(MV)(17.6-250), resistivity (0.0023-0.0417), total dissolved solutes(1.81-176), salinity (0.01-0.1), alkalinity(0-770), nitrates(2.1-5.4). Results of specific Microbes isolated (Total Fecal Coliforms) / colony forming units/ml, reveals Total coliform Enterobacteria spp. (3-200), Total feacal coliform E. Coli (1-70), Streptococcus spp (02-05) Salmonella spp(1-22) Shigella spp(2-4) Staphylococus spp(2-20) Vibrio spp. (0) Comparing results with WHO standards reveals, about 50% were not good for direct consumption as they were contaminated with one or more bacteria.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12212 Contributed abstract

Poster Order: 8020P02

From Storm to Stream: Tracking Shifts in Water Quality Parameters During Rainfall Events of Different Sizes

Olivier Grégoire [1] , *Geneviève Ali* [2] , *Seonaid G. Newell-Macintosh* [3] , *Corinne Arson* [4] , *Alina Kostyuk* [5] , *Liya Miliya* [6] , *Gabriel Morales-Guillén* [7]

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Presented by / Présenté par: *Olivier Grégoire*
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The increased frequency in extreme weather events due to climate change, coupled with the significant impact of agricultural activities on runoff generation, poses a serious threat to water quality. While high-frequency water sampling and testing allows a better understanding of solute transport patterns during hydrological events, little information exists on the unique versus redundant information provided by different water quality parameters. This research aims to (1) quantify redundant information among water quality parameters, (2) assess the consistency of solute transport patterns – inferred from different water quality parameters – during a single hydrological event, and (3) compare transport patterns across a range of regular to extreme rainfall events. The chosen study site is the Ours Creek watershed (Quebec, Canada), a 35.1 km² catchment with 80% agricultural use and a real-time hydrometric and forecasting station at the outlet. From May to August 2024, an autosampler collected creek water samples every 3 to 24 hours, with higher frequencies during storm events determined based flow forecasts. Water samples were analyzed for 44 water quality parameters, including nutrients, metals, rare earth elements (REEs), fecal coliforms and physical properties. Correlation analysis was used to identify non-redundant parameters, while hydrochemographs were created to identify solute transport patterns based on the synchronicity and phase of streamflow and water quality fluctuations during events. Results indicate that REEs and certain metals tend to correlate strongly and thus are highly redundant, unlike nutrients and stable isotopic signatures. Hydrochemographs from five rainfall events, including those associated with tropical storms Beryl and Debby, suggest that solute transport patterns vary by storm magnitude, with only 2 out of 14 non-redundant parameters displaying consistency across events. Further research on the effects of rainfall intensity and duration on solute transport patterns could be crucial for improving our understanding of climate change impacts on river water quality.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12485 Contributed abstract

Poster Order: 8020P03

Chloride concentrations in streamwater, groundwater and soil water in

a heavily salted urban watershed

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Presented by / Présenté par: *Claire Oswald*
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Freshwater salinization negatively impacts human and ecosystem health. In cold regions, the application of chloride-based de-icers contributes to increasing salinity of important water resources. While much of the chloride applied as road salt is flushed from the landscape during snowmelt events, a portion is transported into the subsurface. The magnitude and timing of chloride storage and transport in the subsurface is challenging to estimate, yet critical for understanding the potential benefits of mitigation efforts. Streamwater, groundwater and soil water samples are being collected in the urbanized 63 km2 Black Creek watershed and analyzed for major ions to build an observational dataset to support this line of inquiry. Streamwater chloride concentrations measured at the outlet since 2023 range from approximately 100 to 1000 mg/L in baseflow and can reach peaks over 6,000 mg/L during the winter. Groundwater chloride concentrations measured across 8 wells (all within 250 m of the lowest stream reach) over the same period ranged from approximately 50 to 3,000 mg/L, although 6 of the 8 wells were consistently below 1000 mg/L. Soil water chloride concentrations measured since May 2024 are highly variable in space and time. Samples collected within 1 m of a salted road had chloride concentrations ranging from approximately 150 to 48,000 mg/L, while sites located 5 to 150 m from a road had concentrations ranging from approximately 25 to 350 mg/L. Soil water chloride concentrations generally increase with depth the closer a site is to a road, however, high-frequency electrical conductivity measurements in the vadose zone at two roadside sites reveal localized variability in the pattern of vertical ion transport. Collectively, these observations suggest a large pool of legacy chloride is stored in the subsurface. Future work will focus on estimating the magnitude of this storage and whether it has reached equilibrium.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12227 Contributed abstract

Poster Order: 8030P02

Modelling Winter Hydrological Processes to Simulate Wheat Yield in the Canadian Prairies

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Presented by / Présenté par: *Anukul Basnet*
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The Prairies, where most of Canada's wheat is produced, are dominated by seasonally frozen soil, snow cover, and low precipitation. The post-snowmelt/thaw condition of soil moisture is determined by snow accumulation, melt, infiltration, and residual soil moisture from the preceding season, and is critical for the growing season. Crop models can simulate crop production; however, often lack representation of winter processes. To address this limitation, a hydrology-land surface model can be used to simulate soil dynamics during winter.

The objective of this project is to combine a hydrology-land surface model and a crop model to simulate year-round soil moisture and wheat yield at field scale using a combined model framework. The model framework will be tested against field observations of soil moisture, frozen soil and wheat yield for Saskatchewan sites, allowing us to evaluate how well the model framework represents real-world conditions.

To simulate winter soil hydrology, the physically-based Simultaneous Heat and Water (SHAW) model is used. End-of-winter soil moisture values simulated by SHAW serve as the initial conditions for the FAO AquaCrop model to simulate wheat yield and growing season soil moisture. AquaCrop is a water productivity model suitable for crop yield simulation in the Prairies. Driving data from weather stations, and model parameters of soil and crop at specific sites in Saskatchewan were used. Simulated soil moisture and crop yield values were compared with available field observation data to evaluate the accuracy of simulation. A validated model framework will then be used to assess future soil moisture and crop yield under changing weather conditions.

The SHAW-AquaCrop model framework enables year-round field scale soil moisture and crop yield simulation. This model framework can be useful for farmers and policymakers to estimate crop yield and soil moisture under evolving hydrological conditions in the Prairies.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12237 Contributed abstract

Poster Order: 8030P03

Characterizing rainfall-runoff response and catchment storage variability in a small, forested catchment

Alina Kostyuk [1] , *Genevieve Ali* [2] , *Liya Miliya* [3] , *Olivier Gregoire* [4] , *Seonaid Newell-Macintosh* [5] , *Gabriel Morales-Guillen* [6]

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Presented by / Présenté par: *Alina Kostyuk*
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The hydrological response of a catchment to individual rainfall events through runoff generation can be highly variable in time and space. While numerous studies around the world have focused on hydrological responses dynamics and how they are modulated by catchment storage, few have done so across a range of small to very large precipitation events. This study leverages data from one of the rainiest summers on record in Southern Quebec, including the remnants of tropical storms Beryl and Debby, to characterize the inter-event variability in 1) the timing and magnitude of hydrologic responses, and 2) catchment storage states. The study site is a 55-ha forested catchment located on Mont-Saint-Hilaire. Between May and November 2024, water level was measured continuously. Catchment storage was monitored via water table levels (in wells up to 1.65 m depth) recorded every 15 minutes. Thirty rainfall-runoff events were delineated, and individual storm hydrographs were used to calculate select response magnitude (e.g., runoff coefficient, peak discharge) and timing (e.g., response lag; time of rise) metrics. Additionally, water table data was used to compare the magnitude and timing of the response to that of streamflow. Analyses show that total event precipitation amounts ranged from 2 to 136 mm, with runoff response durations ranging from 38 to 54 hours, and runoff coefficients ranging from 0.03 to 0.56. Depending on the event and measurement location, water table depth reached the highest

value up to 10 hours before or 16 hours after peak stormflow, highlighting complex relationships between catchment storage and discharge. Future analyses will include assessing groundwater data for hysteresis, and building a topology for rainfall-runoff response dynamics across a continuum of regular to extreme events.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12273 Contributed abstract

Poster Order: 8030P04

Assessing the effects of the spatiotemporal variability of old water isotopic signatures on hydrograph separation in a small, forested watershed

Miliya Miliya [1] , *Genevieve Ali* [2] , *Alina Kostyuk* [3] , *Olivier Gregoire* [4] , *Corinne Arson* [5] , *Gabriel Morales-Guillen* [6]

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Isotope-based hydrograph separation, which partitions streamflow into new water from recent precipitation and old water stored in the watershed before the event under consideration, can reveal information about streamwater sources, flow paths, and water ages. A better understanding of watershed hydrological responses to precipitation events can also improve strategies for sustainable water resource management, enhancing resilience against future environmental changes. While many studies have addressed the effect of either the temporal or the spatial variability of groundwater isotopic signatures on hydrograph separation results, few have examined both at the same time, across small to large precipitation events. This study therefore aims to (1) evaluate the sensitivity of hydrograph separation results to the spatial and temporal variability of the old water end-member, and (2) compare hydrograph separation results between regular and extreme rainfall events. The focus was on the 54.7-hectare West Creek watershed

located on Mont-Saint-Hilaire, Quebec, from May to November 2024. Streamwater was sampled at the watershed outlet using autosamplers, at a 4–8-hour frequency during hydrological events and 12-hour frequency between events. Precipitation water grab samples were collected weekly from two rainwater collectors, and groundwater was collected weekly from five 1.65-meter deep wells and a natural spring, located in different topographic positions. All samples were tested for $\delta^{18}O$ and $\delta^{2}H$ towards performing isotope-based hydrograph separation. Significant spatial and temporal variability was observed in groundwater isotopic signatures across the watershed. Preliminary results show that when applying different hydrograph separation scenarios using different old water signatures, estimated old water fractions were highly variable, ranging from 2.3% to 99.9%, highlighting the sensitivity of the method to the selected old water end-member. Future analyses will include the estimation of uncertainty around the calculated old water estimates, to further assess the reliability of hydrograph separation results for typical versus extreme rainfall events.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12300 Contributed abstract

Poster Order: 8030P05

Modelling differential responses of C3 and C4 crops to changing atmospheric CO2, temperature, and precipitation in Alberta

Jamin Achtymichuk [1] , *Monireh Faramarzi* [2] , *Miles Dyck* [3]

[1]

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Presented by / Présenté par: *Jamin Achtymichuk*

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Climate change is expected to impact plant photosynthesis and transpiration, influencing soil and hydrological processes. Rising temperatures and CO2 may either (1) enhance photosynthetic and water use efficiency, especially in C3 plants, or (2) increase photorespiration and stress, reducing water use efficiency. These scenarios will have opposing effects on numerous biogeochemical processes such as hydrology, crop yields, evapotranspiration, and soil nutrient such as carbon dynamics. Current agro(eco)hydrologic models simulate atmospheric CO2 effects well but often lack detailed heat stress responses of vegetation, limiting reliable predictions of soil water dynamics under global warming scenarios. Using a modified Soil and Water Assessment Tool (SWAT-C), this study explores the photosynthesis, photorespiration, and stomatal conductance of annual crops and their potential decoupling mechanisms in response to future climate change. The publically available SWAT-C is modified to reliably simulate plant growth processes for canola and wheat (C3), and corn (C4) under elevated atmospheric CO2 and global warming scenarios in agricultural watersheds of Canadian Prairies. The effect of improved process representation on water use efficiency, crop yields, and soil nutrient (carbon) export for historical (1980–2015) and future (2040–2075) periods are assessed. The study provides a basis for improved understanding of watershed-scale responses to increasing CO2 and temperature in agricultural watersheds and Canadian Prairies, which will inform effective land and water management strategies in similar regions in the mid-to-high latitudes.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12511 Contributed abstract

Poster Order: 8030P06

Contribution of macropores to infiltration and interflow at the hillslope scale for a constructed pit-lake watershed and subsequent design consequences for lake inflow.

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Presented by / Présenté par: *Timothy Trembath*
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Reclamation cover in constructed watersheds often undergo rapid evolution within the first few years following construction. This can have profound impacts on the hydro connectivity of the watershed and its ability to supply water. For pit-lakes that rely on predictable inflow to maintain a sufficient water cap, this is an area concern for future closure designs. The development of macropores can create pathways for rapid infiltration and interflow through the surface layers. In this study, the watershed for a pilot-scale pit-lake closure design was evaluated for its hydro-connectivity at a hillslope scale. Using tension and ring infiltrometers, the contribution of macropores to infiltration was shown to be dominant and orders of magnitude higher than typical rainfall intensity. During rainfall events, the

water table responded faster and with greater magnitude in the swales than the adjacent hillslopes, suggesting preferential interflow through the unsaturated zone. Lack of changes in the soil moisture at depth indicate that this interflow mostly occurs in the upper 40cm, potentially along the interface of the placed soil cover. Essentially unlimited infiltration and preferential flow restricts input to the lake by reducing the overland flow of the swales designed to convey water to the lake. Lake inflow is limited to times of high saturation with a definitive storage-threshold relationship developing in the swales to date. This research has implications for the closure design with emphasis on the need for a groundwater connection to supply the lake in the absence of overland land.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12579 Contributed abstract

Poster Order: 8030P07

Impacts of historic and projected climate change on groundwater resources in Nova Scotia

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Presented by / Présenté par: *Nicole LeRoux*
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Nearly 50% of the population of the Atlantic Canadian province of Nova Scotia relies on private wells for clean drinking water, and this percentage increases for small rural communities. A portion of these wells are shallow dug wells, which are more vulnerable to atmospheric drought. Dug wells in Nova Scotia have gone dry in four of the last seven summers, forcing governments to distribute bottled water through a coupon system. Drilled wells are more resilient to atmospheric drought; however, drilling costs are often prohibitive, and deep coastal wells may encounter saltwater or geogenic contaminants. Climate change threatens fresh groundwater resources by (1) reducing groundwater recharge and (2) increasing the

salinity of coastal aquifers. Changing groundwater recharge can be triggered by changes to precipitation, evapotranspiration, spring snowmelt, and mid-winter thaws. Sea-level rise can drive subsurface saltwater intrusion into coastal aquifers. The compounding impacts of these atmospheric and oceanic stressors on groundwater resources are critical to understand to make informed adaption plans.
To better understand drought and recharge patterns and saltwater intrusion risks in Nova Scotia, we used several field methods and data analysis techniques. We compiled historic drought maps and hydrometric datasets and collected new groundwater level and soil moisture probe data. Data are being used to investigate past hydrometric trends and calibrate a numerical model to simulate impacts of climate change on future groundwater recharge. Coastal geophysical surveys have been collected to investigate the depth to saltwater, and to inform the development of a saltwater intrusion risk map based on analytical solutions. Overall, our preliminary results provide critical insights into the impacts of oceanic and atmospheric climate change on groundwater and lay the foundation for better risk identification and adaptation plans to underpin sustainable groundwater management.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12305 Contributed abstract

Poster Order: 8040P01

Optimizing crop mix for assessment of water saving opportunities in Nelson River Basin

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Climate change and population growth are intensifying global food demand and increasing agricultural water consumption, potentially exacerbating conflicts among water-use sectors and contributing to environmental degradation. The Nelson River Basin (NRB), Canada’s largest agricultural watershed, is among the world’s most water-abundant and nutrient-rich regions, supplying agricultural commodities to over 170 countries annually. More than 90% of agricultural production in the NRB depends on green

water resources, which play a dominant role in the hydrological balance, influencing surface runoff and river system inflows.

In this study, we develop a coupled process-based and machine learning framework by integrating a calibrated Soil and Water Assessment Tool (SWAT) model of the NRB with a reinforcement learning-based optimization approach. This integrated model systematically simulates the interactions among crop growth, hydrological processes, and water availability. We assess the extent to which an optimized crop mix can enhance food production, economic returns, and green water use while sustaining watershed water yield under three distinct scenarios: historical baseline, extreme drought, and projected future climate conditions. Our findings offer critical insights into the trade-offs between regionally and provincially optimized crop mix, highlighting their implications for water conservation and environmental sustainability in both the short and long run and under future changing climate conditions.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12330 Contributed abstract

Poster Order: 8040P02

Towards determining the maximum water force beaver dams can endure before breaching

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Beaver dams are complex structures in headwaters critical in reducing flood and drought risk. As a result, beaver dams are gaining recognition as a nature-based climate and ecosystem restoration solution. The risk of implementing beaver dams as a nature-based solution is their susceptibility to partial or complete breaching during hydrological events, which can result in outburst floods. Yet, the hydraulic forces acting upon beaver dams and the conditions leading to dam failure remain poorly understood. We studied four beaver dams in the montane region of Alberta between May and October 2024 to assess their hydraulic stability and structural changes in response to rainfall events. Water level loggers were installed upstream and downstream of each dam to continuously measure water levels, which were used to calculate hydraulic forces including horizontal pressure, uplift

pressure, and wave pressure. Measurements of the sediment wedge upstream of each dam were taken to estimate silt pressure. Dam volume was determined by 3D modeling of rtk-GPS data points in AutoCAD. Dam weights were assessed via sampling of dam sediment and woody material. Optical methods were used to analyze dam structural changes in response to hydrological events. Rarely did the combined forces from the hydraulic pressures exceed the weight of the dam. One of the dams, however, experienced structural changes during two hydrological events. A 37.8 mm rainstorm on June 27, 2024 caused the hydraulic pressures to exceed dam weight, resulting in ~50% change in dam structure. Two weeks later the failure of an unstudied, upstream beaver dam created an brief flood wave that elevated upstream horizontal and uplift pressures to maximum values, triggering a partial breach of the dam. This research advances the understanding of the influence of rainstorm events on hydraulic load intensification on beaver dams and their structural response to these forces.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12332 Contributed abstract

Poster Order: 8040P03

Assessing budget changes in Prairie basin snow hydrology: snow redistribution, ablation, and runoff.

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Presented by / Présenté par: *Zoë Johnson*
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Snow is a primary source of the manageable fresh water supply on the Canadian Prairies. With about one third of annual precipitation falling as snow, changes in snow cover accumulation, duration, and melt dynamics have profound impacts on water management and agricultural practices in the region, as spring runoff, streamflow, and soil moisture are strongly influenced by wintertime conditions. Wind transport and sublimation of snow controls spring snowpacks and their variability and no studies have examined how blowing snow redistribution has changed over time. To assess trends and changes in Prairie snow processes and water budgets, the Cold Regions Hydrological Modelling platform was forced with ERA-5 reanalysis data from 1950 to 2020 and used to model over 4000 “virtual

basins” across the Canadian Prairie ecozone. Each virtual basin was subdivided into hydrological response units (HRU) corresponding to fallow and cropped fields, grassland, woodland, wetlands and channels. The virtual basin and HRU approach allowed for sub-regional and discretized analysis by landcover type. Simulated blowing snow transport, sublimation, accumulation, and snowmelt were examined on monthly, seasonal, and annual bases, with consideration of land use and climate change influences. Shorter, warmer winters and near-abandonment of summer fallowing have reduced blowing snow transport and sublimation fluxes over time and advanced the timing of snowmelt. The changes have not been spatially uniform and important regional differences have differing impacts on changes to snowmelt water supply. Water resources in the Prairies are governed by snow processes, and this research offers insight into how climate warming is changing the region’s hydrology.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12422 Contributed abstract

Poster Order: 8040P04

Evaluating energy fluxes and snow processes at mountain subalpine forest and alpine tundra sites using MESH

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In mountainous regions, cold regions processes have a strong effect on streamflow generation and are strongly affected by complex terrain windflow, slope, aspect and landcover. Snow redistribution by wind transport, interception in canopies and ubiquitous sublimation lead to unevenly distributed snow cover. Snowmelt is controlled by slope/aspect and land cover. Evapotranspiration is sustained by snowmelt and rainfall infiltration with poorly understood spatial and temporal dynamics in spring. In this study, the hydrological land surface model MESH was used to

evaluate energy and water vapour fluxes and snow processes at forest and tundra sites instrumented with eddy covariance energy balance stations, weighed suspended tree and blowing snow sensors in Fortress Mountain Research Basin in the Canadian Rockies. MESH simulations (1D) were compared to observations at each site, from 2016 to 2023. The tundra results showed that the model slightly underestimated outgoing shortwave radiation and mostly well simulated outgoing longwave radiation in all seasons. At the forest site, MESH simulated the diurnal variation of latent, sensible and ground heat fluxes adequately during the summer months but overestimated winter and underestimated spring evaporation/sublimation fluxes. MESH underestimated both forest snow accumulation and canopy intercepted snow load but overestimated tundra snow accumulation. The overall poor performance of the model during the winter months showed that MESH requires improvement in its representation of snow and evapotranspiration processes in order to reduce uncertainty in its application in mountain basins.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12488 Contributed abstract

Poster Order: 8040P05

Simulating hydrological and biogeochemical cycles in the Maumee River watershed using the integrated MESH-CTEM model

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Presented by / Présenté par: *Tariq Deen*
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The MESH-CTEM model is a newly developed coupled hydrological and biogeochemical model, comprising the Community Environmental Modelling System - Surface & Hydrology system (MESH) and the Canadian Land Surface Scheme-Canadian Terrestrial Ecosystem Model (CLASS-CTEM). This coupled model evaluates the effectiveness of different land use and forest management practices to enhance carbon sequestration and

conserve water resources. It can also be used to quantify the impacts and feedback of future climatic stresses and extreme events on carbon and water cycles at the catchment scale. This study employs MESH-CTEM to simulate energy, water and carbon fluxes in the Maumee River watershed in northern Ohio (Lake Erie basin). Land cover in the watershed consists mainly of agricultural land, with a forested area in the north and a large urban area near Lake Erie. Coupled MESH-CTEM model simulations were compared with observed eddy covariance flux data from the Oak Openings Flux Tower site, a predominantly deciduous forest, and hydrologic data. This work will help to develop novel land (ecosystem) restoration and water management strategies for watersheds in the Great Lakes region to enhance our understanding of their functioning, eco-hydrological processes and climate change impacts. This work is part of the Global Centre for Climate Change Impacts on Transboundary Waters research initiative.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12210 Contributed abstract

Poster Order: 8050P01

Northern Hydroelectric Reservoirs – The Albedo Effect

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Globally, hydropower is a leading source of renewable energy, however the hydroclimatic impact of the creation of hydroelectric reservoirs in northern regions is not well understood. The impoundment of hydroelectric reservoirs modifies the surface's physical properties and the energy exchanges between the earth's surface and the atmosphere. In warm regions, due to the low albedo of water, a greater portion of the solar radiation is absorbed, and the impoundment creates a positive radiative forcing. However, in cold regions, the formation and evolution of ice cover during several months of the year, due to the high albedo of snow and thick ice, results in a negative radiative forcing. The magnitude of this negative radiative forcing depends on the pre-impoundment environment as the vegetation type influences the magnitude of the albedo increase due to snow. A case study of the Romaine River hydroelectric complex (~51°N, ~63°W) is used to investigate the net radiative forcing resulting from the impoundment of a reservoir through the comparisons of in situ measurements. Four-component radiometers are deployed during the open water periods on the Romaine-2 reservoir (2018-present) and installed year-round at two sites typical of the pre-impoundment environment, a natural lake, Lac Bernard (2022-present) and a primarily black spruce boreal forest site, (2018-present). The seasonal variation in the midday albedo of Bernard Lake is greater (~0.02 to ~0.8) than that of the boreal forest (~0.08 to ~0.2). The Canadian Small Lakes Model, a 1D dynamic lake model, will be used to spatialize the analysis to the scale of the Romaine River complex and simulate the radiative forcing resulting from the impoundment under future climate conditions.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12532 Contributed abstract
Poster Order: 8050P02

The Hydrophysical Soil Evolution of a Reconstructed Pilot-Scale Upland Pit Lake

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Presented by / Présenté par: *Thomas Odland*

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In the coming years, more of the oil sands surface mineable area, which made up approximately 895 km² in 2013, will be required to be reclaimed (Government of Alberta, 2024). As such, a Demonstration Pit Lake (DPL) with an upland was constructed in 2019 as a prototypical methodology to store tailings through a water cap within the Alberta Oil Sand Region (AOSR).
With the AOSR being in a freeze-thaw (F-T) zone, the soil and landscapes are bound to change due to this effect and will, therefore, change the predicted hydrology of the reclaimed sites. Soil compaction, in particular, is a primary changing evolution factor, as heavy vehicles were used to construct DPL. By understanding how the placed soils evolve hydrophysically, based on freeze-thaw; higher-level decisions regarding the design and construction of future pit-lakes can be made. Through each of these more informed decisions, the landscape will more readily be able to become a functional piece of the boreal ecosystem.

Session: 14010 POSTER SESSION AFFICHES **27/05/2025 15:30**

ID: 12424 Contributed abstract

Poster Order: 9020P01

Development of a multi-instrument machine learning framework for precipitation retrievals

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Presented by / Présenté par: *Chuyin Tian*

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Measuring precipitation, especially winter snow accumulation, is difficult in remote regions, yet is critical for advancing the understanding of climate and land-use change impacts on energy and hydrological cycles. Retrievals from remote sensing techniques hold promise for surface precipitation estimation. To exploit the synergistic strengths of multiple instruments for enhanced retrieval accuracy, we develop a multiple-instrument framework (PrecipFusionML) to estimate surface precipitation based on ground-based minute-scale data from doppler radar, doppler LiDAR, and microwave radiometer. The data from each type of instrument is processed separately through a dedicated feature extractor, and the extracted features are subsequently concatenated through a late fusion layer for final estimation. In this study, we present evaluation metrics compraing the new PrecopFusionML model with multiple linear regression and other traditional machine learning based retrieval methods, quantifying the benefit of a late fusion layer. We demonstrate, for the first time, wether a combination of radar, LiDAR and radiometer inputs improves the model's accuracy and generalizability. The incorporation of radiometer with multi-frequency brightness temperature appears to help better estimation of extreme values of precipitation. This research at the University of Waterloo and funded by the Canadian Space Agency, supports initial HAWC science development activities. In future work, the PrecipFusionML model will be extended to incorporate coincident HAWC/AOS measurements for precipitation estimate across Canada's North.

Session: 14010 POSTER SESSION AFFICHES

27/05/2025 15:30

ID: 12486 Contributed abstract

Poster Order: 9020P02

Improving Soil Moisture Estimates for Canada Using Machine Learning and Multi-Source Data

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[1]

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Presented by / Présenté par: *Neha Kanda*

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Accurate soil moisture (SM) estimates are essential for hydrological modeling, agriculture, and climate studies. However, the high spatial variability of soil moisture (SM) means in situ measurements are generally unrepresentative of the variability in SM across larger areas. In contrast, the relatively coarse resolution of gridded datasets limits their ability to accurately represent location-specific variations in SM. To address these challenges, high-resolution machine learning (ML)-based global SM datasets have been developed. These datasets rely heavily on data from the International Soil Moisture Network (ISMN), whose data coverage over Canada is significantly lower than in regions like USA, Europe, and Southeast Asia. This imbalance in data distribution can lead to ML models prioritizing climate and soil moisture features from regions with more data, potentially neglecting regional characteristics in Canada. Here, we compiled SM observations from approximately 200 additional Canadian sites that were not included in the ISMN network, to create a more representative dataset for evaluating existing satellite, reanalysis, and ML-based SM products over Canada. We also developed an ML model trained on this

expanded dataset, which outperforms current ML-based SM products for Canada. Beyond improving accuracy, our analysis sheds light on key predictive features and their influence on model performance. Furthermore, we explored different sampling strategies to optimize data selection for ML-based SM estimation. This study underscores the importance of diverse, regionally representative training data for large ML models, and further demonstrates the potential of ML in advancing SM predictions across Canada.

Modeling Iceberg Severity on the east Canadian coast

Madhurima Chakraborty[1], Juliana M. Marson[1], Paul G. Myers[2]
[1] University of Manitoba, [2] University of Alberta

1. Background:

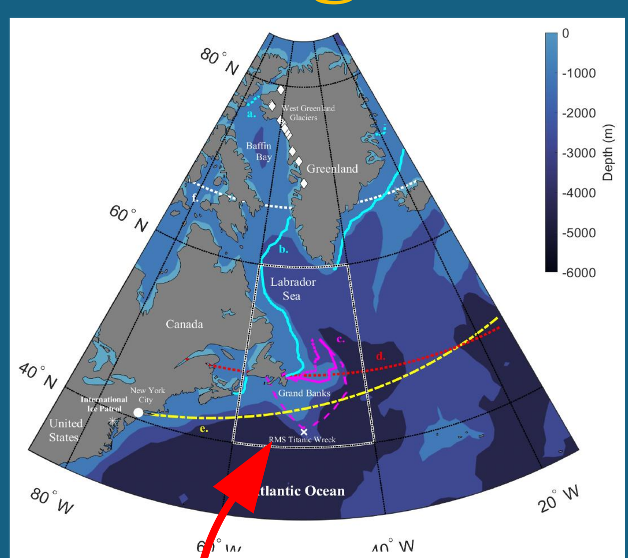


Figure 1: International Ice Patrol reconnaissance region.

- Icebergs are NAVIGATION HAZARDS.
- Number of icebergs south of 48°N = **I48N**
- **Larger** I48N ⇆ **Heavier** season.

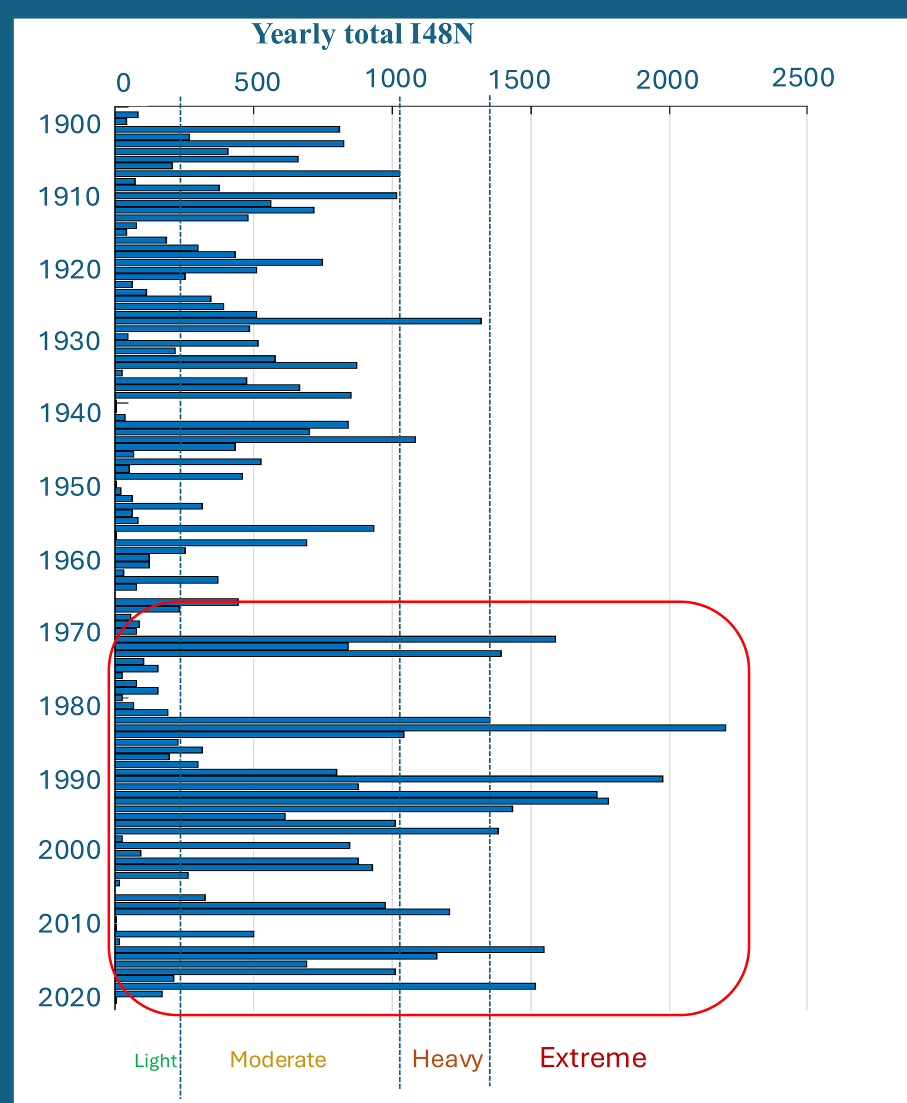


Figure 2: Interannual variability of observed iceberg counts crossing 48°N.

Interannual variability has increased abruptly since the early 1970s. This made the severity of icebergs season on the east coast of Canada harder to predict.

2. Proposed influencers:

- Cooler Labrador shelf
  ↓
  heavier season (1)

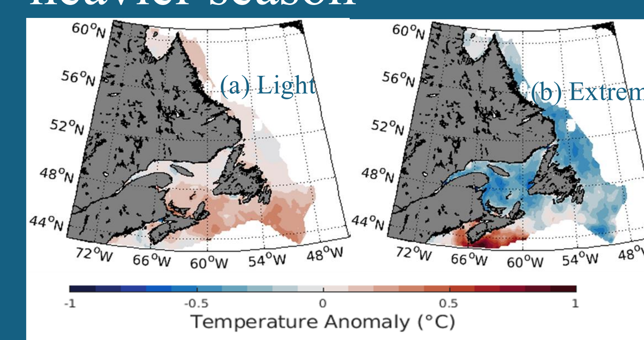


Figure 3: Spring ocean temperature along the Labrador shelf in light (a) and extreme (b) iceberg years.

- More Baffin Bay sea ice
  ↓
  heavier season (3)

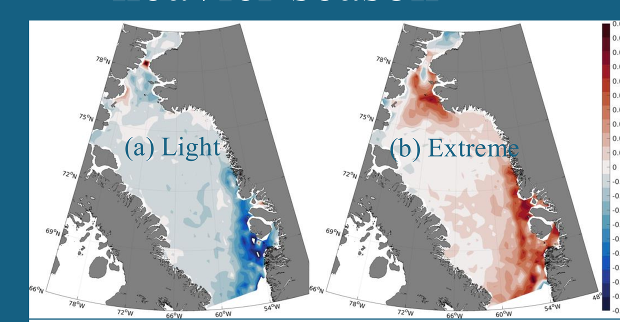


Figure 5: Winter high conc. sea ice over Baffin Bay in light (a) and extreme (b) iceberg years.

- More Labrador shelf sea ice
  ↓
  heavier season (2)

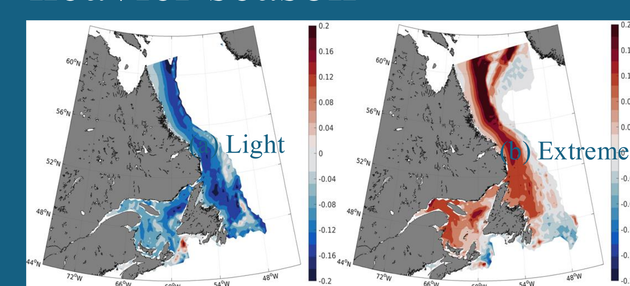


Figure 4: Winter sea ice concentration along the Labrador shelf in light (a) and extreme (b) iceberg years.

- More Greenland calving
  ↓
  heavier season (4)

3. Gaps:

- Lack of agreement among existing studies.
- Lack of upstream observational data.

4. Research question:

What factors determine iceberg severity?

5. Findings:

- **Evaluation of the model simulation JFA (JRA55-do Forced Atmosphere)**

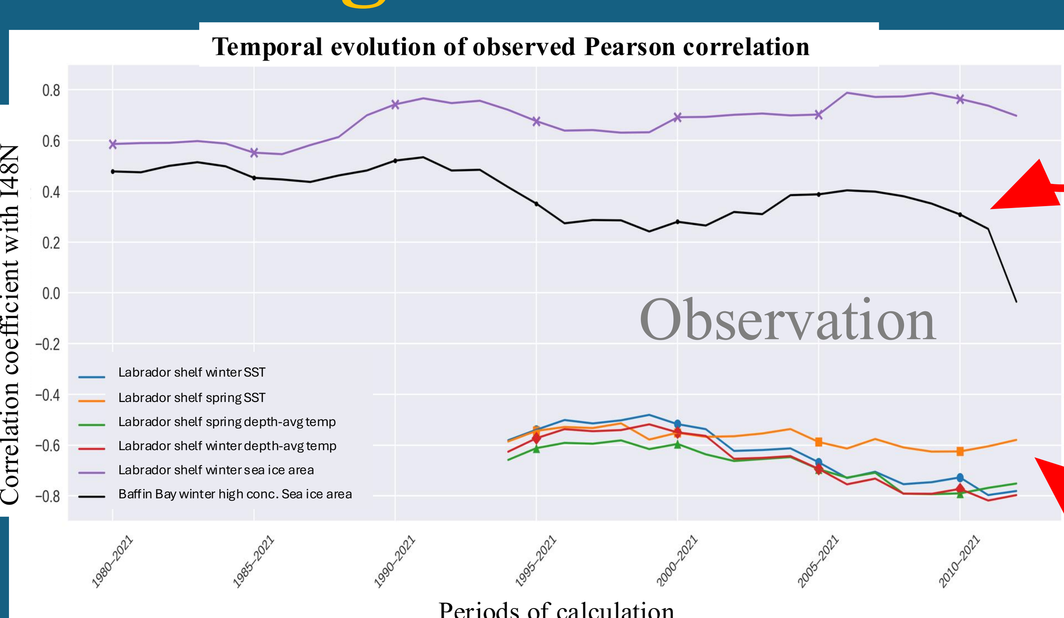


Figure 6: Temporal evolution of observed correlations between iceberg severity and environmental factors.

- The remote sea ice connection varied as the period shortened. The sudden drop in the correlation in the last decade could be because the number of data points has reduced.
- The ocean temperature connections stayed steady for the majority of the period.

The time evolutions of both are well represented in the model.

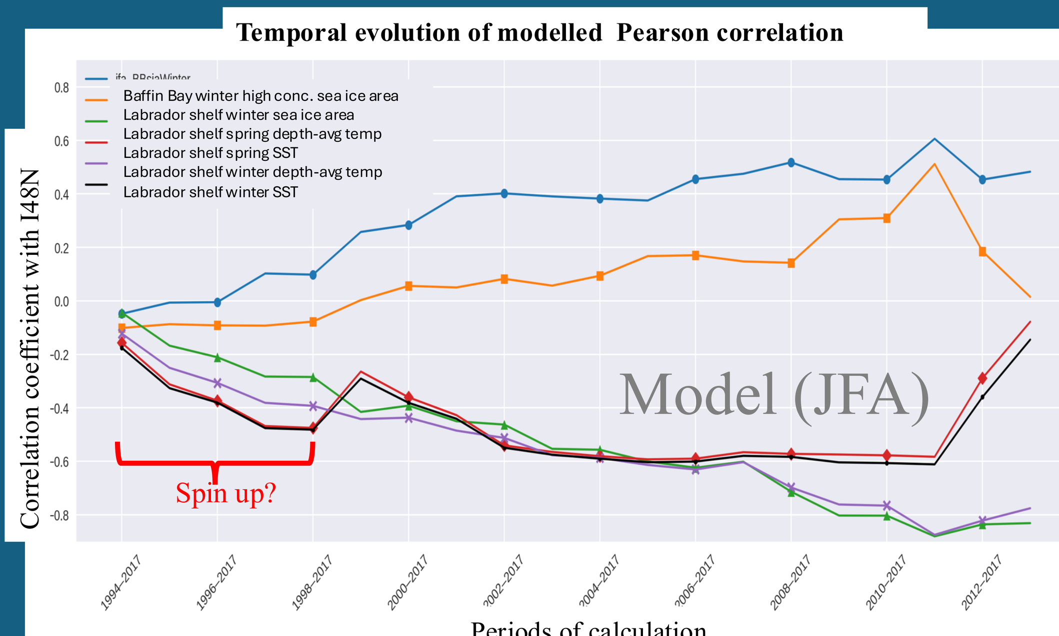


Figure 7: Temporal evolution of modelled correlations between iceberg severity and environmental factors.

- **Comparison with the model CFA (CGRF Forced Atmosphere)**

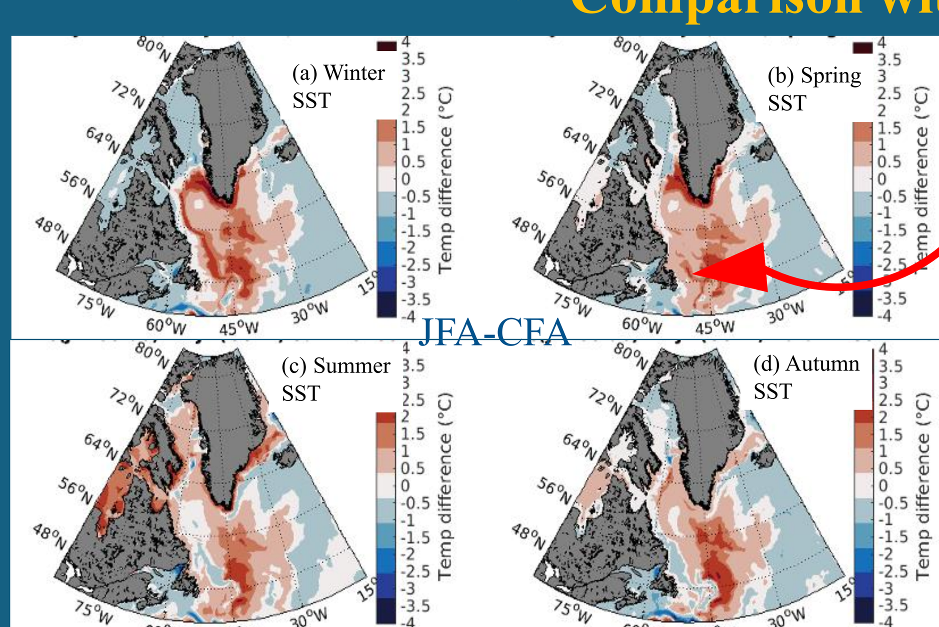


Figure 8: Sea surface temperature in CFA subtracted from JFA during (a) winter, (b) spring, (c) summer, and (d) autumn, averaged over the years 2002-2017.

JRA55-do is warmer over the Labrador shelf. So, the icebergs entering the Labrador shelf melt quickly in JFA.

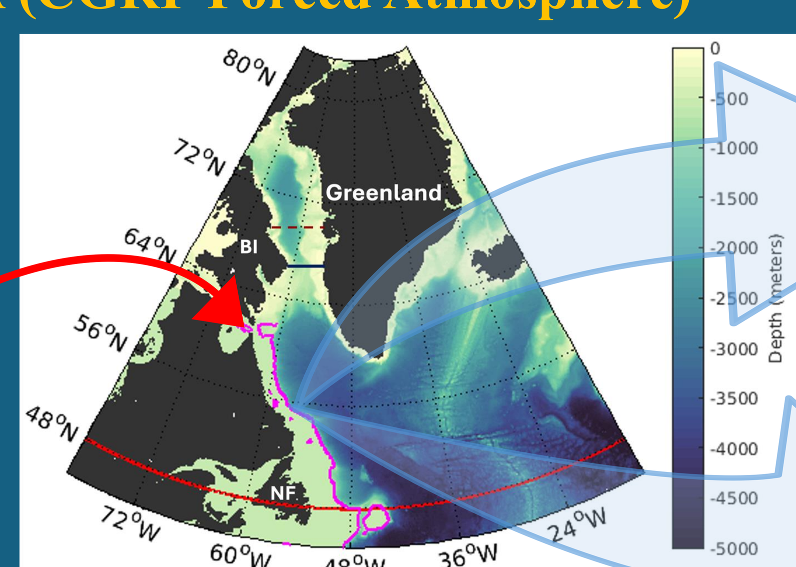


Figure 9: The domain of interest. The red line indicates the 48°N. latitude line. The magenta line shows the contour for the 550-meter bathymetry; everything shallower in that region is the Labrador shelf. The red dashed line shows the mid-basin cross section.

	JFA	CFA
No. at 58°N	6490	5578
No. at 48°N	450	493

	JFA	CFA
Avg. mass per particle at 58°N	~80.51 X 10^9 Kg	~83.23 X 10^9 Kg

JFA has more particles than CFA for 2002-2017. Still, a smaller number of particles reach 48°N in JFA. JFA icebergs lose more mass before entering the Labrador shelf than CFA.

What role does the upstream ocean play in causing the difference in iceberg mass and count loss between the JFA and CFA simulations?

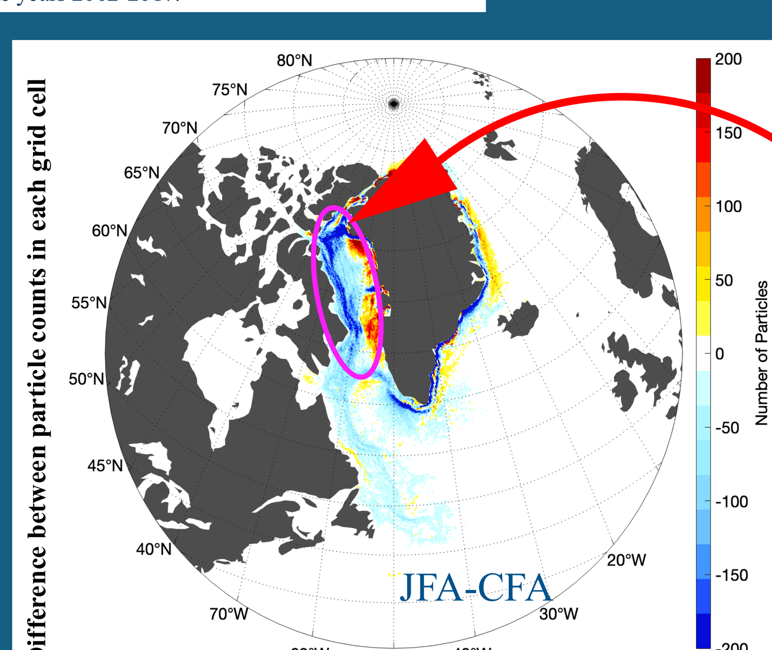


Figure 10: Number of particles in each grid cell in the CFA simulation subtracted from the number of particles in each grid cell in the JFA simulation. Red means JFA had more particles than CFA in that grid cell.

In JFA, many particles are not able to reach the Baffin Island Current due to a flatter Sea Surface Height. In CFA, a more energetic Baffin Bay circulation delivers the particles to the cold Baffin Island Current.

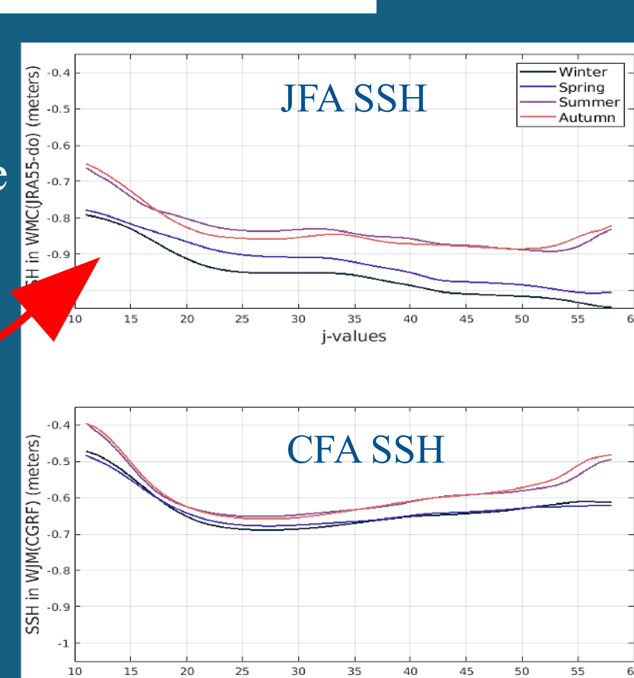


Figure 11: Sea surface height for four seasons across the mid-basin cross section shown with a red dashed line in Figure 9.

JFA particles drift more to the interior of the Baffin Bay basin and melt in the warmer water.

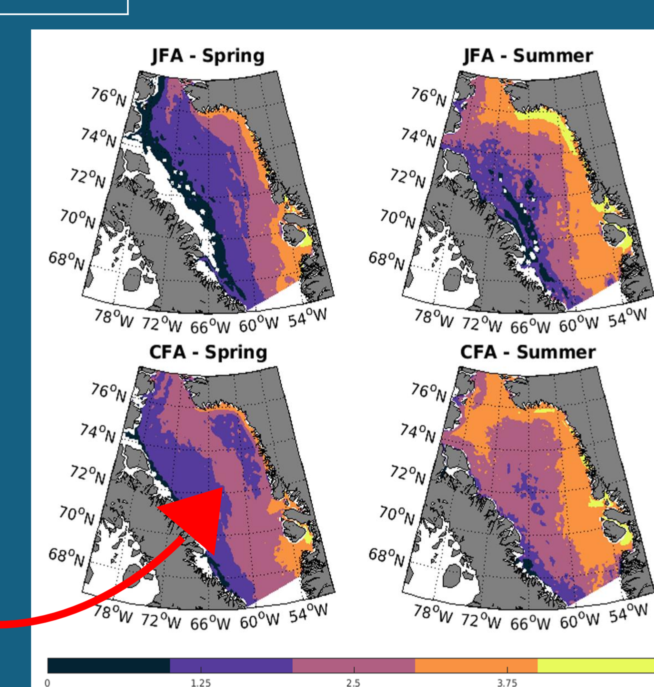


Figure 12: The logarithm (power of 10) of the rate of iceberg melt in JFA (top row), and in CFA (bottom row) for the seasons Spring and Summer, averaged over the period 2004-2017.

6. Conclusions

- A more sea ice-covered ocean in winter and a cooler ocean over the Labrador shelf were observed during the extreme iceberg seasons.
- Baffin Bay circulation has a significant influence on the iceberg influx into the Labrador shelf.
- A longer spin-up for future runs is recommended to give the system time to adjust so the real-world relationships between I48N and environmental factors are reproduced from the beginning for the whole period of simulation.

Model configuration and details

- Name: **N**ucleus for **E**uropean **M**odelling of the **O**cean V 3.6
- Domain: **A**rctic and **N**orthern **H**emispheric **A**tlantic 1/4°
- Coupled with: Louvian-la-Neuve sea **I**ce **M**odel V2
- Parameterizations:
  1. Vertically integrated ocean fields (6,7)
  2. Sea ice locking (3)
- For details about JFA and CFA simulations, scan the QR code on the right:

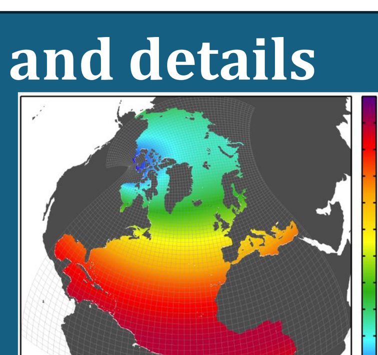
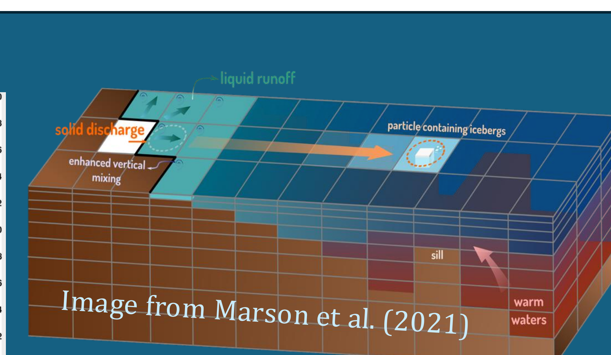


Figure 14: The horizontal resolution of the model over ANHA4 domain.



Calving distribution (8)

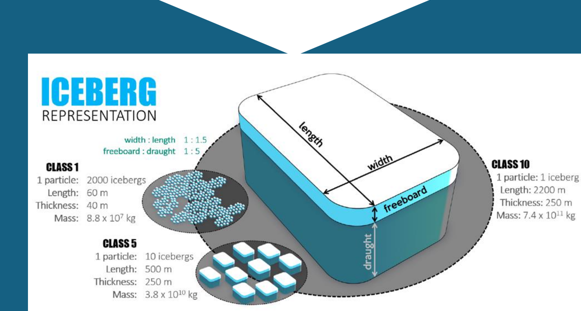


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Figure 1 source: Report of the International Ice Patrol in the North Atlantic 2023.
Figure 2 data source: International Ice Patrol I48N dataset Version 1, doi:10.7265/Z6E8-3027
Figure 4 data source: Multi Observation Global Ocean 3D Temperature Salinity Height Geostrophic Current and MLD, doi: 10.48670/moi-00052
Figure 5 and 6: Scanning Multichannel Microwave Radiometer (SMMR on the Nimbus-7 satellite), the Special Sensor Microwave/Imager (SSM/I sensors onboard the Defense Meteorological Satellite Program's i.e. DMSP -F8, -F11, and -F13 satellites), and the Special Sensor Microwave Imager/Sounder (SSMIS boarding DMSP-F17 satellite), doi: https://doi.org/10.5067/8GQ8LZQVL0VL
Figure 14 source: http://knossos.eas.ualberta.ca/anha/model_configuration.php

Ocean Optics: Development of Glider-Based Productivity Analysis in BC Waters Using Backscatter

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University of Victoria

UVic Ocean Gases Lab

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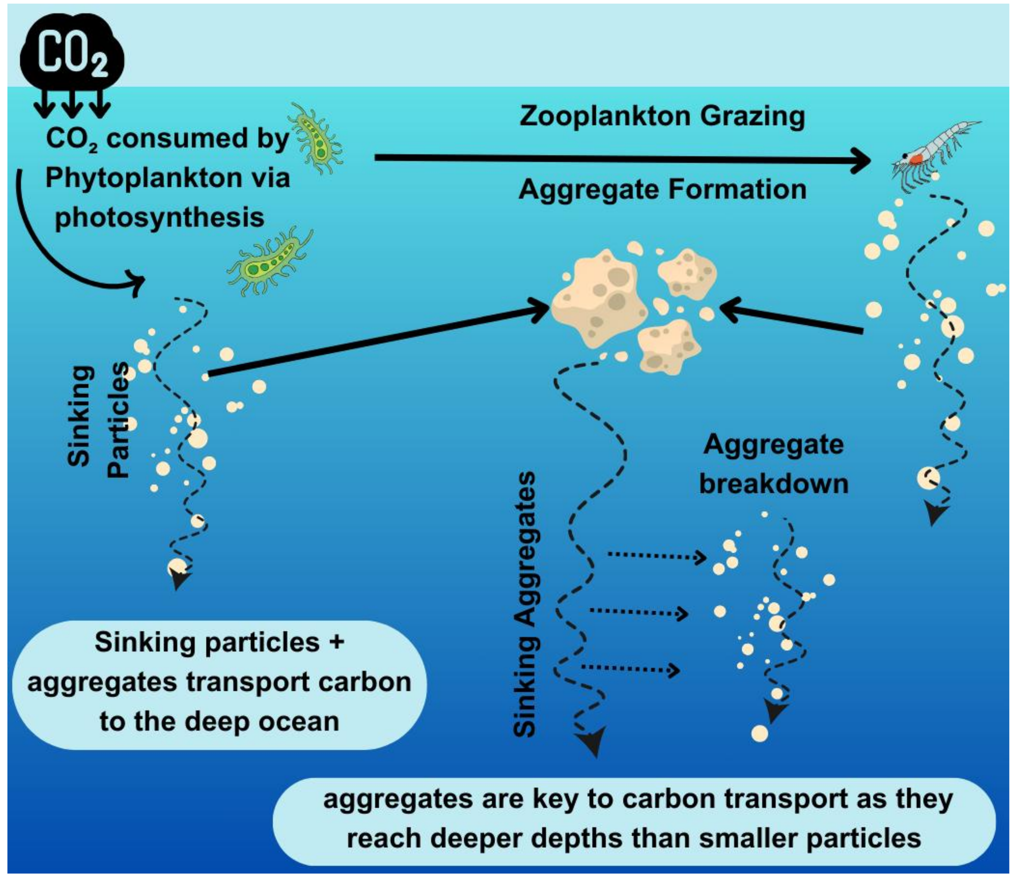
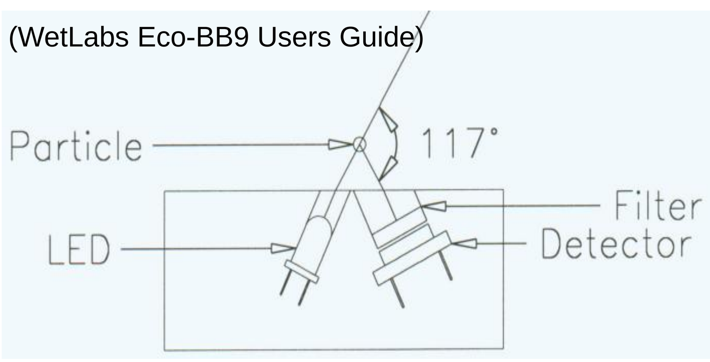
Research Goal : To develop a processing algorithm for glider-based optical backscatter data to better understand oceanic particle distributions and carbon cycling.

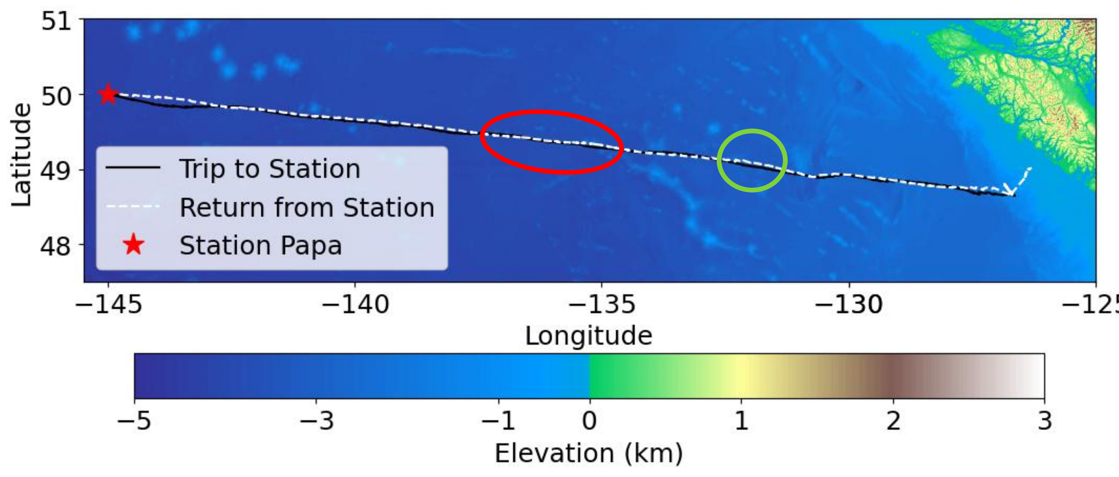
Gliders, Optics and the Biological Pump

The ocean stores carbon through a collection of processes known as the Biological Pump…



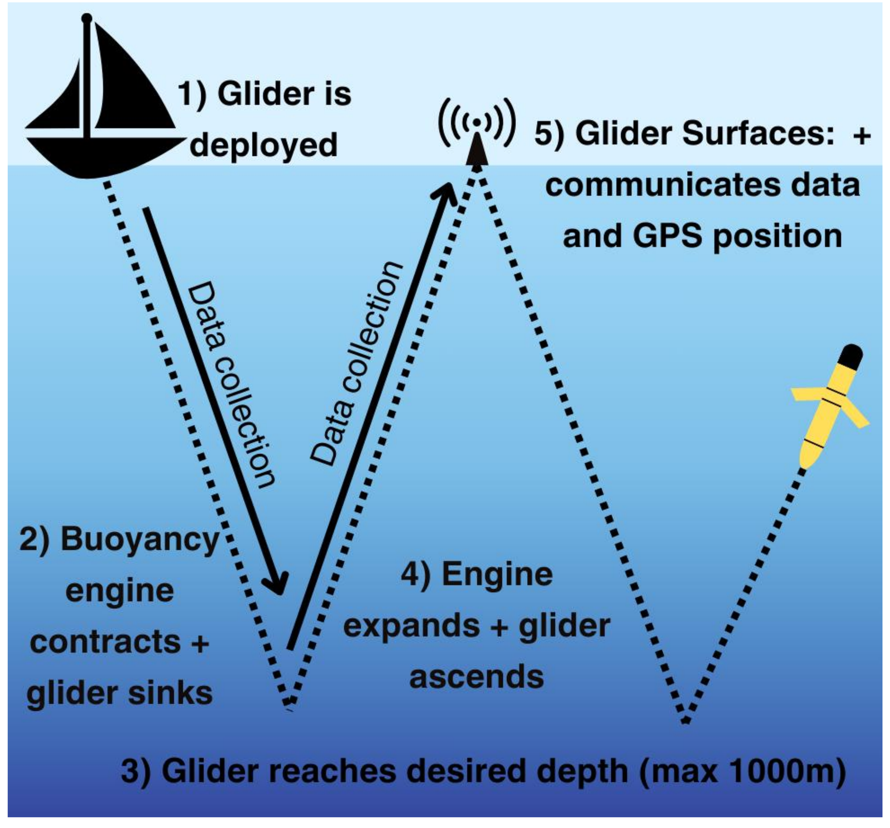
Optical backscatter sensors measure the intensity of light scattered by suspended particles at a fixed angle





This Glider mission spanned from August to November 2023 where it travelled along Line P from offshore Tofino to Ocean station Papa (50° N, 145° W)

What is a Glider?



= An autonomous underwater vehicle equipped with sensors for various oceanographic measurements[3].

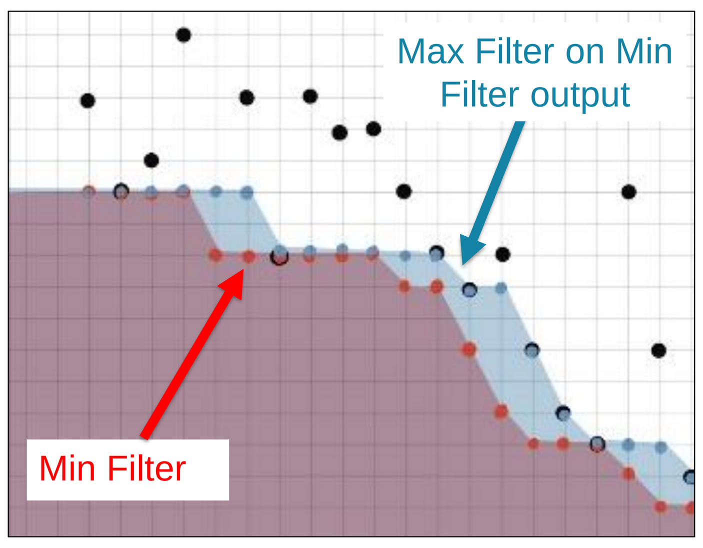
Algorithm Development

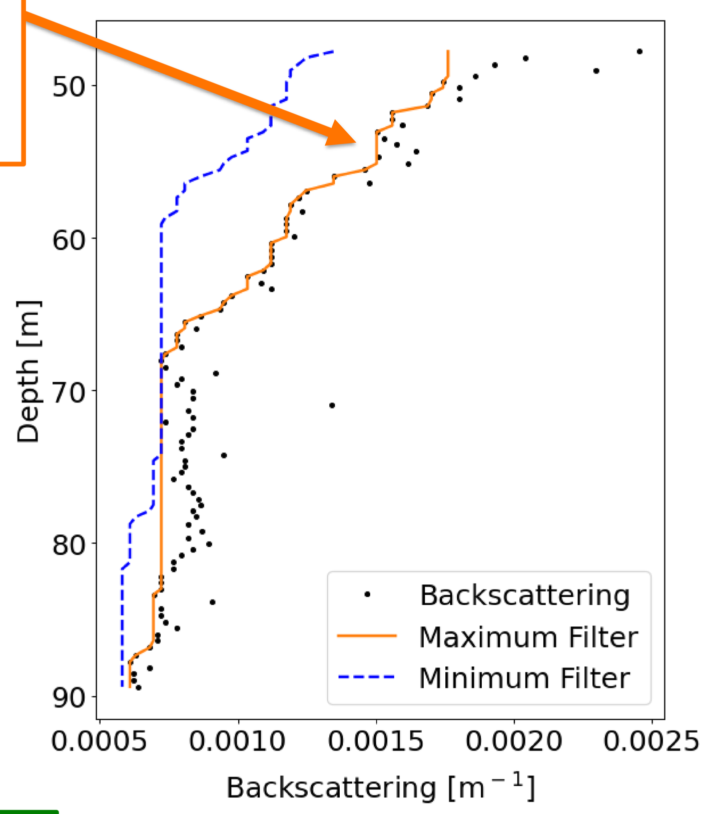
Total backscatter was partitioned into three components[2]:

Raw = *Small* + *Noise* + *Large*

1. Backscattering from Small particles
   - Roughly <100 µm
   - Isolated with a 43-point window running minimum and maximum filter.

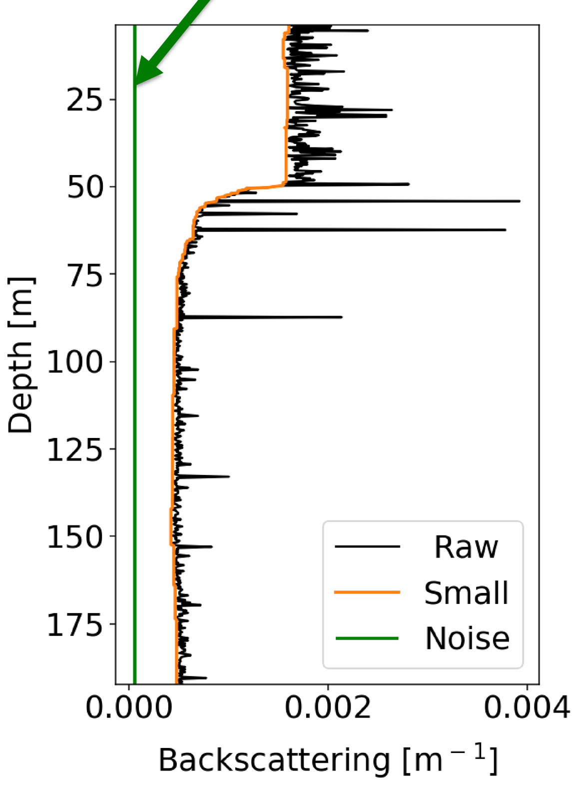
How the min-max filter works:

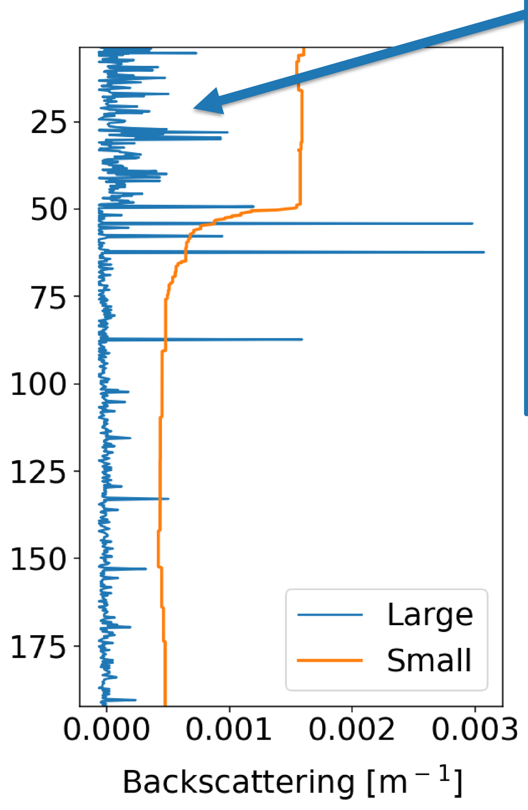




2. Backscattering from Instrument Noise
   - estimated using the backscatter at depths >180m.

3. Backscattering From Larger Aggregates
   - Roughly >100 µm - multiple mm.
   - Isolated by subtracting small and noise scattering from the total raw.

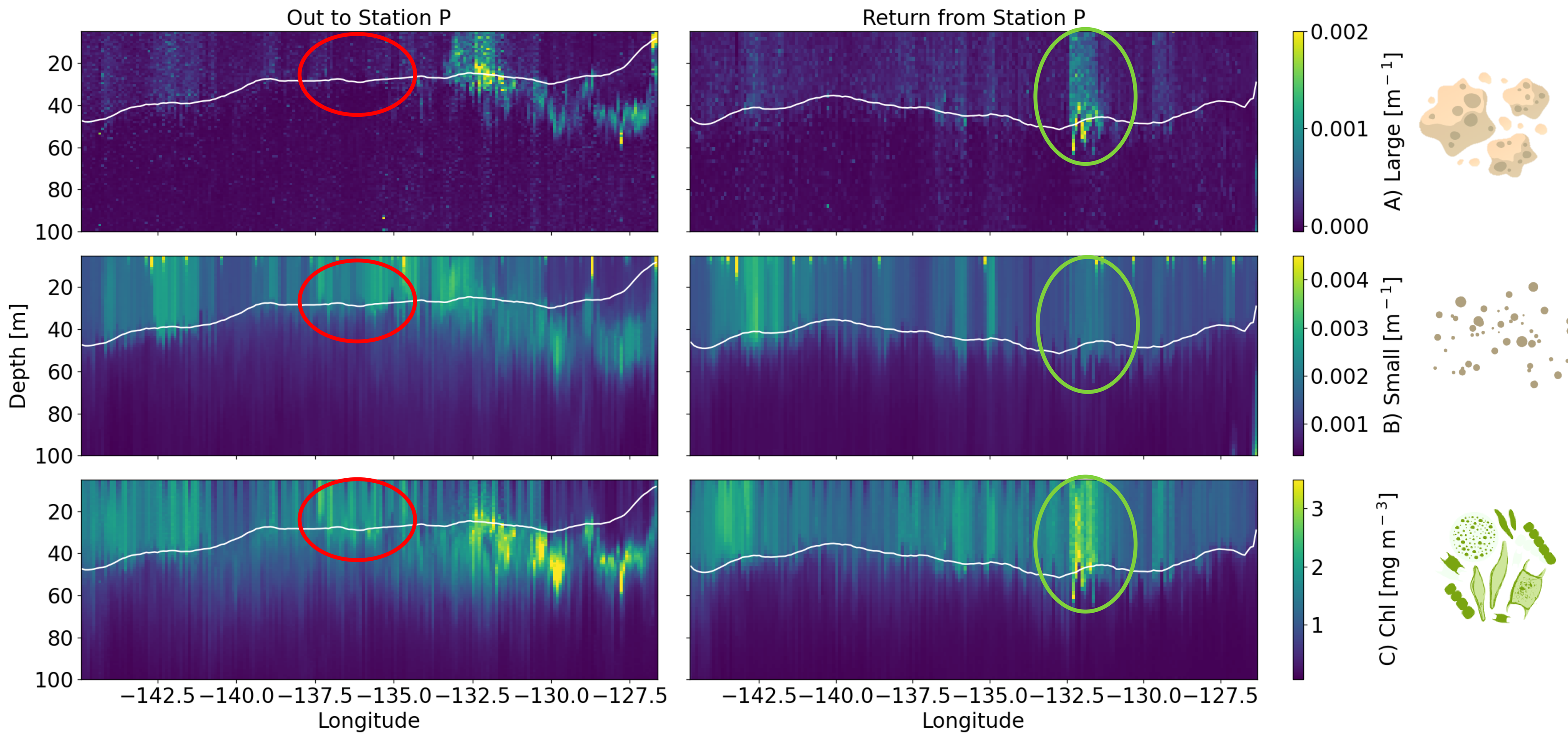




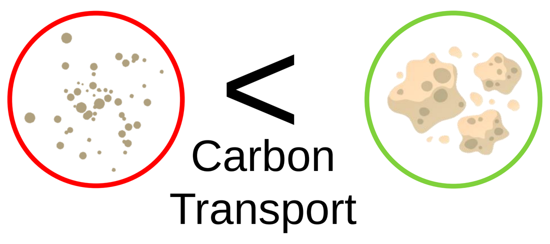
This separation allowed for identification of regions dominated by each size class.

Algorithm Application

These figures show that some high chlorophyll regions are dominated by small particles and others by larger aggregates



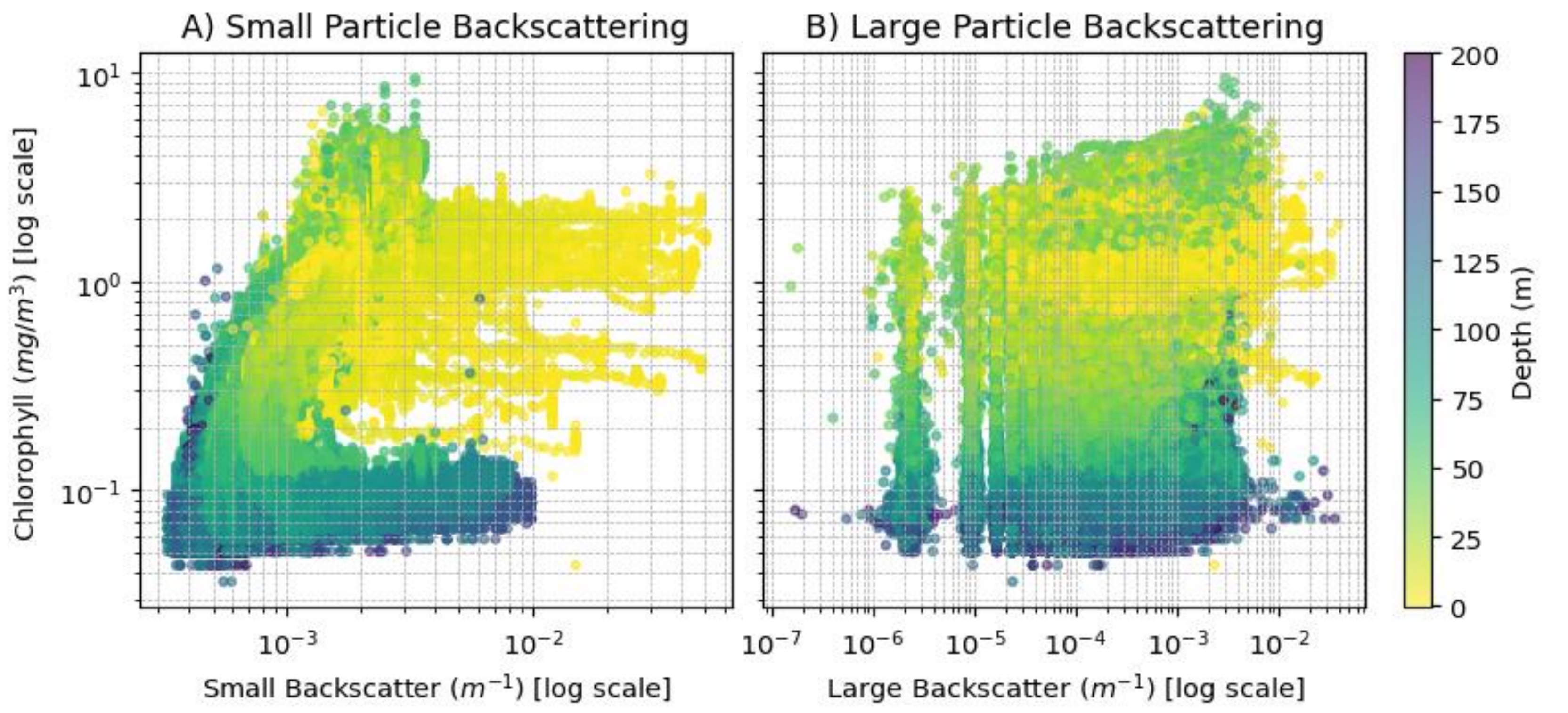
high productivity (chlorophyll), but the backscatter is dominated by smaller particle signals



high chlorophyll, but the backscatter is dominated by the larger aggregate size.

Small-particle backscatter is strongly correlated with chlorophyll, indicting it primarily reflects phytoplankton presence.

Large particle backscatter shows weaker and more variable correlations, highlighting the importance of size separation of optical data



Acknowledgements

Thank you to the C-PROOF team for their glider data and support, the UVIC ocean gases lab team for their encouragement and feedback, and the Jamie Cassels Undergraduate Research Award for funding.

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Conclusions

Summary of Findings:
- Developed and adapted an algorithm to process glider-based backscatter data for particle size analysis
- Observed regional variation in particle size and concentration
- Found small particle scattering to have a stronger correlation to chlorophyll than large aggregate scattering

Implications
- Expands the application of glider technology in carbon cycle research
- Enables high resolution particle and aggregate mapping
- Identifies regions with high carbon sequestration potential

Future Work:
- Apply algorithm to additional C-PROOF glider missions
- Investigate correlation of backscatter with productivity in varying environments
- Investigate anomalous productivity events to enhance understanding of episodic carbon export

Low Oxygen Utilization Rate below the mixed layer using BGC-Argo float data in Northeast Pacific Ocean

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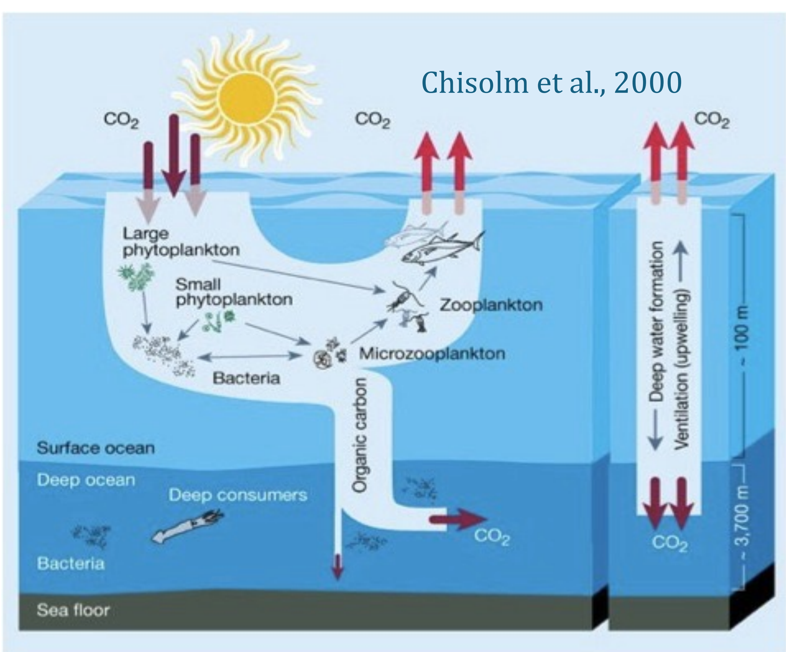
Biological Carbon Pump (BCP)

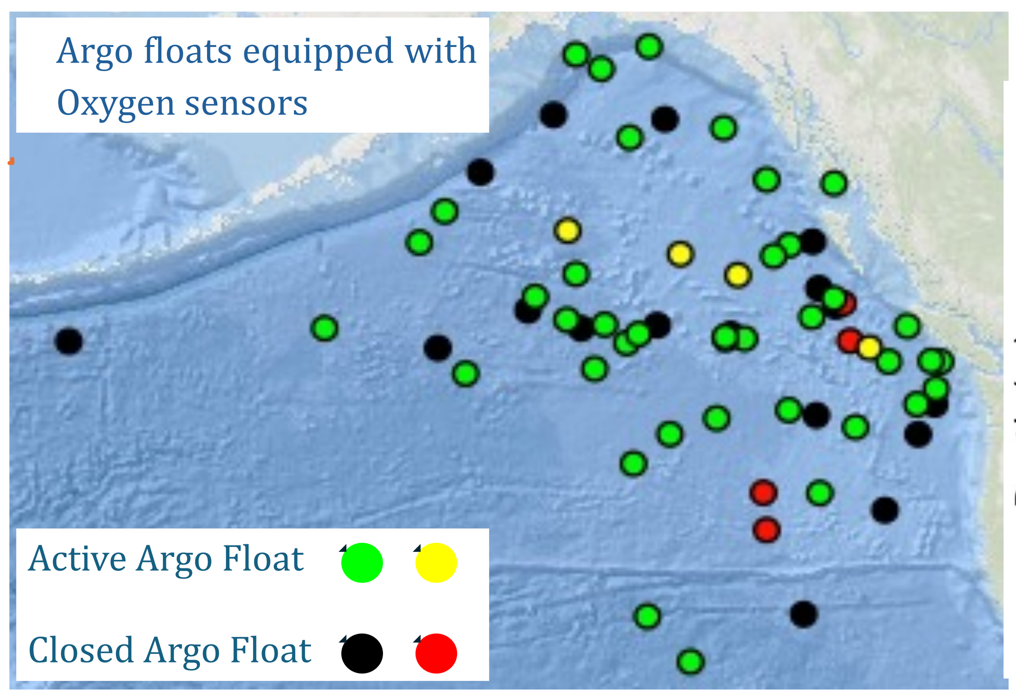
The ocean plays a key role in the global carbon cycle by absorbing atmospheric CO_2 through the biological carbon pump (BCP), which transports organic matter from the surface to deeper waters, where it is either respired or stored long-term. Changes in the BCP can alter how much carbon sinks below the surface, thereby influencing ocean carbon storage and the ocean's ability to absorb atmospheric CO_2 over decadal to centennial timescales (Yang, et al., 2017; Emerson, et al., 2008; Hennon, et al., 2016a).

Oxygen Utilization Rate (OUR) quantifies how much oxygen is consumed by microbial respiration of sinking organic matter below the mixed layer. This oxygen loss reflects the amount of exported organic carbon that is respired, providing insight into the efficiency of the biological carbon pump (BCP) in sequestering atmospheric CO_2 (Martz, et al. 2008).



Study Region

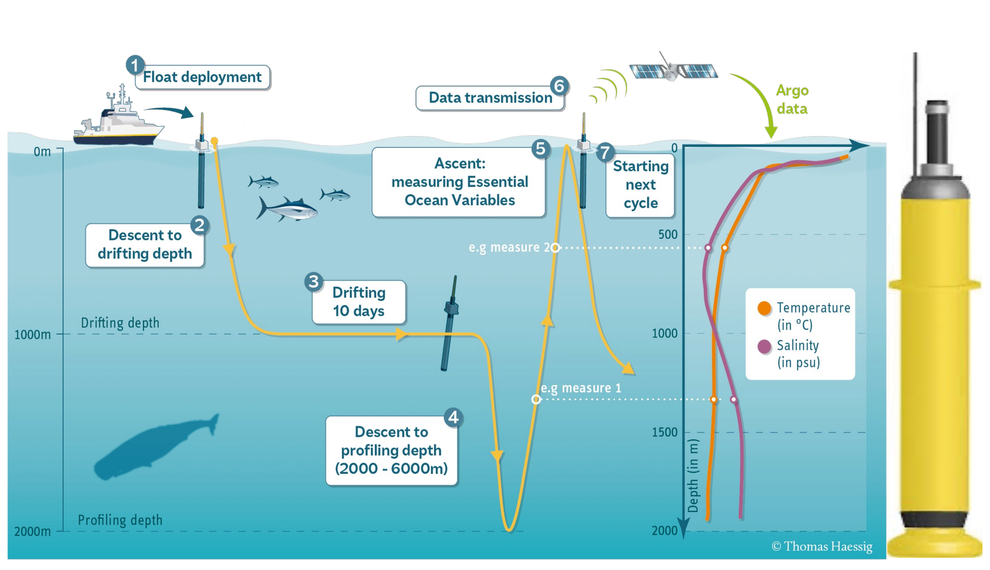
This study used oxygen sensor data from Argo floats funded by the C-PROOF project.



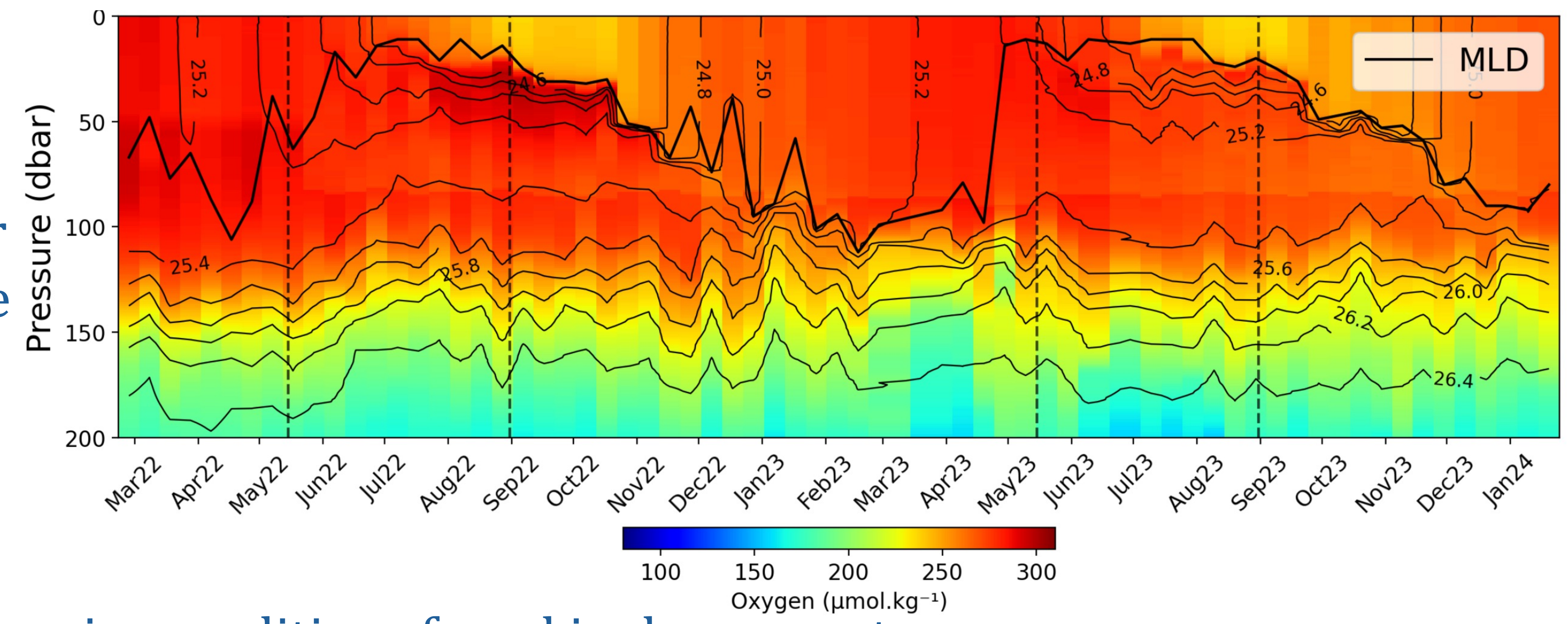
BGC-Argo Float

profiling floats equipped with sensors to measure biogeochemical parameters such as oxygen in the ocean.

They collect high-resolution vertical profiles from the surface to ~2000 m, drifting with ocean currents and profiling the water column every 10 days (https://argo.ucsd.edu/about/).



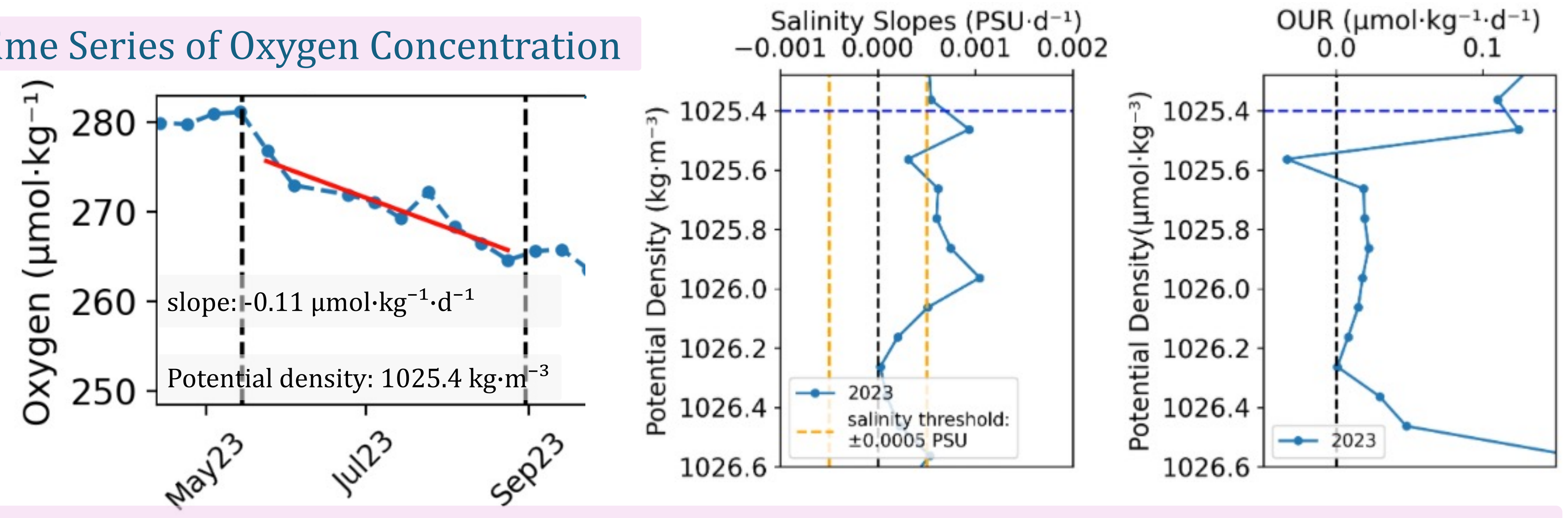
Method and Result



We calculated OUR from 20m below the mixed layer (ML) to 200m to isolate the zone of subsurface respiration, minimize the influence of air-sea gas exchange near the surface, and avoid the low signal-to-noise conditions found in deeper waters.

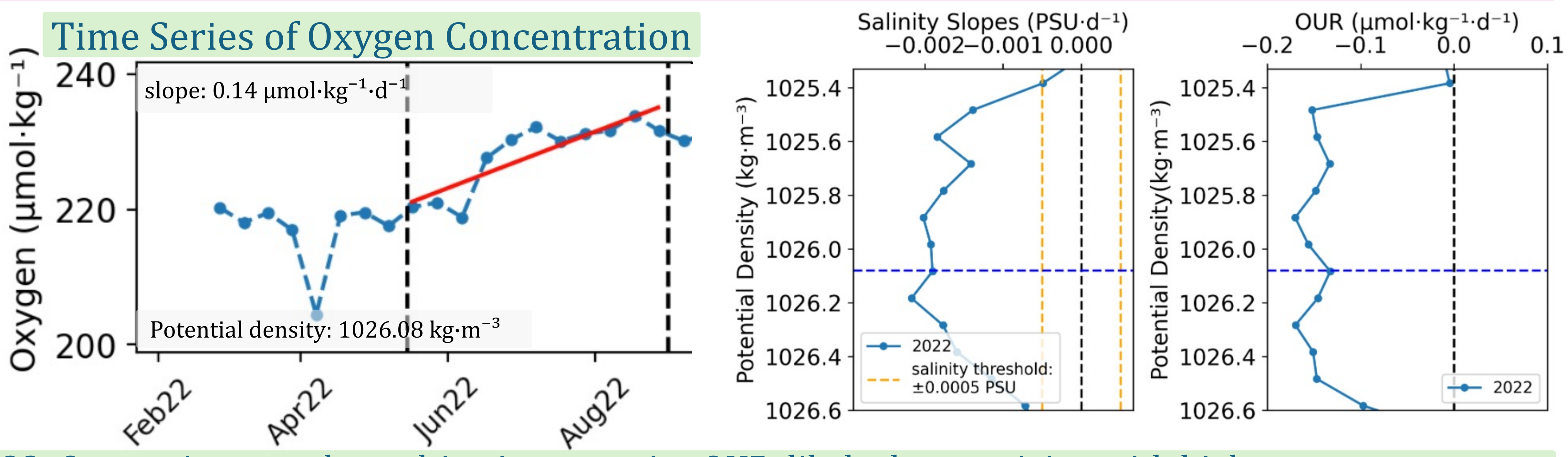
We tracked temporal changes in oxygen concentration on different isopycnals from May to August, a time when mixing is minimal and biological respiration dominates oxygen loss.

Time Series of Oxygen Concentration

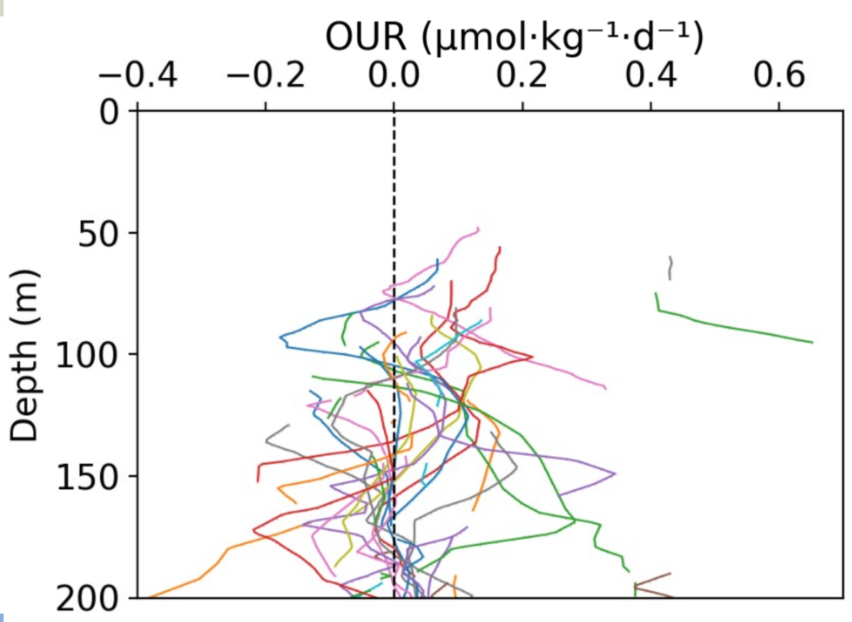


In 2023: Oxygen decreased, leading to a positive OUR driven by respiration. The stable salinity indicates minimal mixing, suggesting that the Argo float remained within a homogeneous water mass.

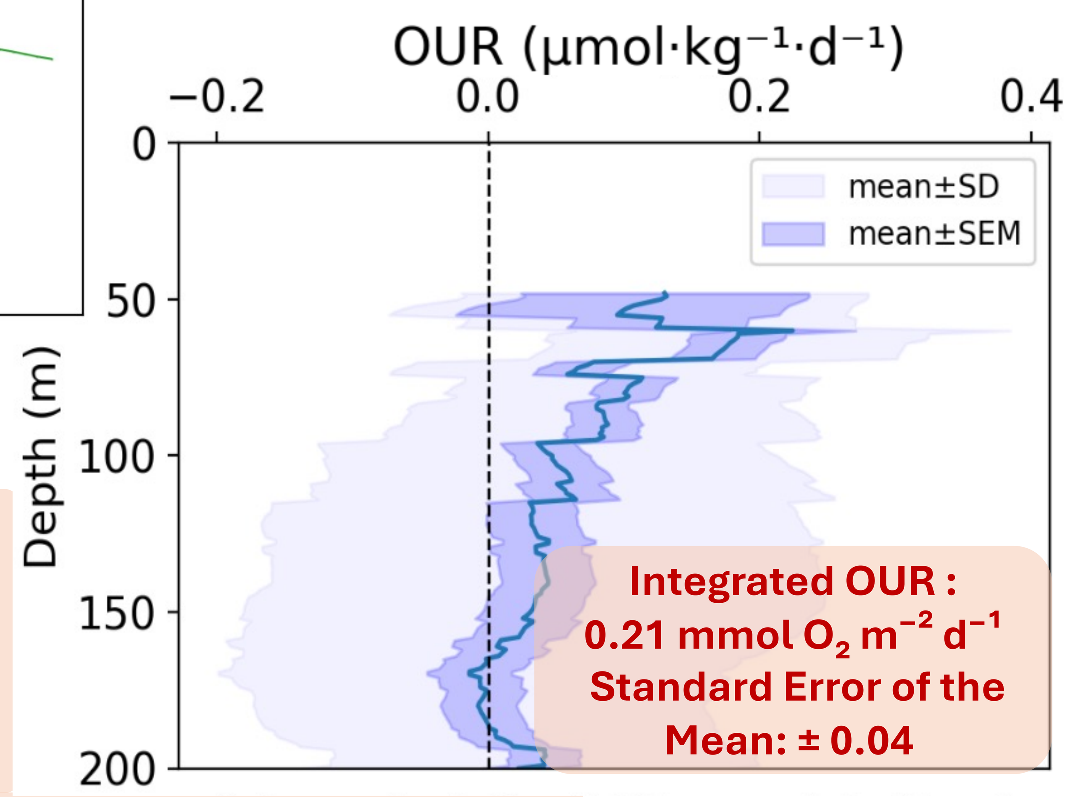
Time Series of Oxygen Concentration



In 2022: Oxygen increased, resulting in a negative OUR, likely due to mixing with high-oxygen water. This is supported by a large slope in salinity, which suggests that the float moved into a different water mass.



All floats and years meeting the salinity threshold, excluding profiles influenced by float movement.



- Averaged OUR profile shows consistent oxygen consumption, peaking above 100 m.

- Positive averaged and integrated OUR indicate respiration during May to August.
- Compared to regions like the Eastern North Atlantic (~121 ± 18 mmol O_2 m^{-2} d^{-1}; Tilstone et al., 2015) and the northeast subarctic Pacific Ocean (24 mmol O_2 m^{-2} d^{-1}; Emerson et al., 2010), this research study area shows much lower OUR, likely due to its high-nutrient, low-chlorophyll (HNLC) conditions that limit productivity and respiration.

Discussion and Future work

The differences between previous estimates of annual carbon export, such as 2.8 ± 1.9 mmol O_2 m^{-2} d^{-1} (Bushinsky et al., 2015) and 9.5 ± 1.15 mmol O_2 m^{-2} d^{-1} (Yang et al., 2017), mainly reflect variations in the models and methodologies used.

It is also important to compare oxygen utilization rates (OUR) between nearshore and offshore Argo floats to determine whether there are differences in OUR between these regions.

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Northern Hydroelectric Reservoirs – The Albedo Effect

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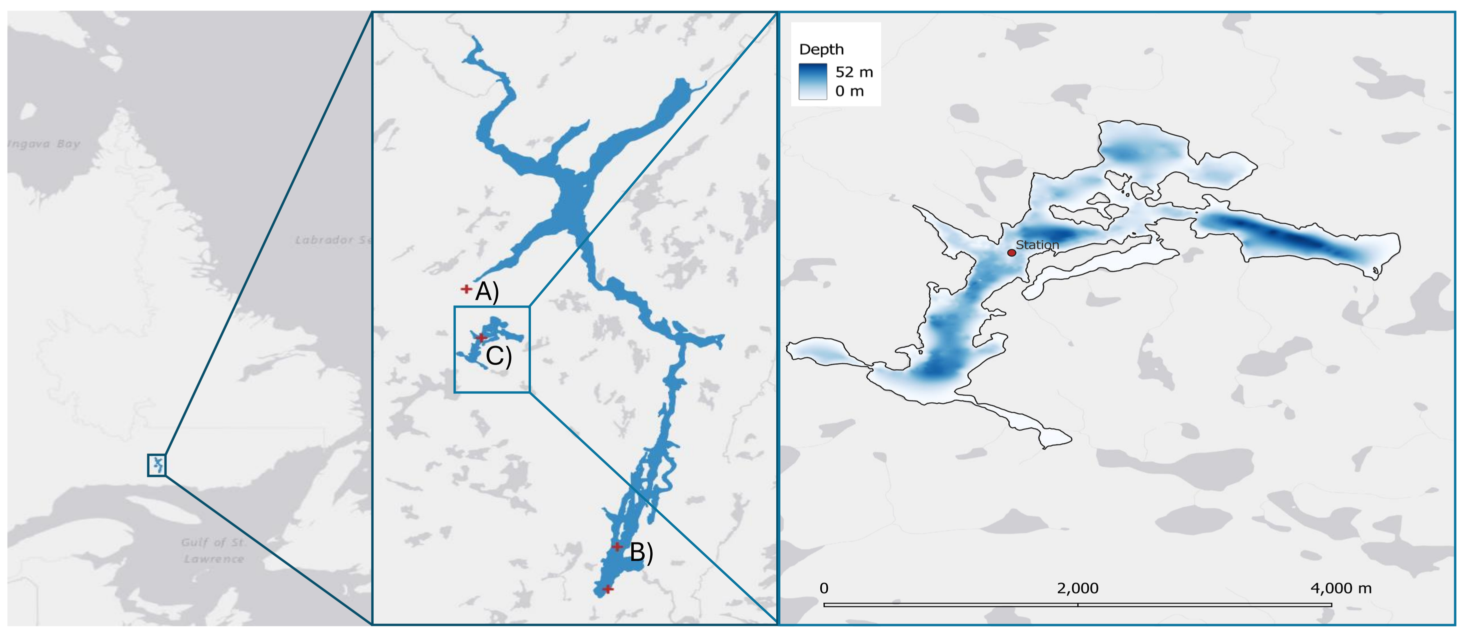
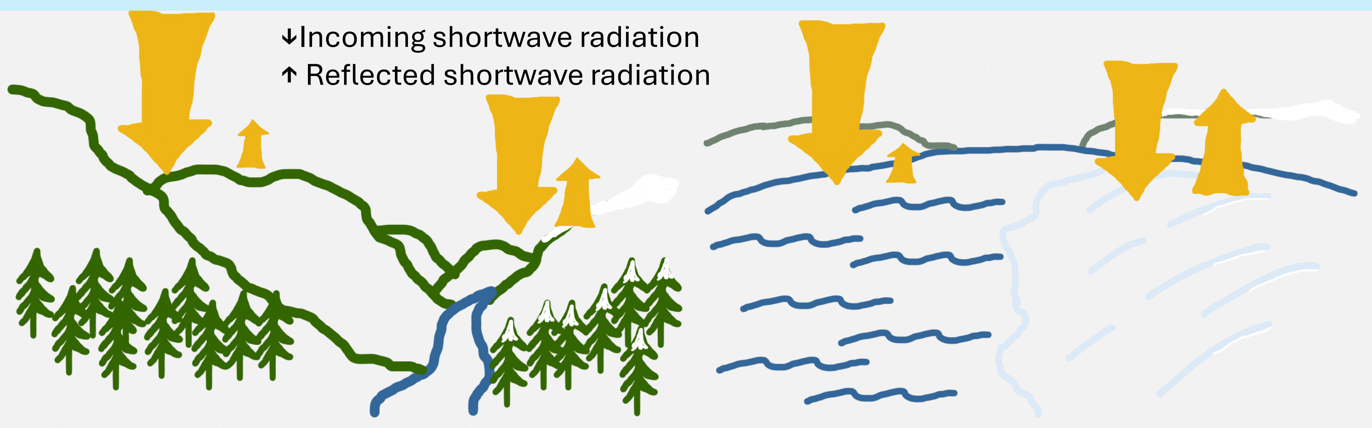
Introduction

Reservoir impoundment for hydroelectricity lowers surface albedo in the open water period. In the winter, ice cover and snow may increase the reservoirs albedo relative to the snow-covered pre-impoundment terrestrial environments. At northern latitudes, the annual net radiative forcing may be negative. Leading to the question:

What is the net radiative forcing resulting from hydroelectric reservoirs in the boreal region of Canada and how might this change in face of an evolving cryosphere?



Solar radiation balance schematic

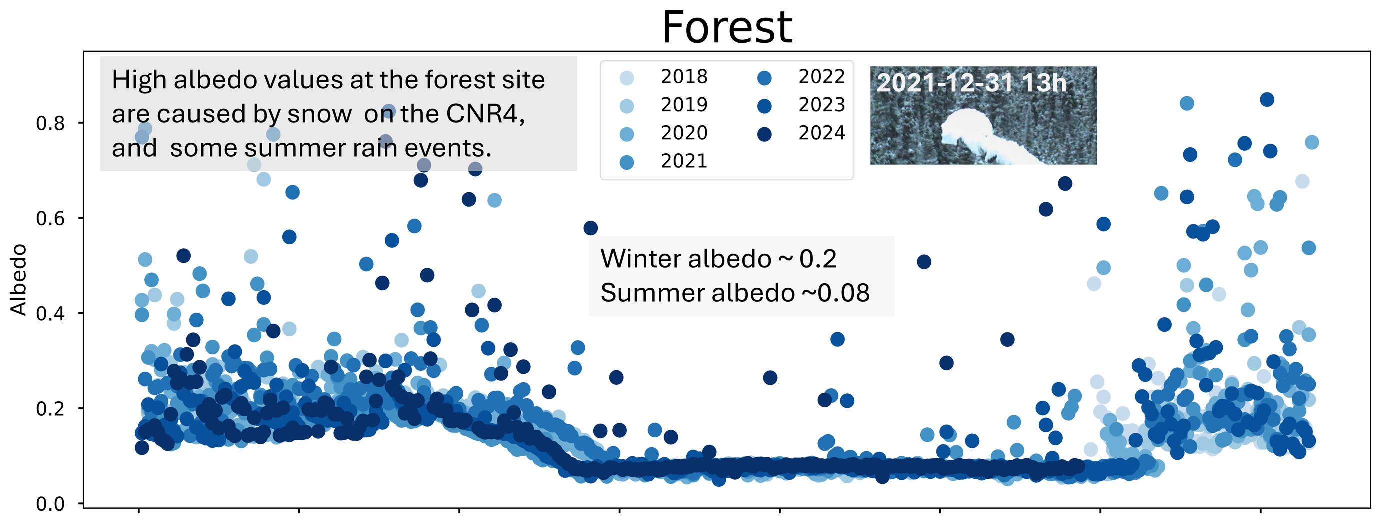


Pre-impoundment summer and winter radiation balance at A).

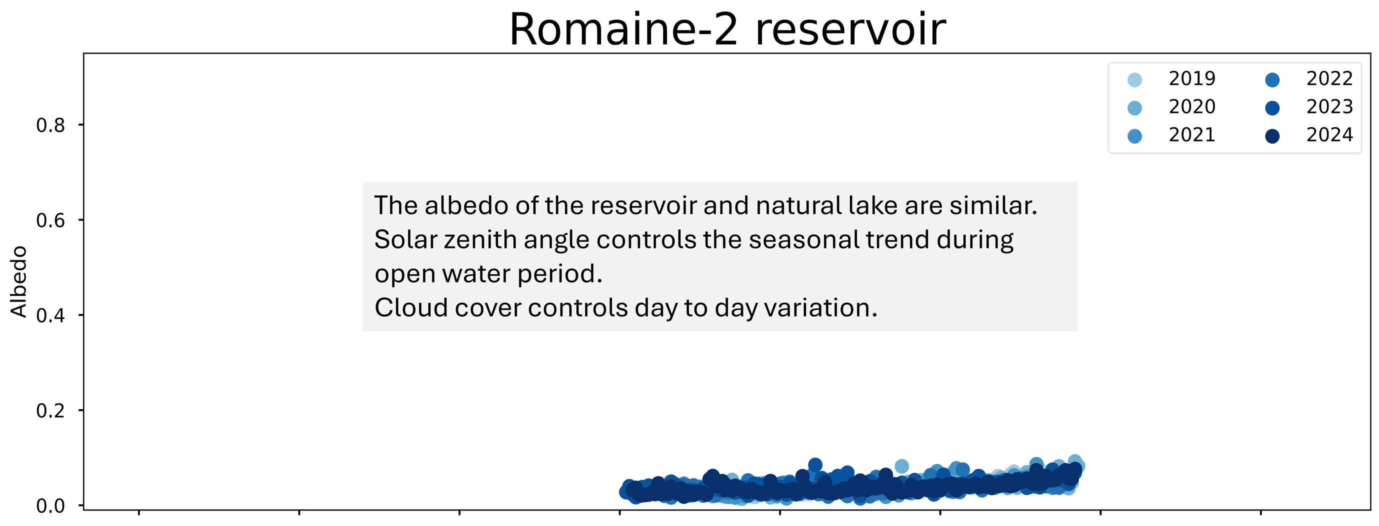
Post -impoundment summer and winter radiation balance at B) and C).

CNR4 Observations

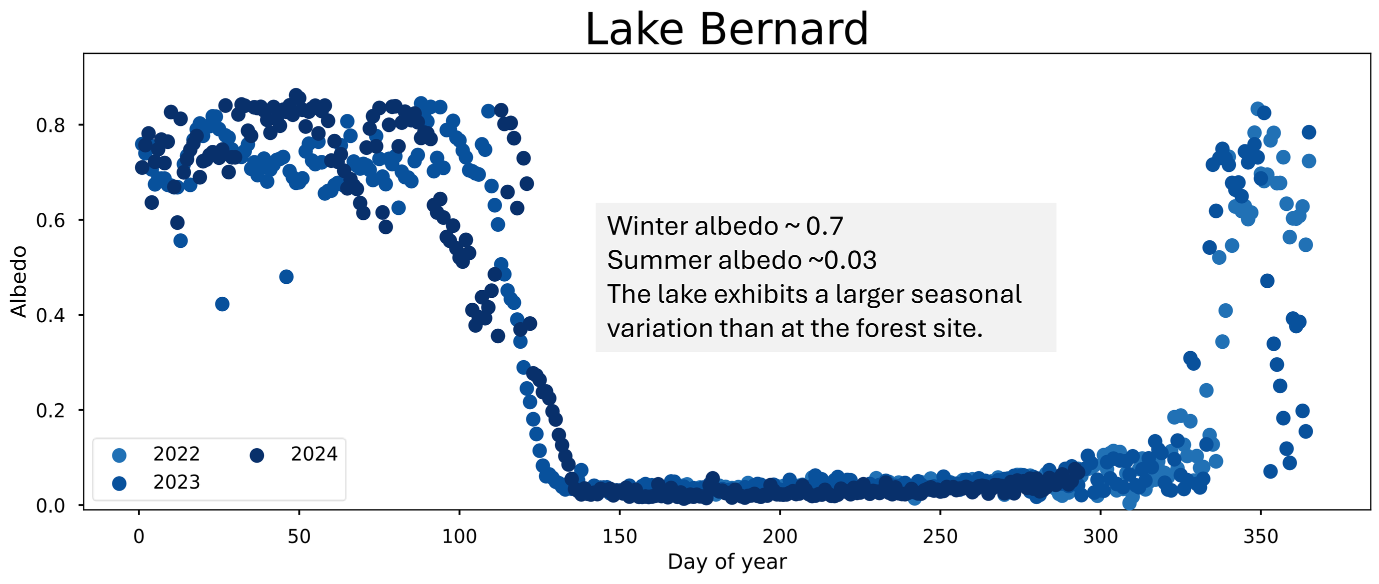
Forest

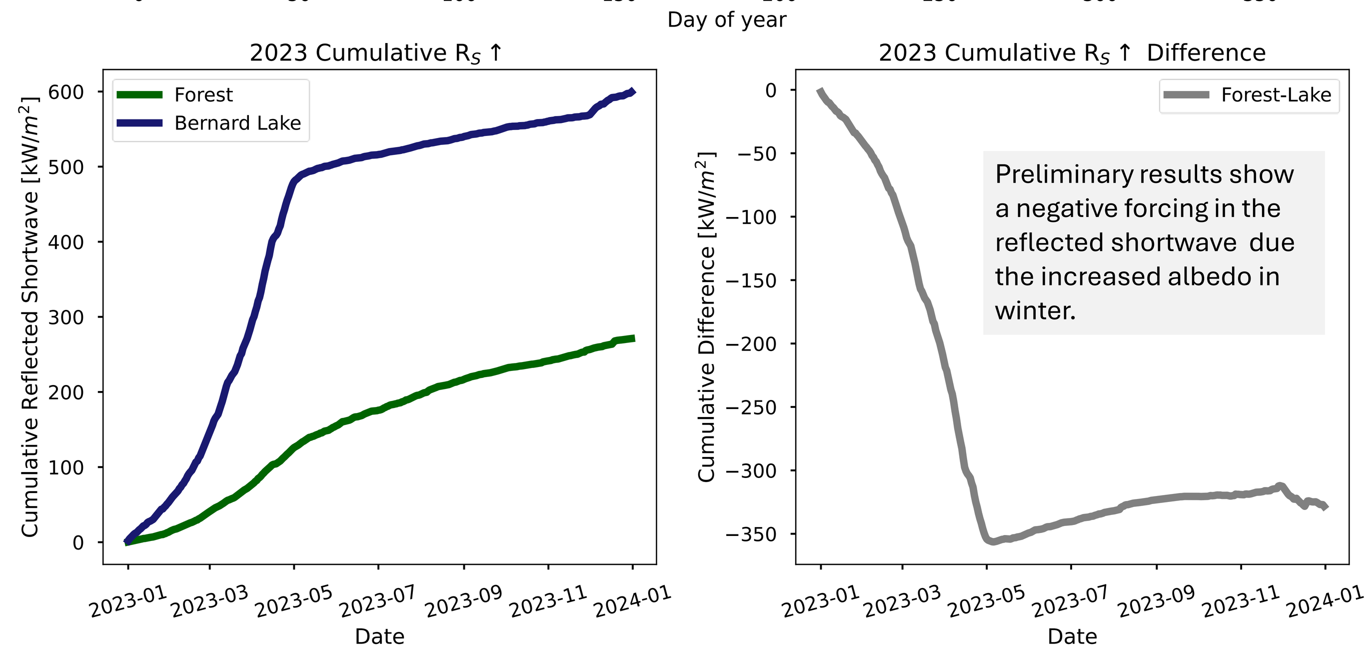


Romaine-2 reservoir



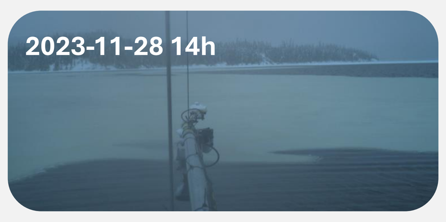
Lake Bernard

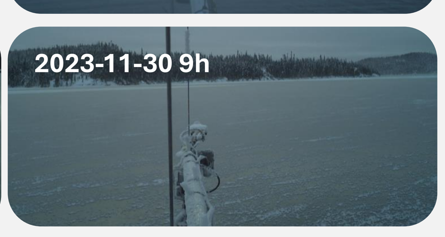




* Ice on and off observations

Observed ice fraction fluctuates over several days before the lake completely freezes.



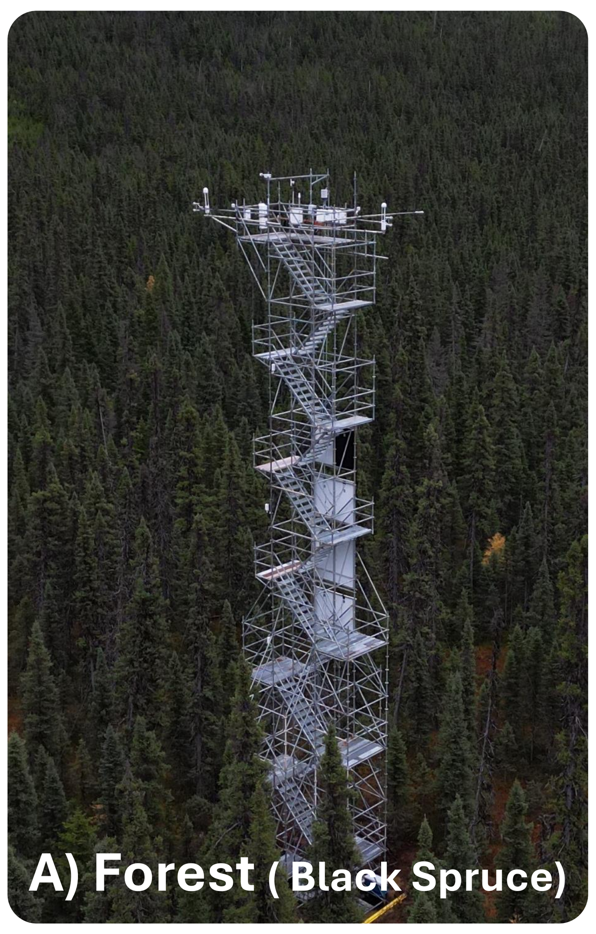


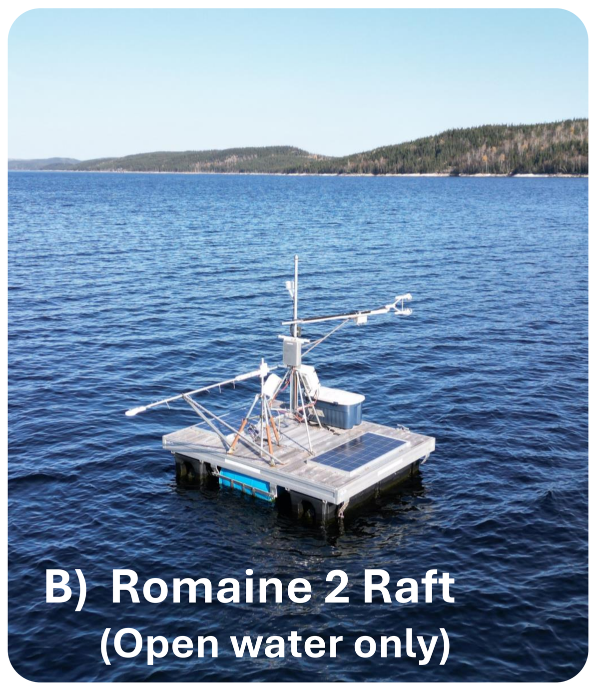
Water on the ice will also impact observed albedo during melt.

Methods

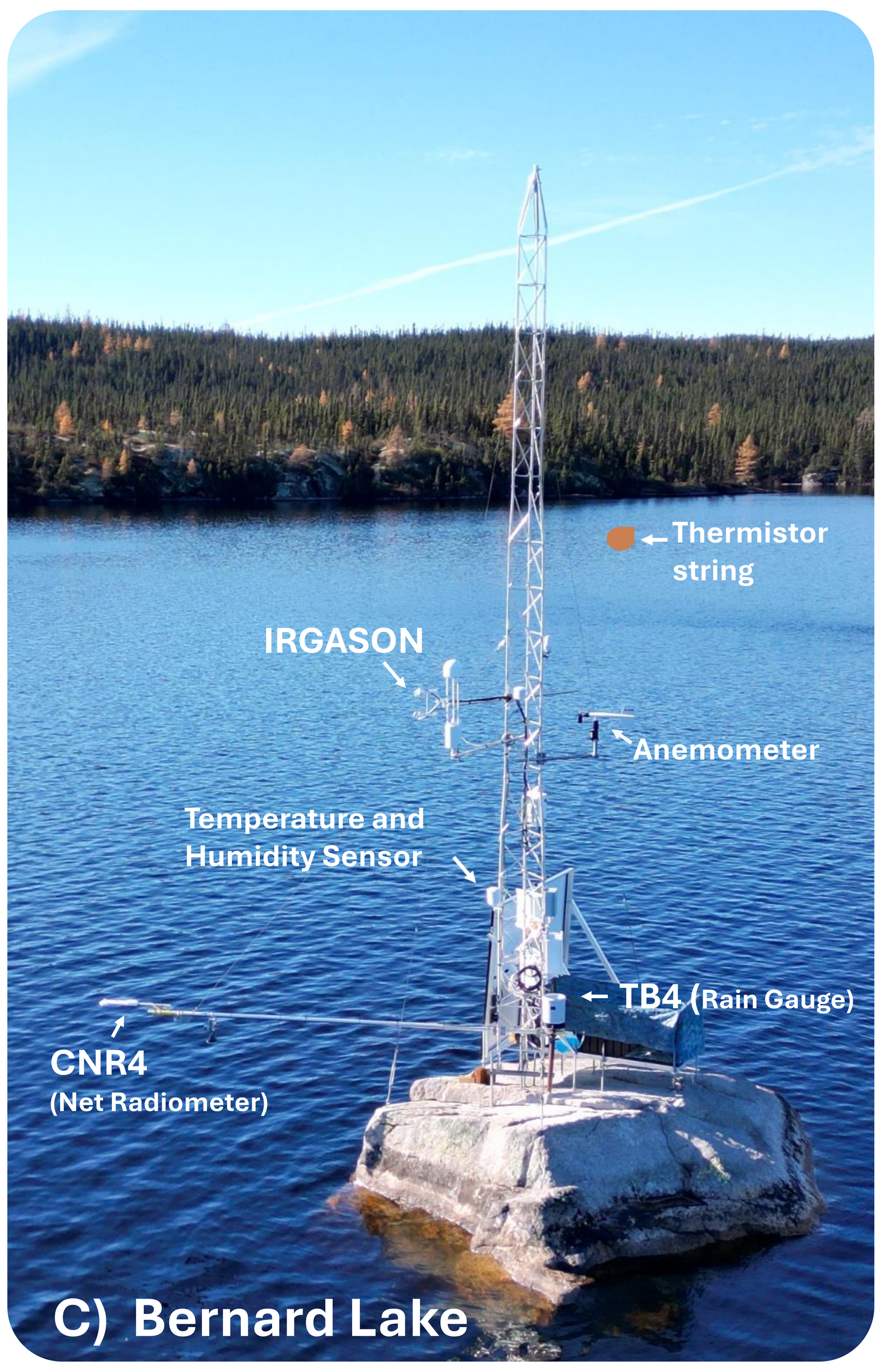
Observed albedo is analyzed using CNR4 data.

The Canadian Small Lakes Model (CSLM) and CLASSIC will be used to spatialize the analysis.





A and C are representative of the pre-impoundment natural environment.

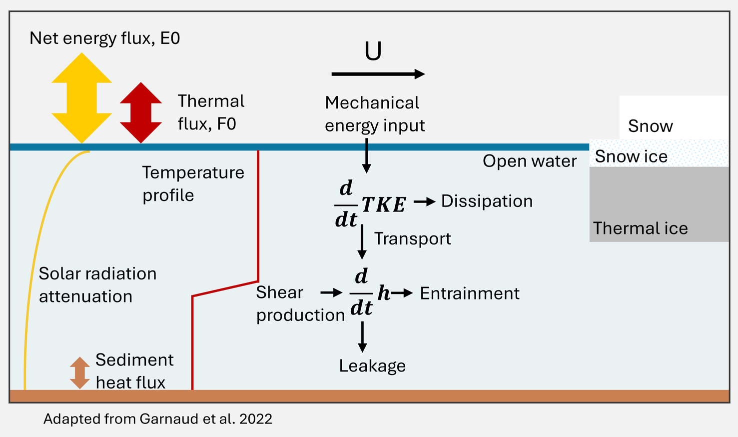


CSLM Simulation

Model description

CSLM is a 1D small lake model including:

- Thermal model with surface energy balance
- Turbulent kinetic energy mixed layer model
- Snow, ice and snow ice formation



Albedo parameterizations

Open water albedo

$$\alpha = \frac{b}{\max(\cos(\theta), 0.1)}$$

Ice albedo

$$\alpha_i = 0.08 + 0.44 h_i^{0.28}$$

maximum 0.44

Snow albedo

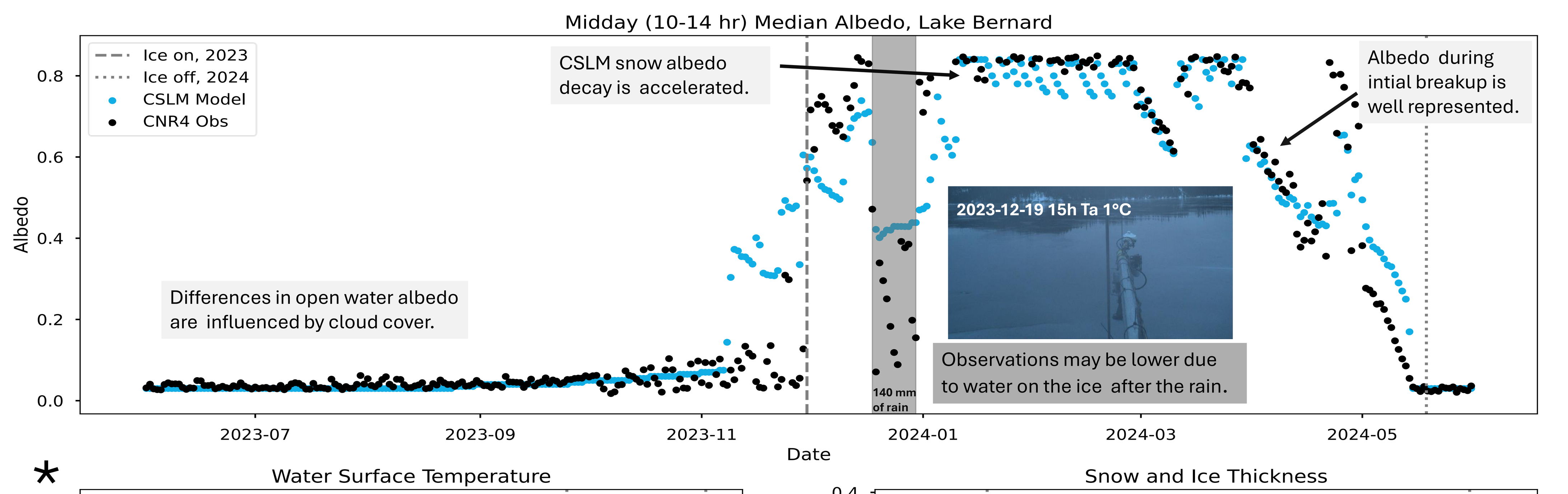
$$\alpha_s(t+1) = [\alpha_s(t) - \alpha_{s,old}] \exp\left(-0.01\Delta t/_{3600}\right) + \alpha_{s,old}$$

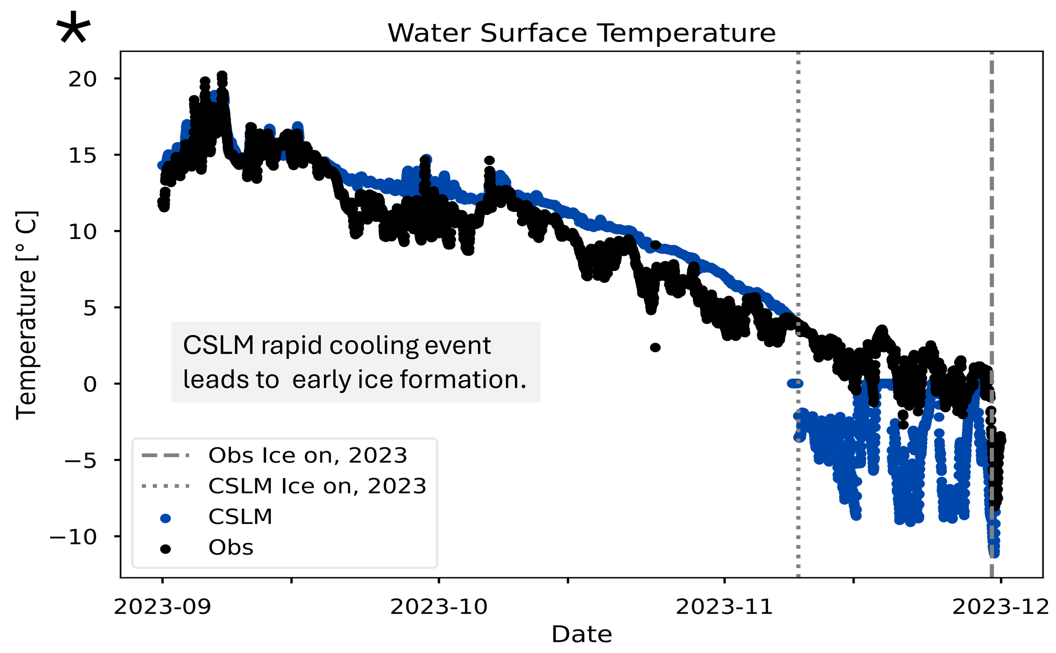
$\alpha_{s,old}$ = 0.7, during melt $\alpha_{s,old}$ = 0.5

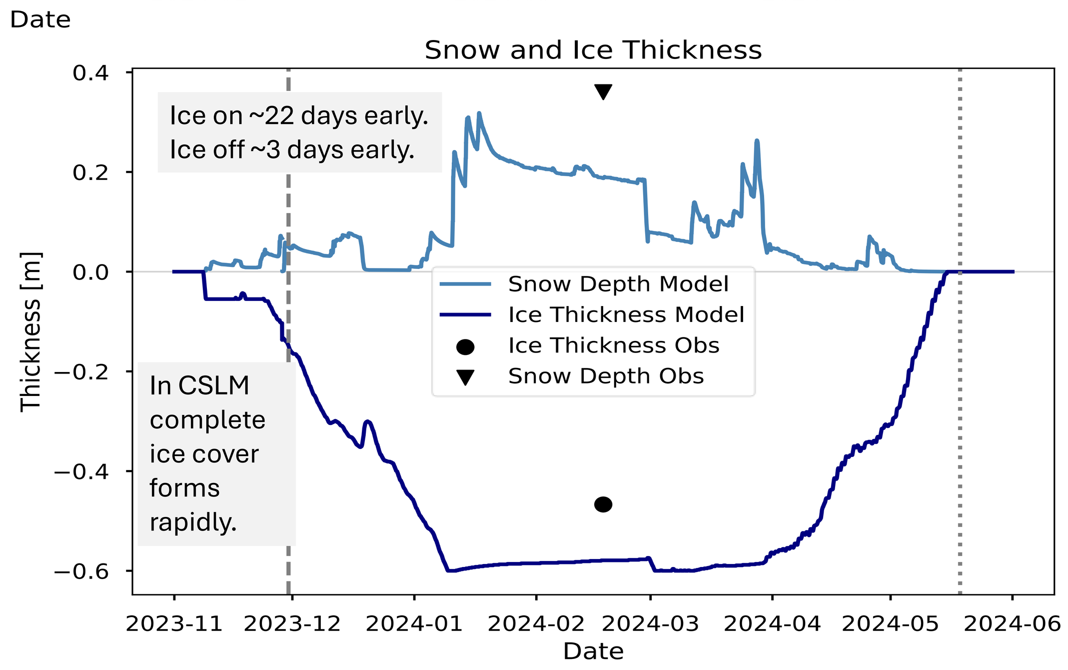
Table 1: Model Parameters

Lake Bernard June 2023 – June 2024

Fetch	2109.5 m
Mean depth	13.0 m
Max depth	52.0 m
Resolution	0.5 m
Ext. coefficent	0.5 m^{-1}
Water albedo b	0.025
Intial Tw profile	23-06-01 12:00
Timestep	1800 s







Next steps

Satellite validation of CSLM ice fraction → Albedo parameterizations → Complex scale analysis → Simulations in future climate

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Acknowledgements

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Mapping help from Thomas Brady.

Towards Determining the Maximum Water Force Beaver Dams can Endure before Breaching

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INTRODUCTION

Beaver dams serve as natural infrastructure in headwater systems, providing flood and drought mitigation benefits that have led to their growing recognition as nature-based climate solutions. These complex structures, composed of woody debris, mud, and vegetation, create wetland habitats that enhance biodiversity while regulating water flow through watersheds.

Despite their ecological importance, beaver dams remain vulnerable to breaching during high-flow events, potentially causing downstream flooding and limiting their reliability as management tools. A critical knowledge gap exists regarding the hydraulic forces that beaver dams can withstand and the specific conditions leading to failure. Previous studies have documented beaver dam impacts on hydrology, but rarely quantified the relationship between water forces and structural integrity. **Our research in Alberta's montane region addresses this gap by determining the hydraulic load conditions that lead to dam failure**. This study has implications for informing watershed restoration projects that utilize these structures as climate-adaptive, ecological solutions.

RESEARCH OBJECTIVES

- To quantify hydraulic loads experienced by beaver dams under varying discharge.
- To evaluate whether changes in hydraulic load modify the dam structure.

METHODS

STUDY SITE

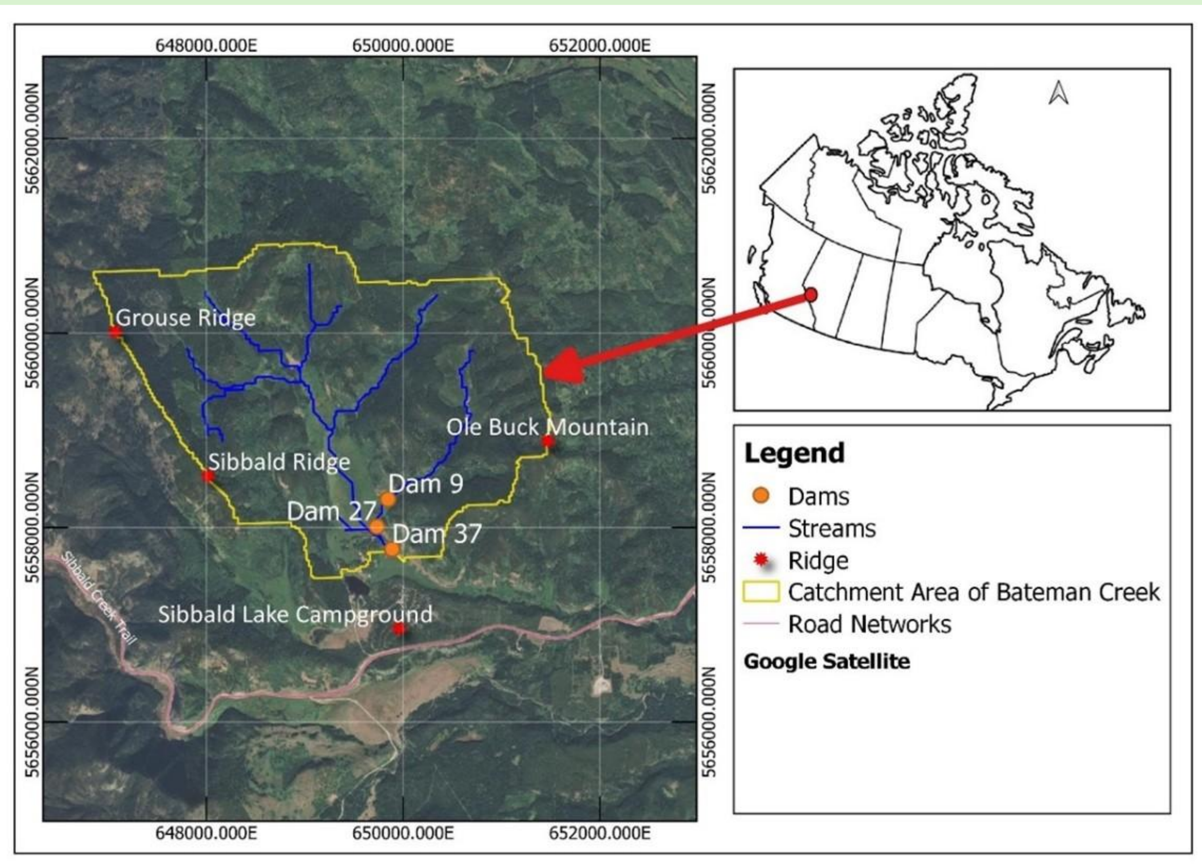

Fig. 1: Study Area at Sibbald Fen, Kananaskis, Alberta

We adapted gravity dam hydraulic principles to measure forces on 4 beaver dams in the study site (Fig. 1), accounting for their unique organic and semi-permeable structure. This approach establishes critical thresholds for beaver dam integrity under various water conditions (Figs. 2& 3). ImageJ software was used to quantify change in dam structure using wildlife-camera acquired images.

Horizontal Water Pressure

$$P_h = \frac{1}{2} * \gamma_w * h^2$$

Upstream and downstream forces act in opposite directions and were calculated separately.

Uplift Water Pressure

$$P_u = \frac{1}{2} * L * \gamma_w * (h + h')$$

Vertical pressure acting upward at dam base

Wind Wave Pressure

$$P_{wave} = 2 * \gamma_w * h_w^2$$

Force from wave action

Silt Pressure

$$P_{silt} = \frac{1}{2} * \gamma_{sub} * h_1^2$$

where:
γ_w=water specific weight,
h= water depth,
h'= tailwater depth,
h_w =wave height,
L= dam base length,
γ_{sub}=submerged unit weight of silt, and
h_1= silt depth

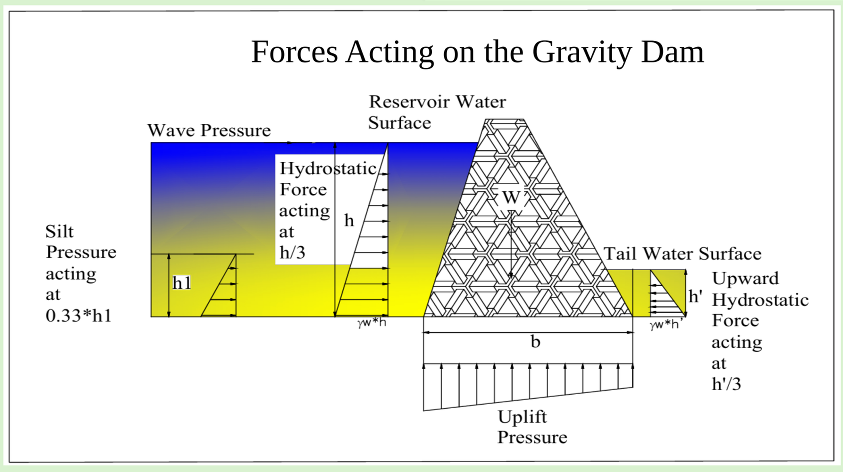

Fig. 2: The diagram illustrates the different forces acting on a beaver dam conceptualized as akin to a gravity dam.

METHODS

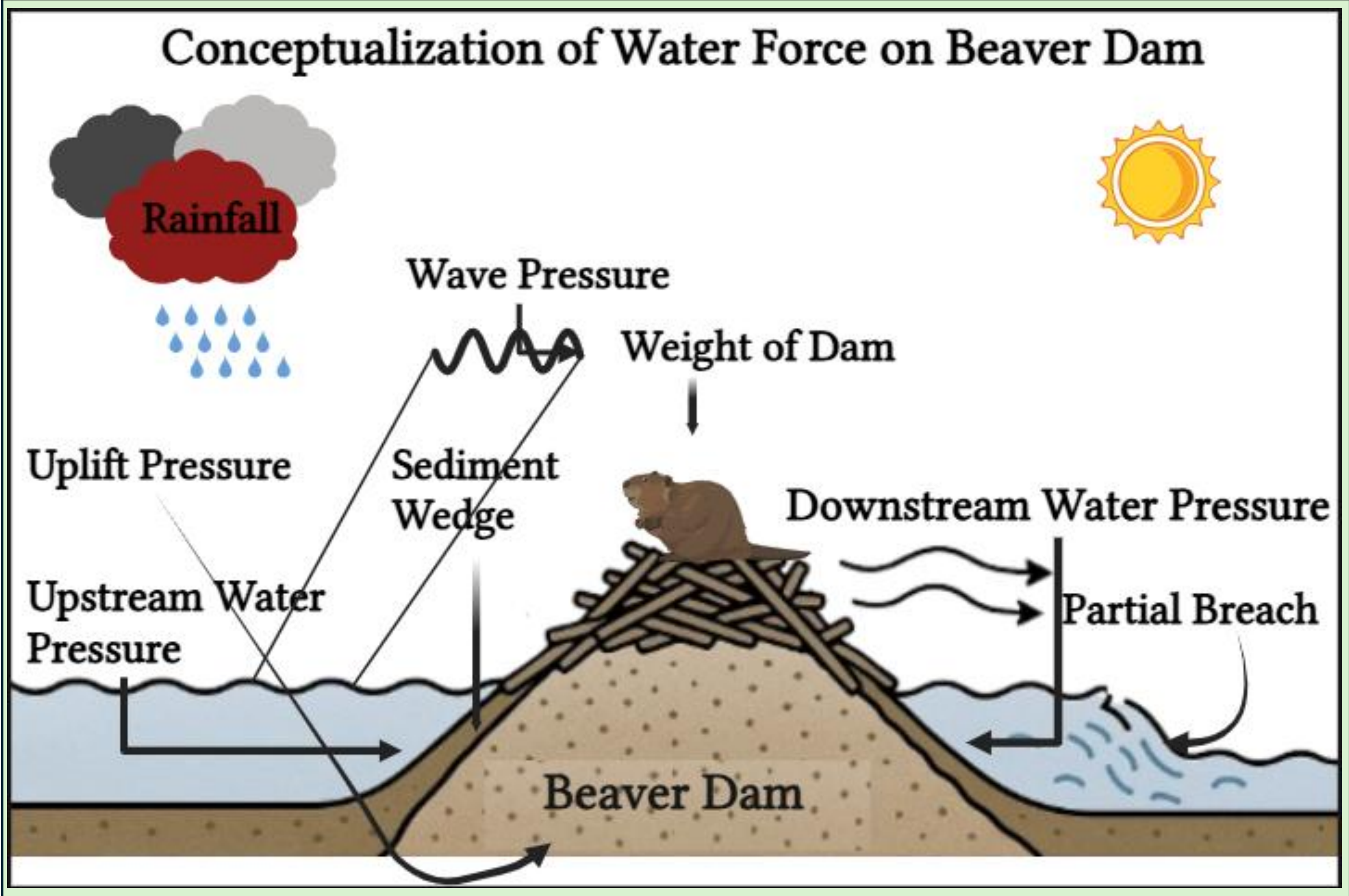

Fig. 3: Schematic diagram of various forces acting on a beaver dam, including upstream water pressure, uplift pressure, wave pressure, the weight of the dam, and downstream water pressure.

RESULTS

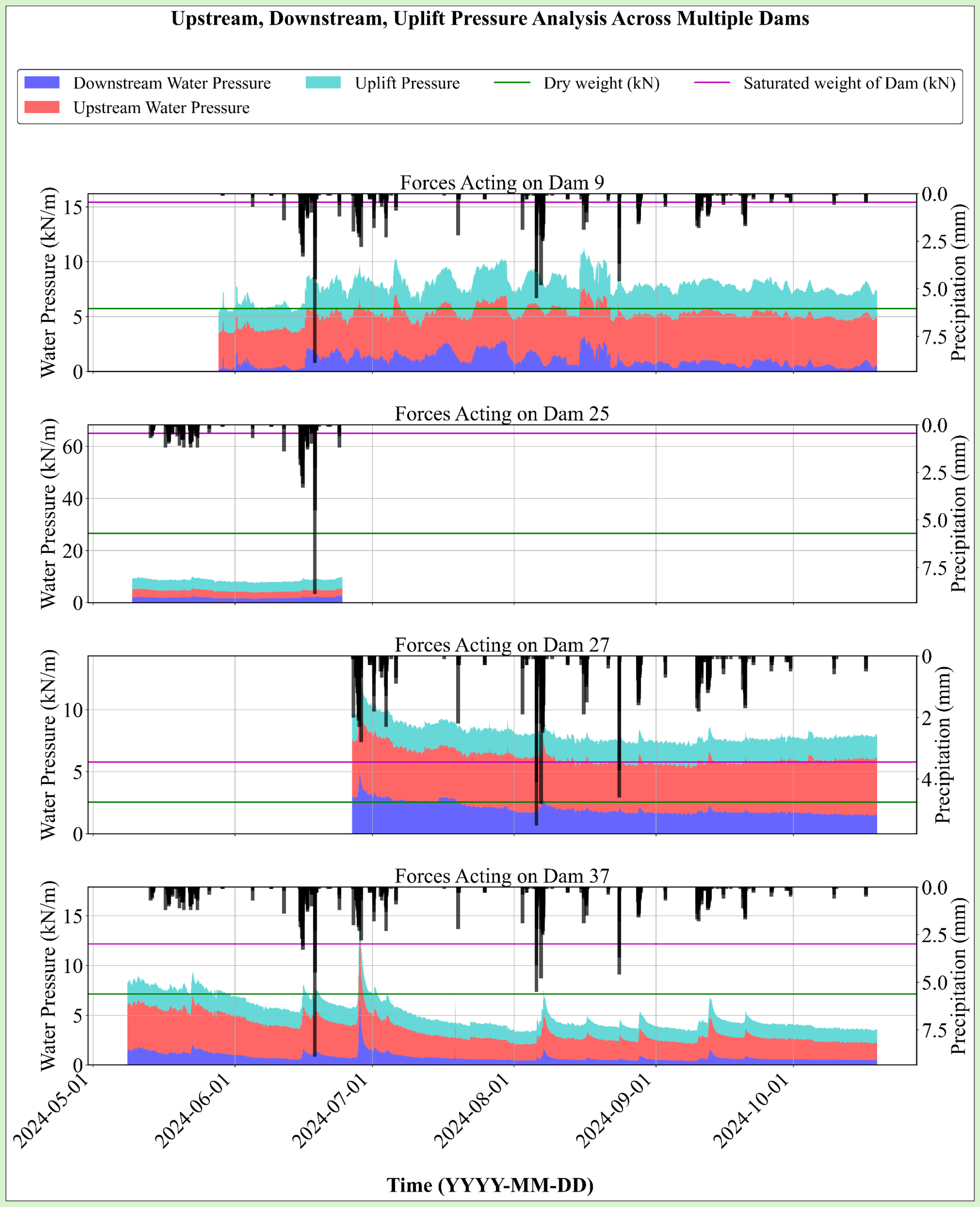

Fig. 4: Time series of the principle forces acting on the four studied beaver dams, from May to October 2024, in relation to precipitation events (black bars). The solid horizontal lines indicate the upper (pink; saturated) and lower (green; dry) beaver dam weights estimated from field measures, which is the primary resisting force. Wave pressure was not >0.03 kN/m and is so not shown.

RESULTS

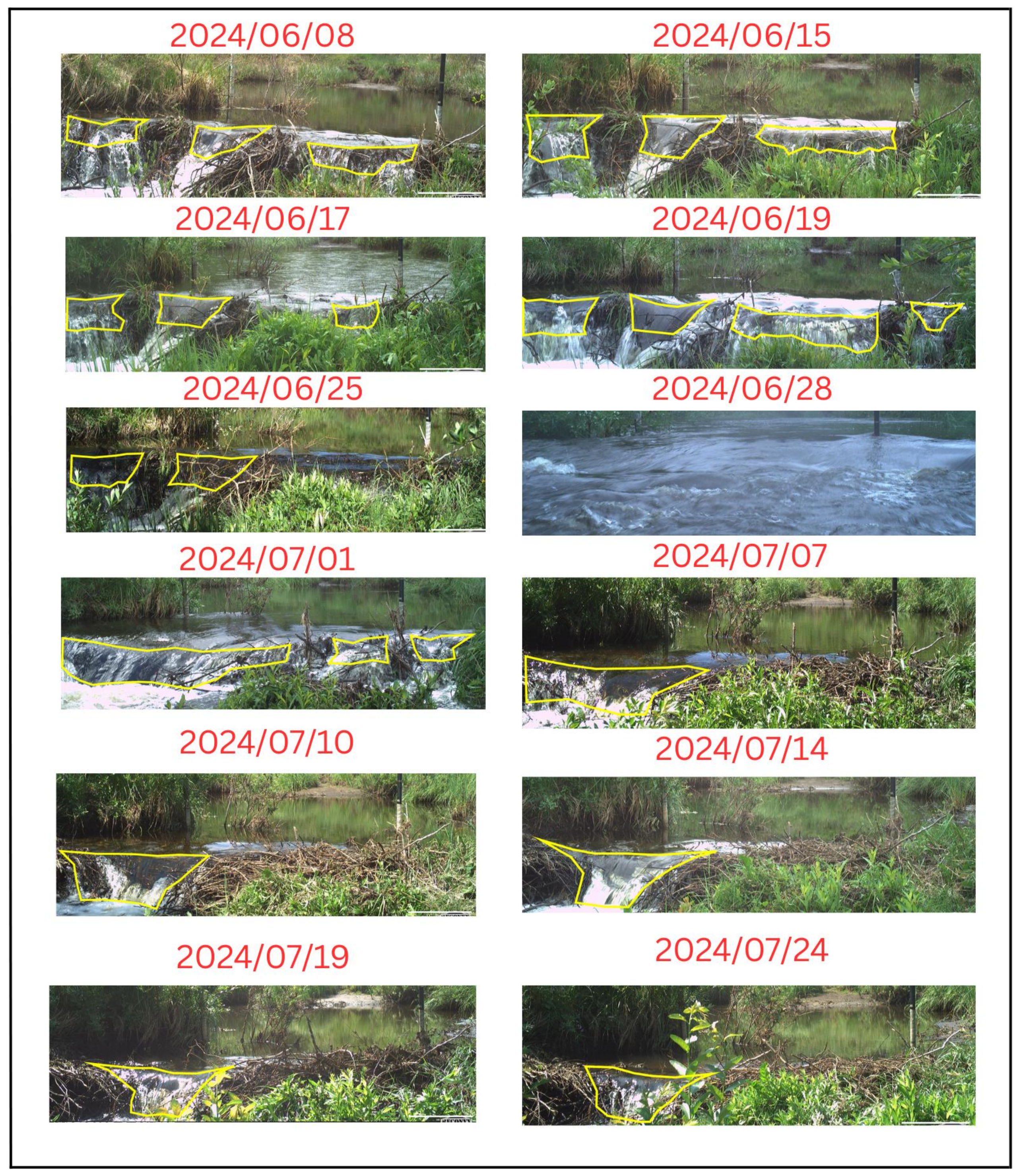

Fig. 5: An example time series of wildlife camera acquired images for Beaver Dam #37 overlaid by polygons showing breached extent. An expansion of breached area is clearly observable following a 38 mm rainfall event that led to floodwaters overtopping the dam on 2024/06/19, with subsequent addition of woody material by the beavers to partially repair the breaches in the 2024/10/19 & 2024/07/19 images.

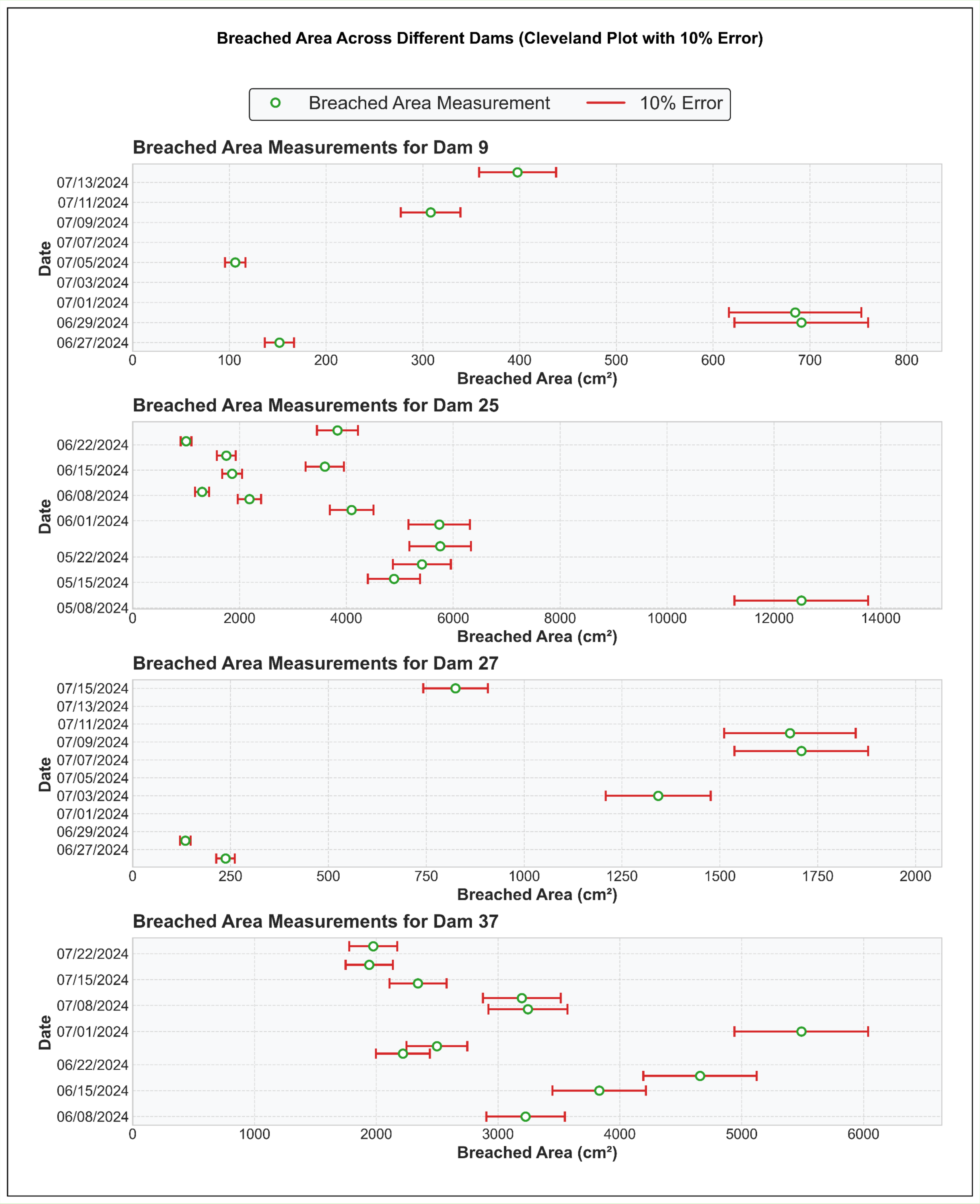

Fig. 6: Cleveland plot illustrating dam breached area (+/-10% uncertainty) for the four dams in cm². Dam breach size expands and contracts over the study in response to damage during rainfall-runoff events and beaver maintenance.

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MAIN FINDINGS

- ❑ Hydraulic loading analysis revealed forces acting upon beaver dams are dynamic in response to precipitation events. Only occasionally were the hydraulic loads on the dams higher than the force resisting dam failure. (Fig. 4)
- ❑ Partial breaching of some dams, specifically Dam #37, occurred in response to hydraulic loads greater than the resisting force of dam weight. Changes in dam structure were measurable using optical analysis during these breach events. (Figs. 5 & 6)
- ❑ Conceptualizing beaver dams as similar to gravity dams is useful for advancing quantification of dam failure (Fig. 2). But, because beaver dams are regularly overtopped by floodwaters (Fig. 5), future research should extent the conceptualization to quantitatively account for this.

Modeling Cold Region Hydrological Processes to Simulate Crop Yield in the Canadian Prairies

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[3]Global Institute for Water Security, University of Saskatchewan, Saskatoon, SK, Canada

Background:

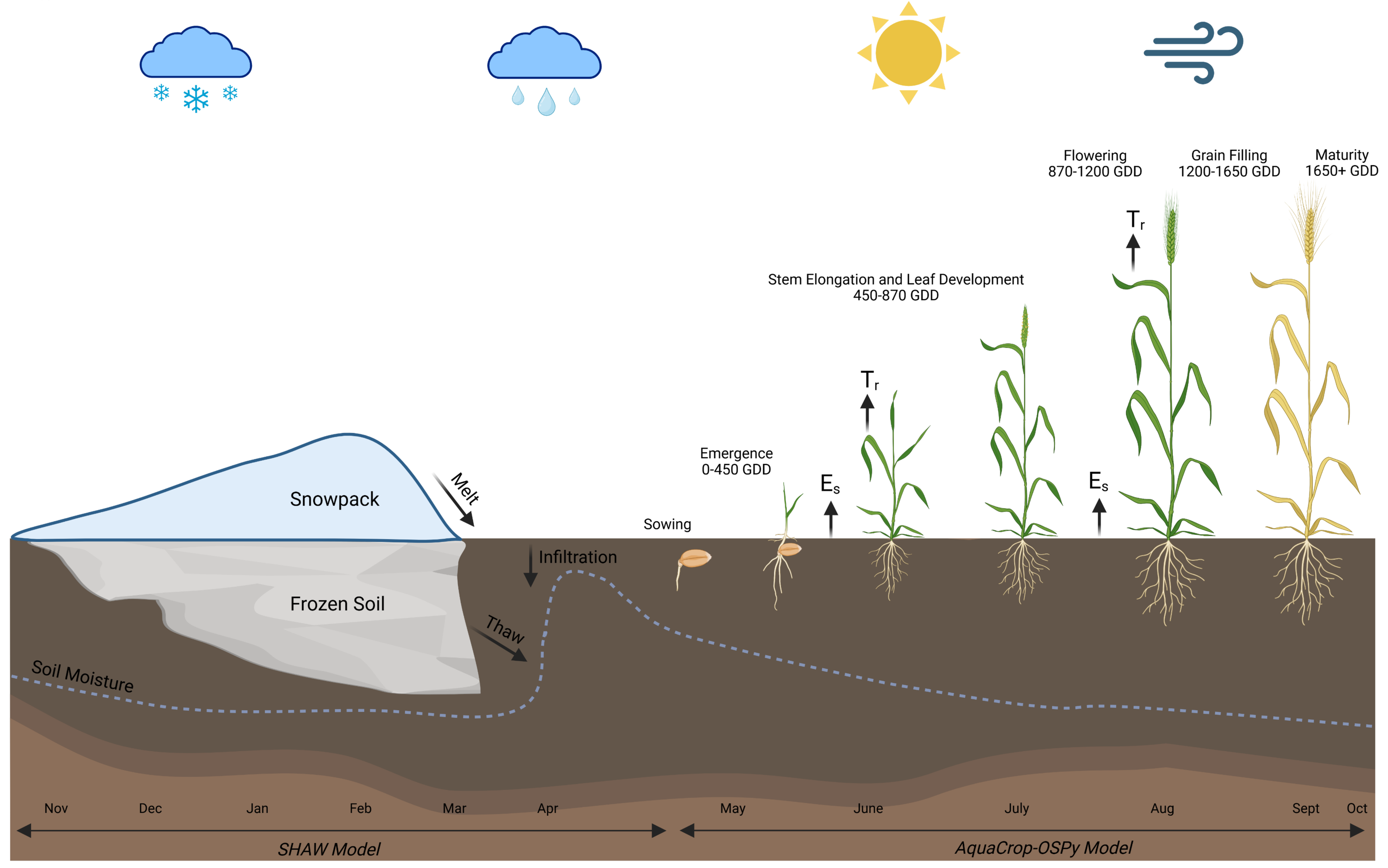
- Antecedent soil moisture and winter hydrological processes are critical for the crop growing season, particularly in seasonally-frozen dryland agricultural settings[1] like the Canadian Prairies.
- We need to predict snowmelt quantity, timing and infiltration/runoff partitioning to enable us to estimate cropping season soil moisture and crop yield.

Objectives:

Crop models can simulate crop phenology, and hydrology-land surface models can simulate winter hydrology.

1. Develop a field scale modeling framework for prairie agriculture to quantify soil moisture dynamics and crop yield.
2. Estimate timing and amount of snowmelt and soil moisture recharge.
3. Simulate the trend of soil moisture throughout the hydrological year.

Fig. 1: Conceptual Model of the Study



Methodology:

- Site: UoS Livestock and Forage Centre of Excellence
- 530 masl, 32km SE of Saskatoon
- Annually cropped with Barley
- Weather station instrumented with soil moisture and temperature sensors

- SHAq (SHAW[2] + AquaCrop-OSPy (ACOSP)[3])
- Model soil parameters estimated from Rosetta[4] based on soil texture.
- Default crop parameters from ACOSP for Barley
- SHAW quantifies soil moisture dynamics and water fluxes across the winter season, and passes the initial soil moisture value to ACOSP.
- ACOSP simulates soil moisture, and growing degree day driven crop growth. Final soil moisture value is passed as initial to SHAW for the next simulation.
- Evaluate model results of: i) Soil moisture and soil temperature
  ii) Post snowmelt/ thaw soil moisture recharge and its timing

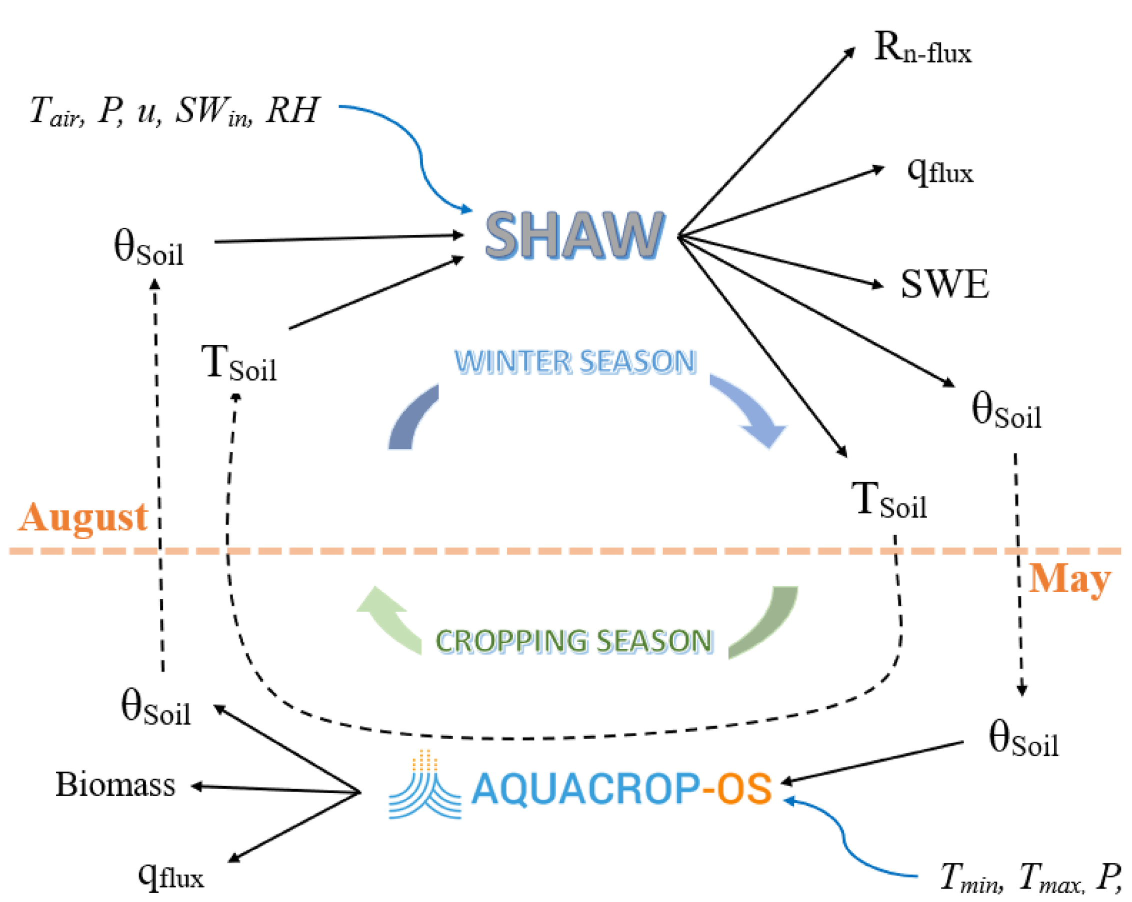


Fig. 2: The SHAq model framework

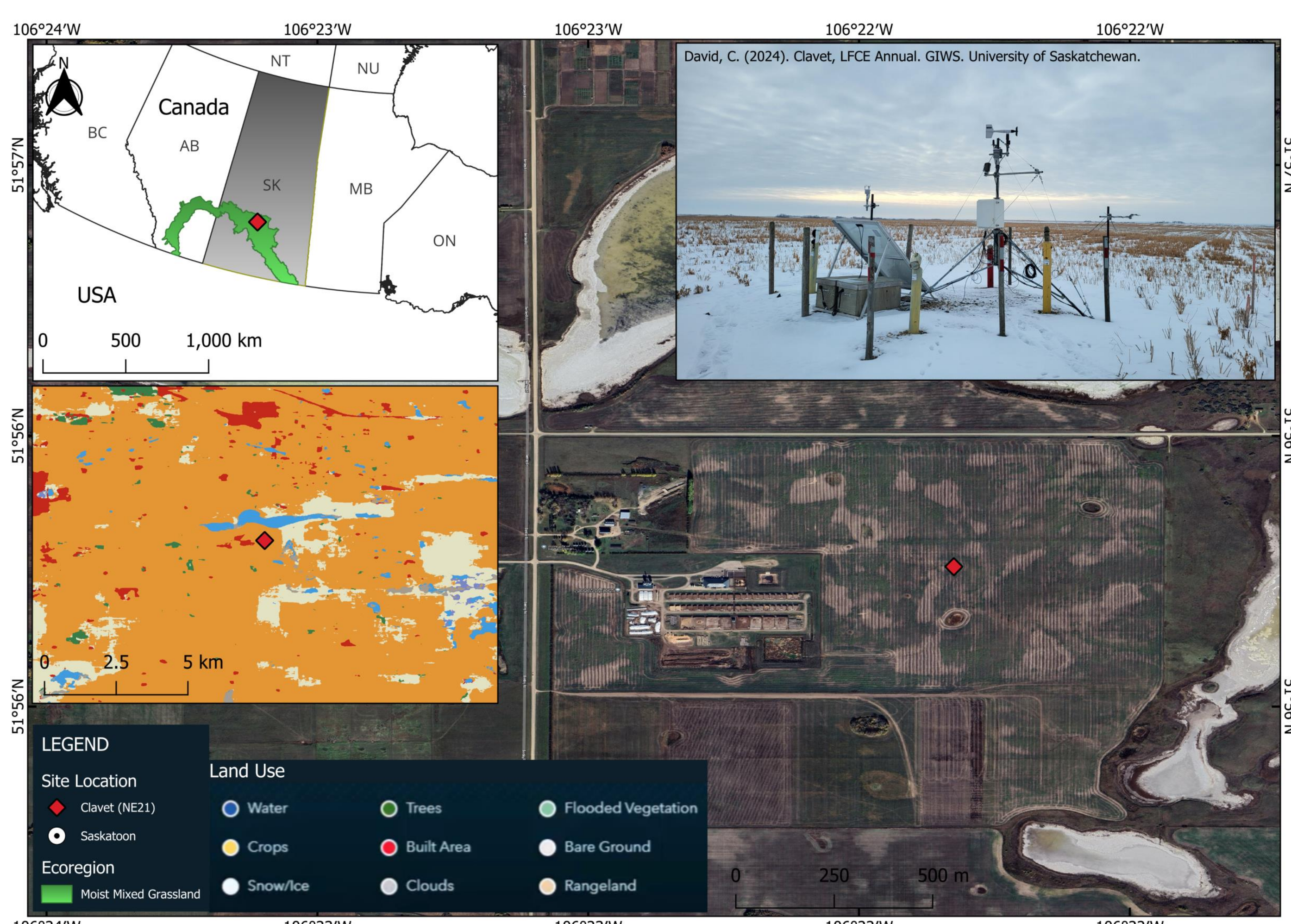


Fig. 3: Site Location and Characteristics

Results:

1. The SHAq model framework can simulate soil water dynamics, along with winter hydrological fluxes.
2. 0-degree isotherm/ soil temperature was well simulated.
3. SWE estimation was good. Snow depth is overestimated as SHAW does not simulate blowing.
4. Comparative changes in liquid water content was reasonable. The underestimation might be a parameterization issue as the physically based model was not calibrated.
5. Model performed well to capture timing of snowmelt infiltration which can be observed by the change in soil moisture.

Metrics (SHAq vs Obs)	RMSE	MBE	PBIAS %
SWE (cm)	2.08	1.06	17.37
Snow depth (cm)	11.48	7.08	34.02
Total soil moisture (cm)	3.07	-0.13	-1.35
Soil Temperature (°C)	2.51	-1.21	-17.71

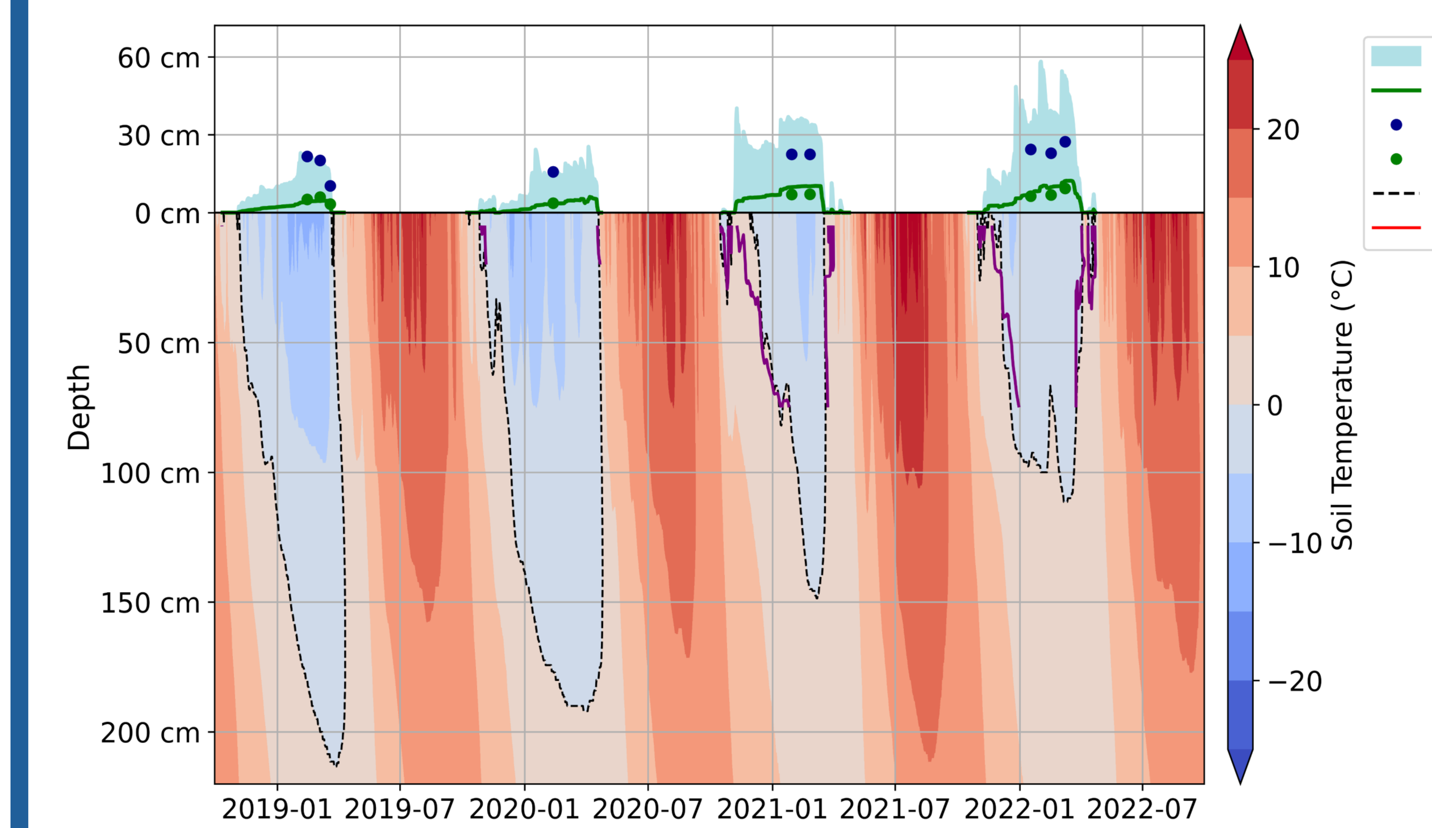


Fig. 4: Snow, SWE, and Soil Temperature Profile with 0°C Isotherm

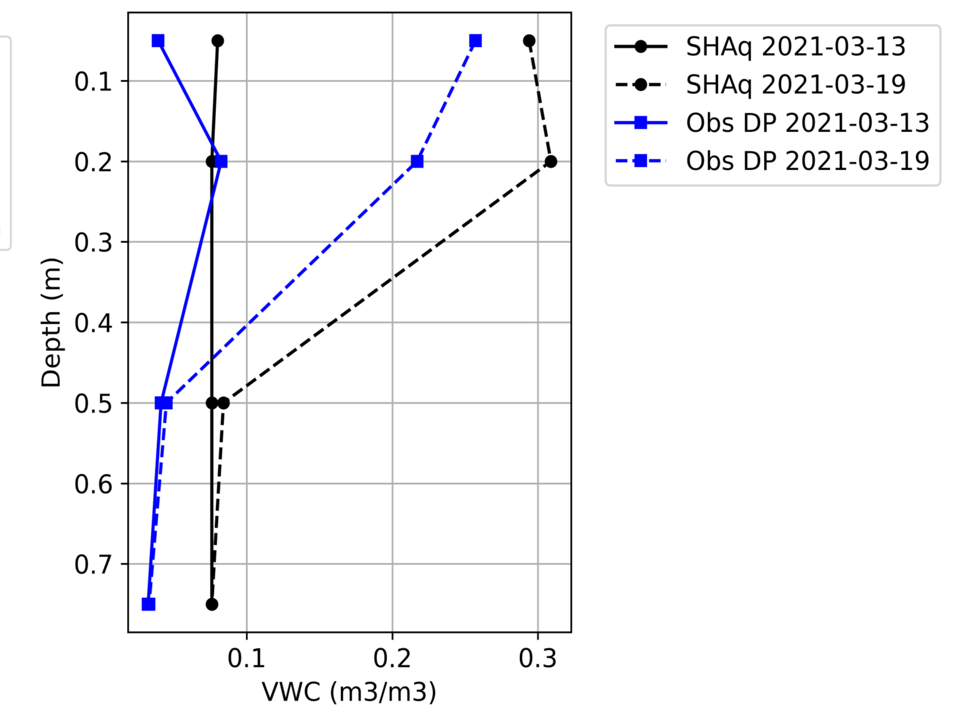


Fig. 5: Pre and post snowmelt VWC: SHAq vs DP Observation

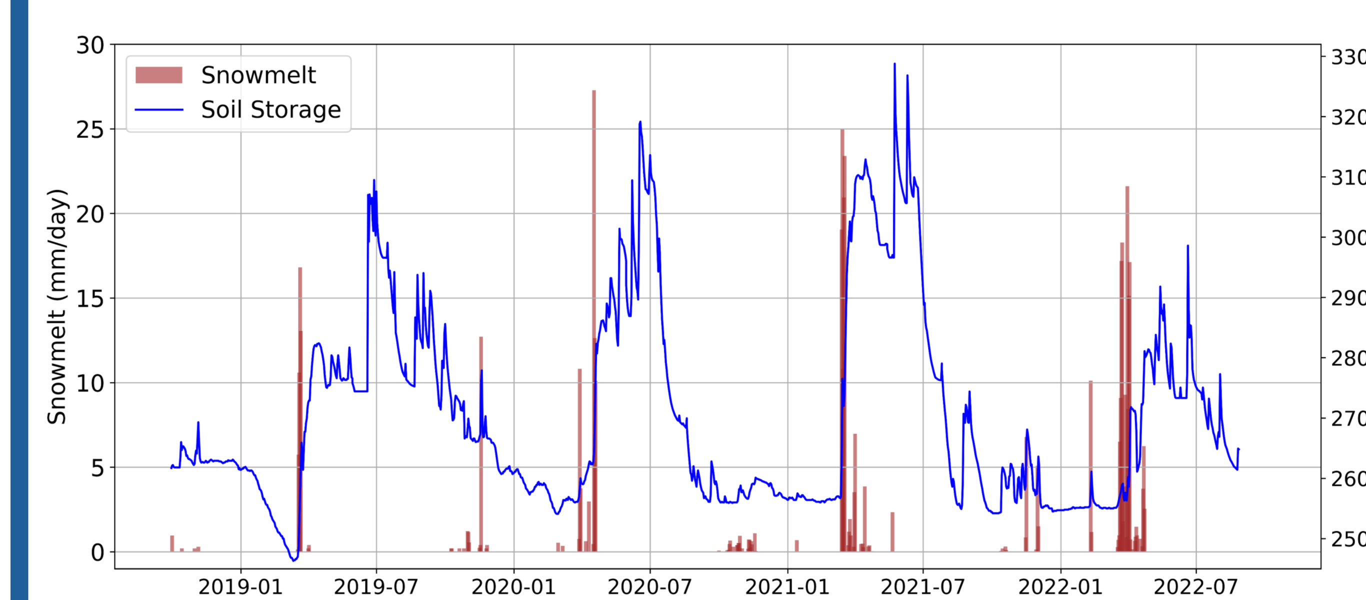


Fig. 6: SHAq Simulated Soil Water Storage and Snowmelt (0–2.2m)

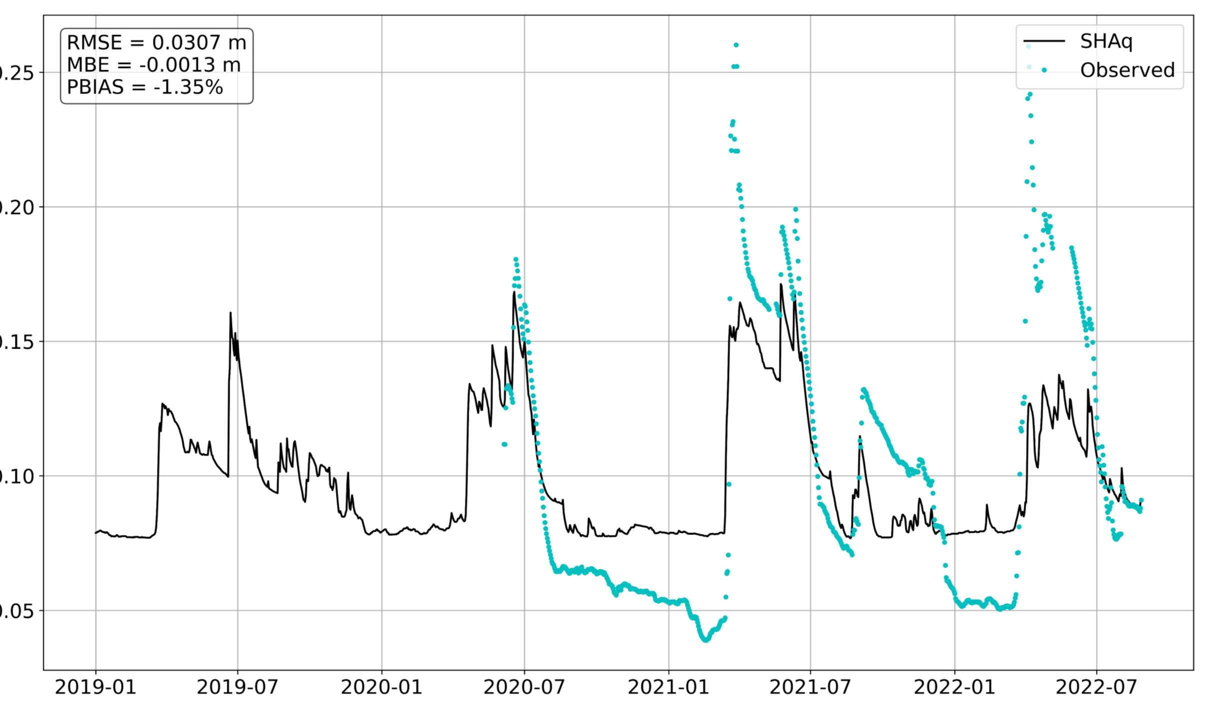


Fig. 7: SHAq vs DP Observed Soil Water Storage (0–1m)

Conclusion and Future Work:

- Overall, the coupled SHAq model captures soil moisture changes, SWE, timing of snowmelt infiltration and soil temperature reasonably well.
- Estimation of the snowpack depth could be improved by incorporating blowing snow.
- Next, SHAq will be used to simulate crop growth dynamics and growing season soil water fluxes, and validate them with field observations of crop biomass and moisture dynamics.
- Further, SHAq framework will be applied considering the evolving hydrological conditions in the Prairies, which provides a valuable tool assisting farmers and policymakers to make informed decisions.

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Environment and Climate Change Canada Environnement et Changement climatique Canada

ID: 12416

Using GIS to Improve Weather Station Resilience Against Wildfires

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Meteorological Service of Canada (MSC), Environment and Climate Change Canada (ECCC)

Atmospheric Monitoring Division (AMD), Monitoring and Data Services Directorate (MDSD), MSC, ECCC

- MDSD's mission is to provide timely and accurate weather and climate information to users
- Supports MSC's mandate to inform Canadians by collecting, processing, QA/QC'ing, and disseminating data and observations
- AMD manages and maintains the monitoring infrastructure for six national atmospheric networks

Land-based Networks

Surface: Automatic	571
Radar: S-band	33
Upper Air	30
Lightning Detection	83

Marine: Moored Buoys	39
Marine: Ocean Protection	4
Marine: Ship (AVOS)	41
Satellite Reception: POES	4
Satellite Reception: GOES	4

Wildland Fires

- Wildland fires are any natural or planned ignition that burns in wildland areas (forest fires, grassland fires, cultural fires, prescribed burns, etc.), consumes natural fuels (trees, brush, grass, etc.), and is influenced by landscape, and weather and wind patterns
- Wildfires are unplanned, uncontrolled wildland fires and are Canada's second costliest disaster, increasing in frequency, size, and intensity due to climate change
- A year-round risk, but most active from May to September
- Damage and losses to the environment, economy, critical infrastructure, communities, etc.

Wildfire Data

Natural Resources Canada's Canadian Wildland Fire Information System (CWFIS) integrates data from fire management agencies and provides products and access to current and archived fire data

- *Active Wildland Fires* report current active fire locations, size, and control status
- *Fire Perimeter Estimates* are produced using satellite-derived polygons of burned season-to-date areas

Enhancing Weather Station Resilience

- Increasing extreme weather events pose growing risks to station infrastructure and network operations while increasing demand for MDSD's program services
- In 2024, AMD and Digital Services Branch (DSB) quickly incorporated (near) real-time data into internal Network Management Tools (NMT) using Geographic Information Systems (GIS) to visualize and analyze spatial data to monitor fire activity to identify stations at risk and support operational planning
- Updated in 2025 for improved accuracy and responsiveness

Wildfire Proximity Notification Emails

- Daily spatial analyses performed to issue early warning notifications of wildfires within 50 km of an AMD land-based station
- In 2024, the distance between burned-to-date fire perimeter polygon boundaries of wildfires > 500 hectares (ha) were used
- In 2025, updated to use coordinates of active wildfires > 500 ha that are Out of Control (OC) or 0-25% contained
- Sample warnings:

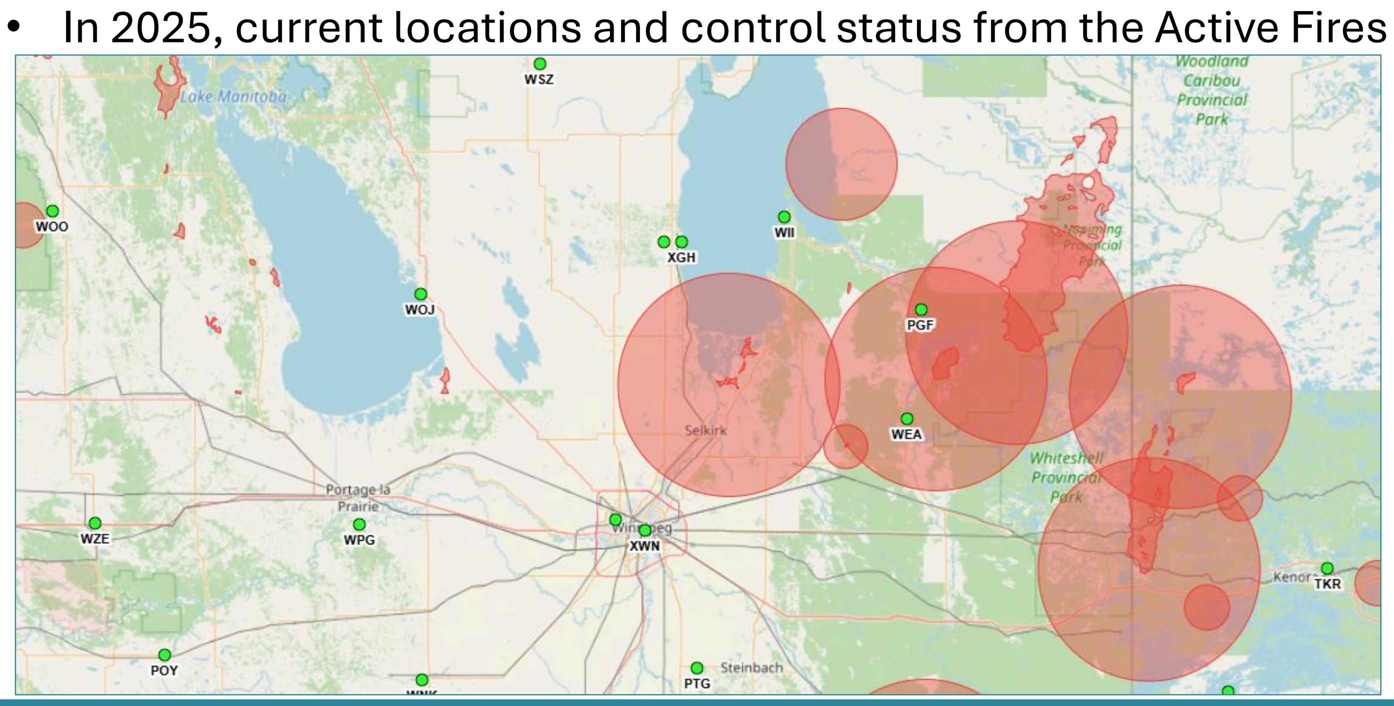
PINAWA (WEA) is in proximity to 3 wildfires, the closest is 12.07 km away (wildfire sizes 4000.00 ha, 100000.00 ha, 5000.00 ha)
THE PAS CLIMATE (PQD) is 16.26 km away (wildfire size 42650.80 ha)
KENORA RCS (TKR) is 46.52 km away (wildfire size 23281.40 ha)
VICTORIA BEACH (AUT) (WII) is 47.96 km away (wildfire size 5000.00 ha)
WINNIPEG 'A' CS (XWG) is 48.72 km away (wildfire size 5000.00 ha)

The Pas (YQD) is 11.86 km away (wildfire size 7459.52 ha)
Sept-Isles (YZV) is in proximity to 2 wildfires, the closest is 32.83 km away (wildfire sizes 3934.71 ha, 682.37 ha)

Fort McMurray (CASFM) is 16.35 km away (wildfire size 21238.10 ha)
Cold Lake (CASCL) is in proximity to 2 wildfires, the closest is 33.80 km away (wildfire sizes 540.41 ha, 885.36 ha)

Surface Network Map Layer

- The Surface NMT provides features such as station metadata, data, and a map of all stations in the network to monitor the network's health and performance
- In 2024, GIS-integration into the map layer to display locations and boundaries from Fire Perimeter Estimates
- In 2025, current locations and control status from the Active Fires data are being added



Surface Weather Stations
Active Fires
Fire Perimeter Estimates

Highlights

- Daily alerts support operations to manage field staff safety, prepare for wildfire threats, and to strengthen resilience of critical monitoring infrastructure to continue delivery of essential services
- Map layers allow for quick access to view wildfire weather stations locations, as no such tool exists otherwise

Challenges

- Dependent on external agencies for accurate and up-to-date data
- Misalignment in timing of CWFIS data updates and generation of AMD products
- Initial over-reporting of potential stations at risk due to limitations of outdated fire perimeter data

Future Enhancements

- Customized proximity criteria by region or network
- Dynamic wildfire/hazard data dashboard
- Hazards map with locations of all AMD networks
- Addition of other environmental datasets, including wildfire forecasts

References

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Acknowledgements

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Lessons Learned

Wildfires and other hazards can start and evolve quickly. GIS can help improve weather station resilience using maps and spatial analyses to provide some early warning, but good network resilience also involves early preventative measures using standard practices.

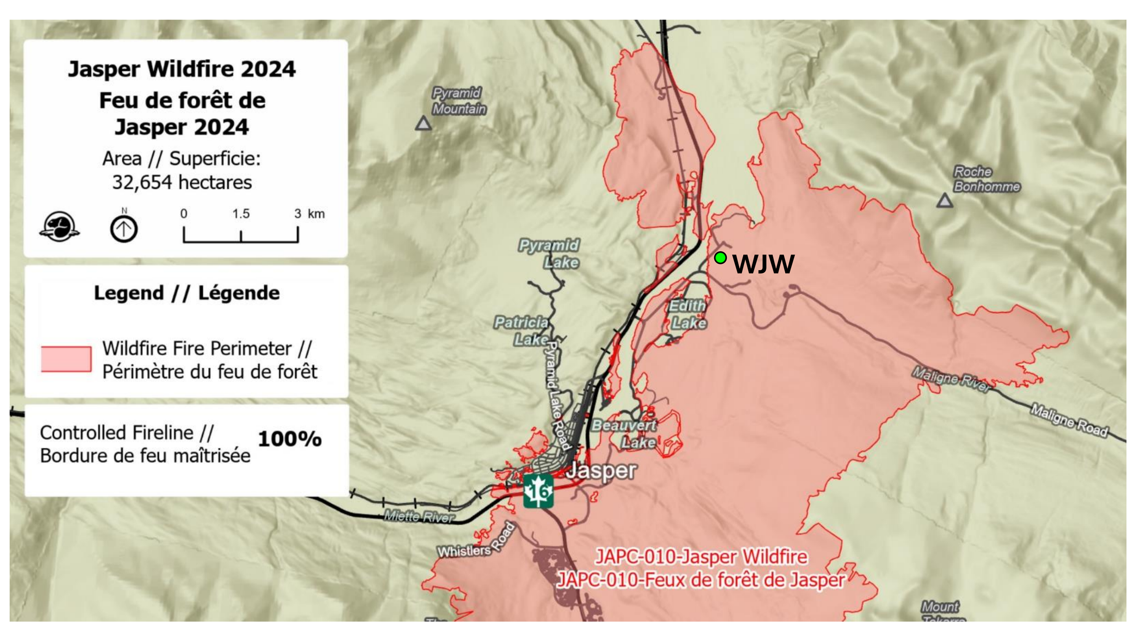
2024 Jasper, Alberta Wildfire

- Wildfires ignited under hot, dry conditions on July 22
- Town and national park began evacuations on July 23
  - No time for AMD Meteorological Technologists to travel to the weather station to implement additional preventative measures or deploy a mobile unit due to the travel restrictions
- Fire destroyed the powerline, station stopped transmitting data on July 24
- Wildfire Proximity Notification appeared in the July 25 report

JASPER WARDEN (WJW) is in proximity to 2 wildfires, the closest is 1.77 km away (wildfire sizes 546.75 ha, 16811.60 ha)

- Techs regained access on August 19 with Parks Canada support as the only route remained closed
  - Station is in a meadow about 20 m from the surrounding forest that was significantly burnt
  - Minor grassfire passed through the station causing minimal damage due to the FireSmart principle of vegetation management that reinforces the need for regular landscaping to mitigate fire risk to infrastructure in forested areas

Northwest view of fire-damaged trees and grass at Jasper Warden AWS, August 19, 2024.



Jasper 2024 Wildfire Fire Perimeter and Controlled Fireline around Jasper Warden AWS. Source: Parks Canada, accessed May 16, 2025, https://parks.canada.ca/pn-np/ab/jasper/visit/feu-alert-fire/feudeforet-jasper-wildfire.

Citizen Science Contributions to Enhancing Precipitation Observations:

Insights from a Volunteer Community Collaborative Rain Hail and Snow (CoCoRaHS) Precipitation Observer on the Prairies

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WHAT IS CoCoRaHS?

The **Co**mmunity **Co**llaborative **Ra**in, **H**ail, and **S**now Network is a non-profit, community-based network of volunteers who measure and report rain, hail, and snow in their backyards. It originated in Colorado in 1998 in response to a very localized and devastating flash flood, with the intent of better mapping and reporting intense storms. (www.CoCoRaHS.org).

WHY IS IT IMPORTANT

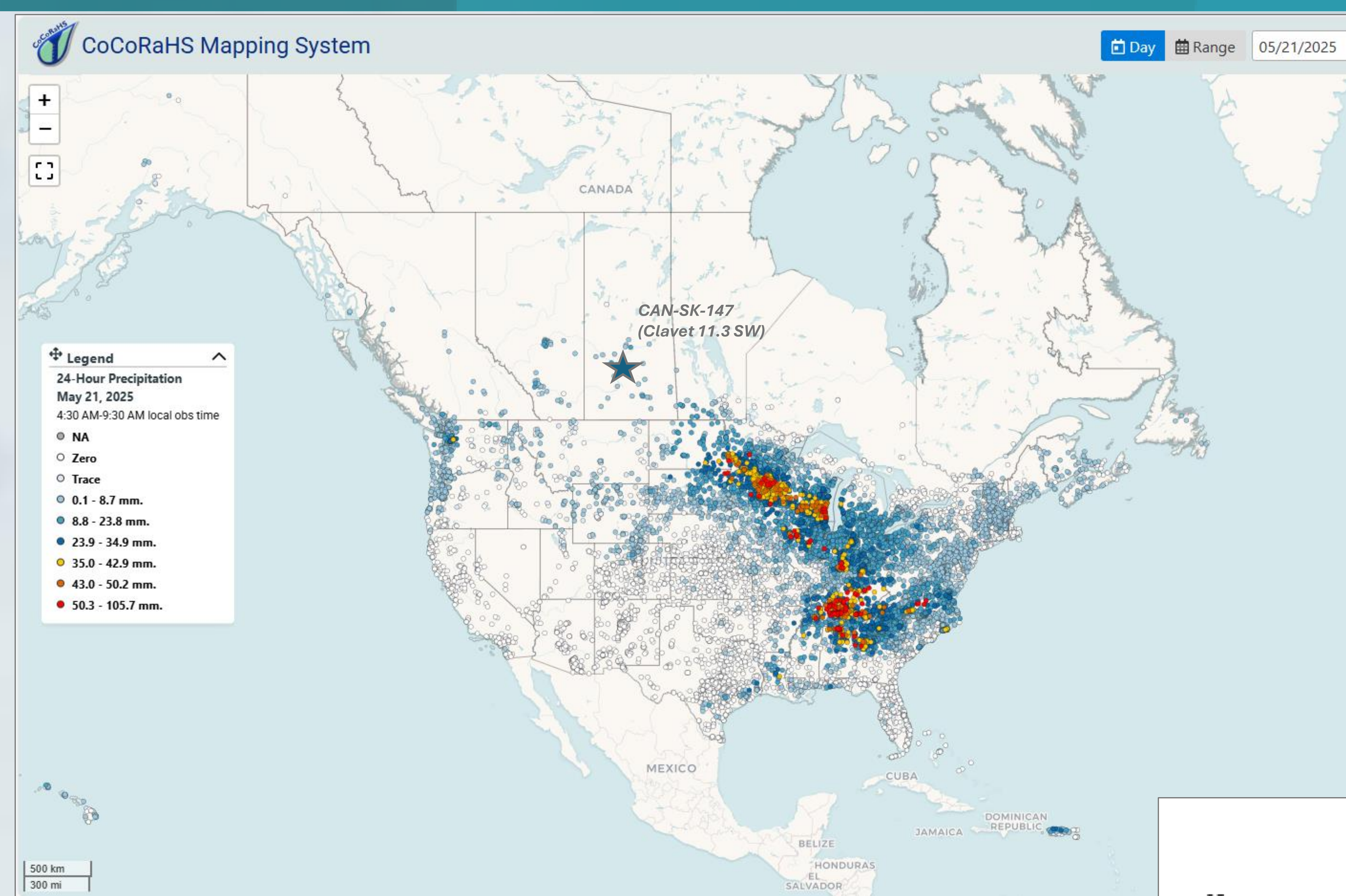
- The volunteer network helps increase the geographical density of precipitation data, which better captures its spatial variability.
- Observations are essential for monitoring and predicting environmental conditions.
- Uses within Environment and Climate Change Canada (ECCC) and beyond include:
  - ***Weather summaries***
  - ***Canadian Precipitation Analysis*** (CaPA): *In its deterministic configuration, produces an optimal estimate of the amount of precipitation over 6 and 24 hour periods.*
  - ***Seasonal and daily maps***
  - ***Warning preparedness and public weather offices***
  - ***Other uses***: Agencies that monitor conditions such as ***drought and water supply***, as well as insurance adjusters, teachers, and others interested in their local environment.

ISSUES/CHALLENGES

- **Expectations vs Reality for Observing Precipitation on the Prairies**
  - **High winds** make snowfall observations difficult.
    - Following approximately six seasons of experience with snow observation, an optimal representative location was found. This site is situated in a shallow low-lying area (pothole) surrounded by willows and some aspen trees (see satellite map below).
    - Precipitation **gauge under-catch** due to wind has been observed.
      - Some under-catch of **rain** observed in an exposed site due to wind.
      - Under-catch is more obvious during **snowfall** events. Anecdotal evidence of gauge under-catch during snow events associated with high winds can range between **20% and 80%.** However, according to CoCoRaHS data, catch efficiencies range from 101% to 105% when compared to U.S. National Weather Service gauges.
- **Spatial representation and data accuracy**
  - Gaps in the network (eg, Southwest Saskatchewan and northern Canada)
  - Observers are required to report **0** precipitation instead of no report.

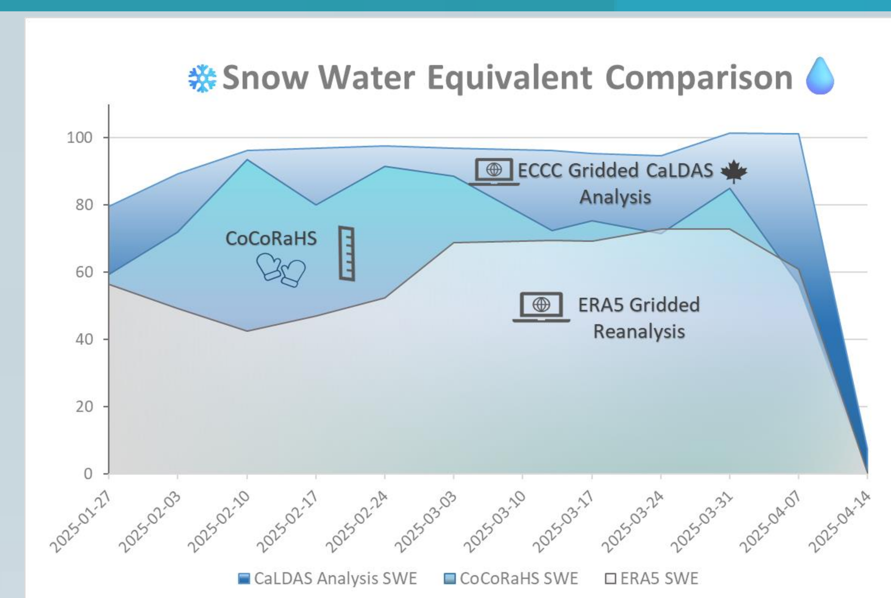
BENEFITS AND SOLUTIONS

- Participation in the network is encouraged, creating opportunities for **continuous learning** and contributing to the broader community.
- Improve the quantification of gauge under-catch.
- Some ideas for expanding and strengthening the network include:
  - Forming an online Community of Practice.
  - Strengthening the volunteer coordination program to enhance communication between observers and the network, providing additional encouragement.
  - Expanding the collection of value-added data, such as photographs.

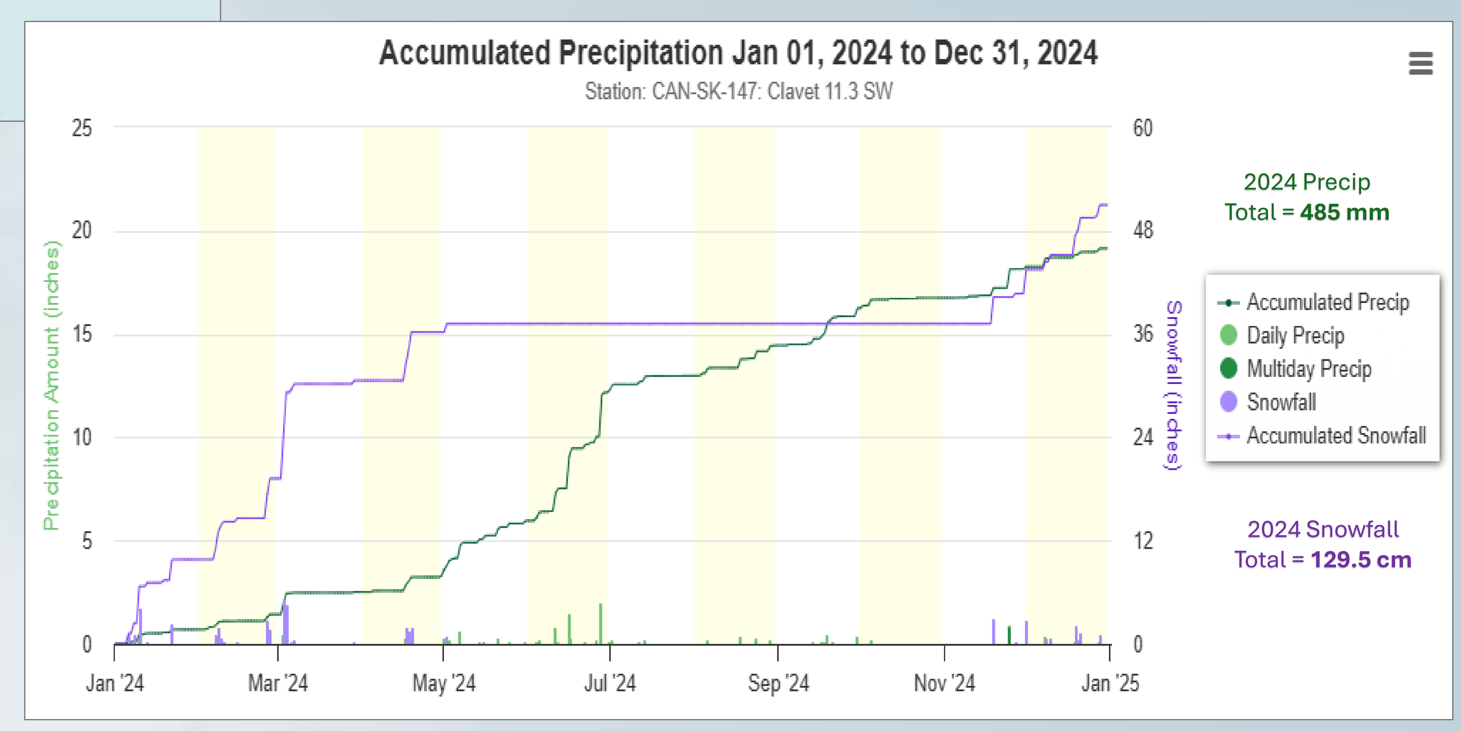


Map of the CoCoRaHs network stations (www.CoCoRaHS.org)

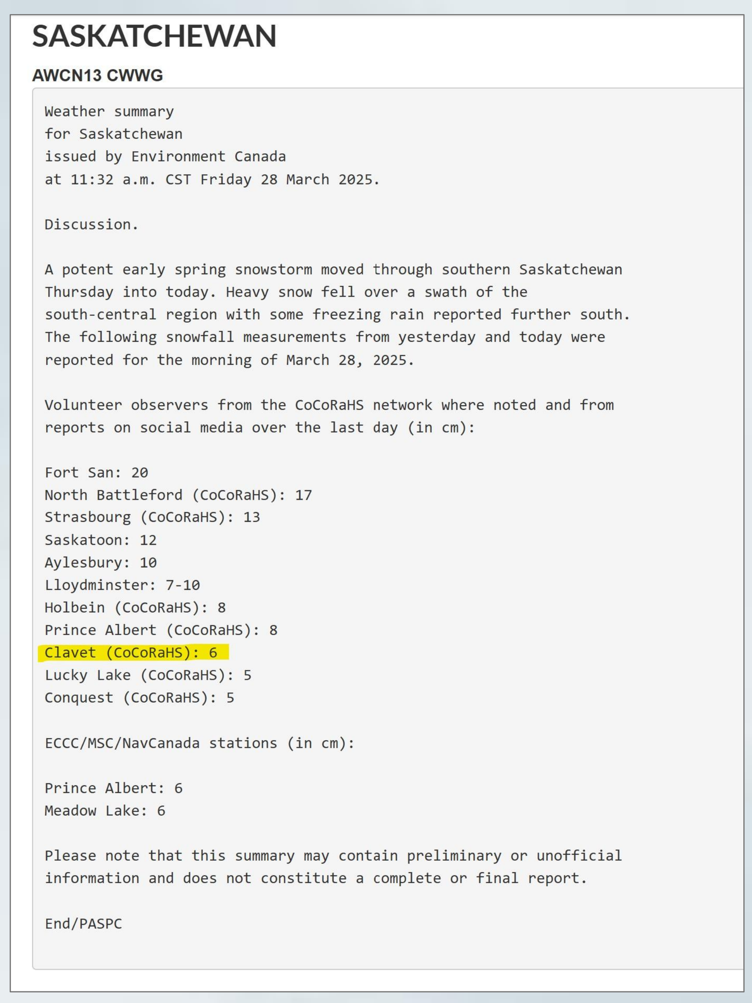
- There are areas within Canada that could benefit from additional precipitation observations. One example is in the southwest portion of Saskatchewan, where the network is **seeking to recruit additional volunteers**.
- ***CAN-SK-147*** *(**Clavet** 11.3 SW):* Author's station



The experimental National Surface and Rivers Prediction System - Canadian Land Data Assimilation Scheme (CaLDAS) snow values are consistently higher than observed values, which is **a known issue on the prairies.** The European Centre for Medium-Range Weather Forecast 5th Generation Reanalysis (ERA5) is mostly lower than the observed values.



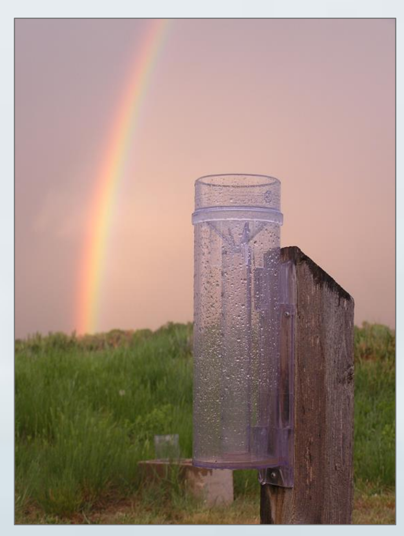
CoCoRaHS data can be used for **hydrologic prediction**. Prediction of stream flows, river levels, reservoir volumes, water supplies and flood/drought potential benefit from supplemental precipitation data


SASKATCHEWAN

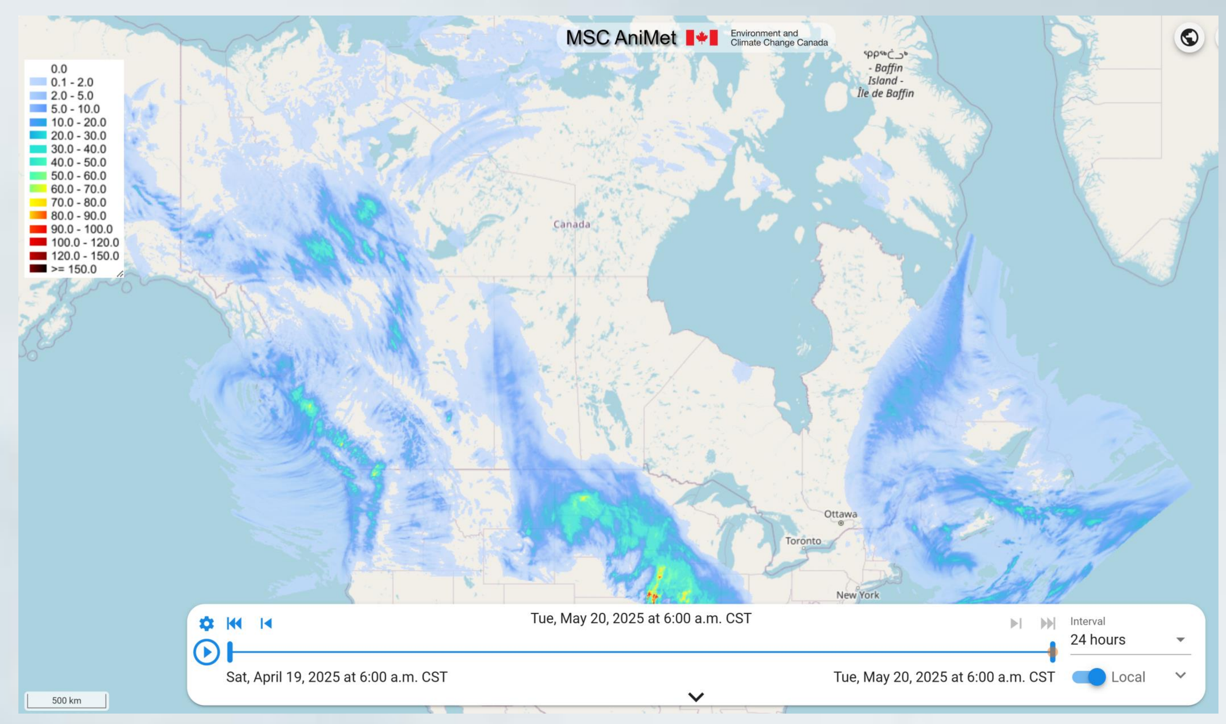
AWCN13 CWWG

```
Weather summary
for Saskatchewan
issued by Environment Canada
at 11:32 a.m. CST Friday 28 March 2025.

Discussion.

A potent early spring snowstorm moved through southern Saskatchewan
Thursday into today. Heavy snow fell over a swath of the
south-central region with some freezing rain reported further south.
The following snowfall measurements from yesterday and today were
reported for the morning of March 28, 2025.

Volunteer observers from the CoCoRaHS network where noted and from
reports on social media over the last day (in cm):

Fort San: 20
North Battleford (CoCoRaHS): 17
Strasbourg (CoCoRaHS): 13
Saskatoon: 12
Aylesbury: 10
Lloydminster: 7-10
Holbein (CoCoRaHS): 8
Prince Albert (CoCoRaHS): 8
Clavet (CoCoRaHS): 6
Lucky Lake (CoCoRaHS): 5
Conquest (CoCoRaHS): 5

ECCC/MSC/NavCanada stations (in cm):

Prince Albert: 6
Meadow Lake: 6

Please note that this summary may contain preliminary or unofficial
information and does not constitute a complete or final report.

End/PASPC
```

CoCoRaHS observations are included in **ECCC weather summaries** following significant precipitation events, like this potent snowstorm in March, 2025.



CoCoRaHS Gauge, photo credit Henry Reges (www.CoCoRaHS.org)



Canadian Precipitation Analysis (CaPA), Environment and Climate Change Canada. In its deterministic configuration, CaPA produces an optimal **estimate of the amount of precipitation over 6 and 24 hour periods.** It assimilates CoCoRaHS rainfall observations recorded at or near 12:00 UTC.

😀 EXPECTATIONS

The CoCoRaHS snow observation training presentation (www.CoCoRaHs.org) makes it look easy!:


Images from the training presentation shows relatively even snowfall distribution on the snow board, in the gauge and on the ground.

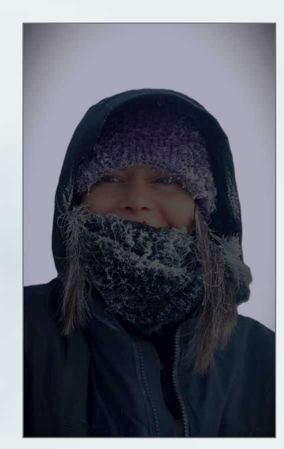
Lightly dressed and hands exposed while taking an observation

😲 REALITY

Observing snow on the Prairies is not so easy!:

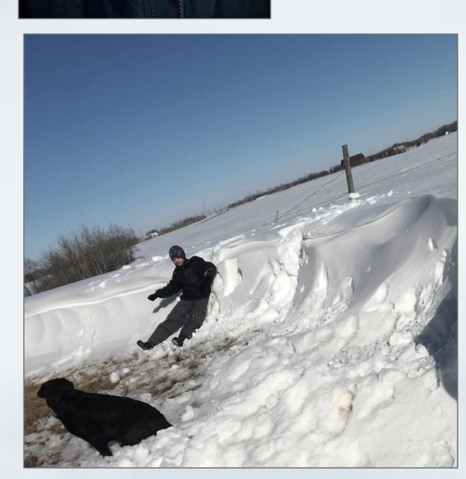
During snow events, wind can sweep the **snow board** clean and leave it perched in exposed locations.

Snow events on the Prairies are often accompanied by **high winds**, which cause drifting and **make snow observations challenging**.



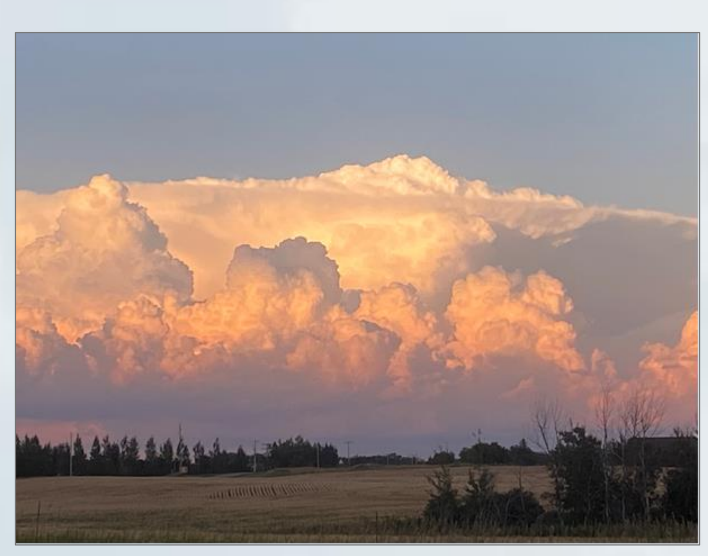
Morning observation time can be **cold and dark and windy** – dress warmly!

Snow typically accumulates asymmetrically, with the gauge **catching only about 40% of snowfall** during windy conditions.



Establishing an online Community of Practice to exchange information and expertise would benefit both observers and the network.

There are **many benefits** associated with being an observer, including contributing to your community and creating opportunities for learning



ECCC's public weather offices and Warning Preparedness Meteorologists frequently use CoCoRaHS observations for **communicating weather information.**

Trees protect the snow observation site from the effects of wind.

Meteorological Service of Canada – **Animet.** A tool to create custom weather animations.

Community Collaborative Rain Hail and Snow Network

National Standards and Building Resilience in MSC's Automatic Weather Station Network

Gary Tsim (gary.tsim@ec.gc.ca), Summer Warren, Larry Dusolt, Dean Kelly

Environment and Climate Change Canada - Meteorological Service of Canada - Monitoring and Data Services Directorate - Atmospheric Monitoring Division - National Surface Networks

Introduction

Meteorological monitoring networks are essential for accurate weather forecasting and climate studies. However, the standard network instruments used often struggle to maintain good performance under diverse environmental conditions, leading to data loss and inaccuracies. This case study explores challenges and considerations needed to integrate alternative meteorological instruments to enhance network resiliency.

Background

Two coastal stations, Solander Island and Sartine Island, experienced frequent failures of their RMY 5106 anemometers due to high winds. To address this, the RMY 5108, an alpine variant with a smaller propeller, greater blade angle, corrosion-resistant ceramic bearings, lightweight construction, and an ice-resistant coating, was installed at Solander Island on September 22, 2022, and at Sartine Island on March 20, 2023. Both RMY 5108 and RMY 5106 sensors were operated concurrently on a wind tower with a U-arm at both stations.

The stations on the ocean facing side of Vancouver Island


Damaged and misaligned RMY5106[1]


Both RMY5106 and 5108 are operational on the U-arm on the 10m tower[1]

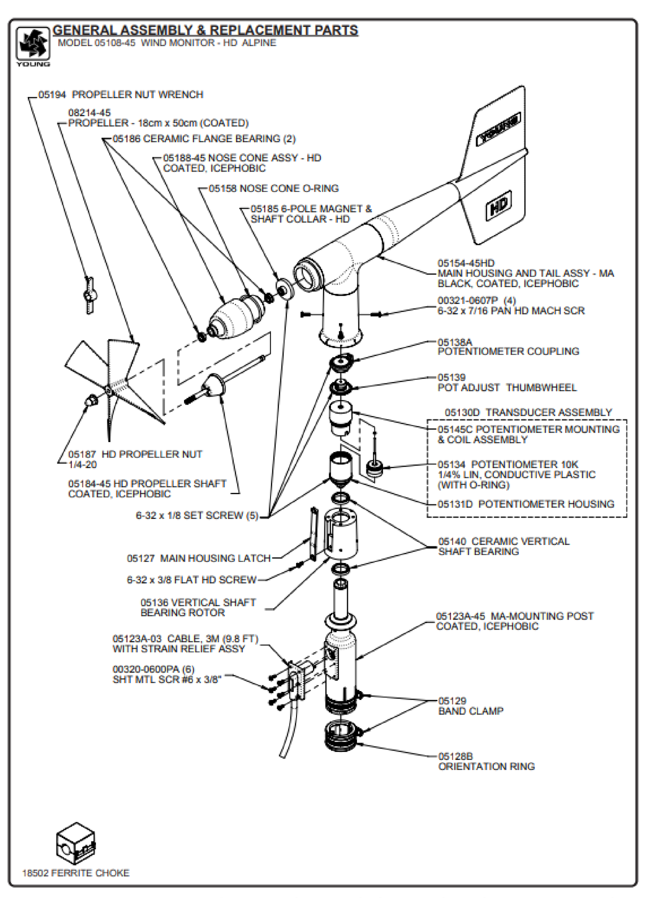

South west view of Sartine Island

Deviation Considerations

Introducing new sensors is time consuming and involves procurement rules, life cycle management, data logger version control issues, and potential client confusion. The Deviation Procedure[2] was developed and piloted using Solander and Sartine Islands. It includes two main parts:

1) Problem Description: Detailing the problem and the expected benefits of the deviation, including an evaluation of stated instrument specifications.

2) Proof of Performance (PoP) Evaluations: Focusing on Data Comparability and Data Availability (DA).



Numerous parts for each model need to be procured and managed[3]

Analysis Method

Data Comparability: Statistical tests compared the RMY 5106 and 5108 readings over approximately three months[4]. Six wind variables were analyzed using RMSE, MBE, MPE, MAE, Coefficient of Determination, and ANOVA.

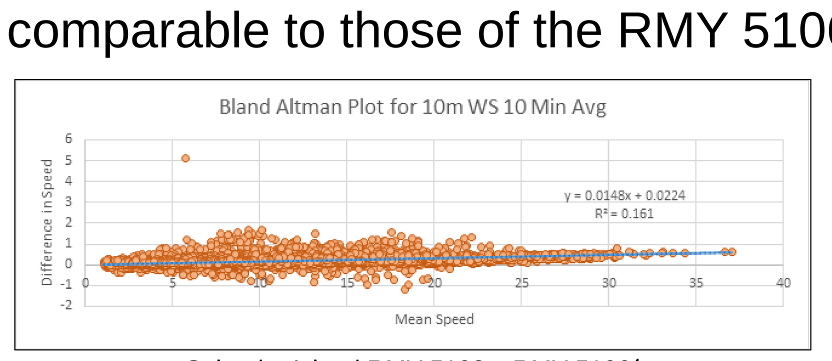
Data Availability:

Public Data DA was evaluated by calculating the percentage of missing data in the National Climate Archive.

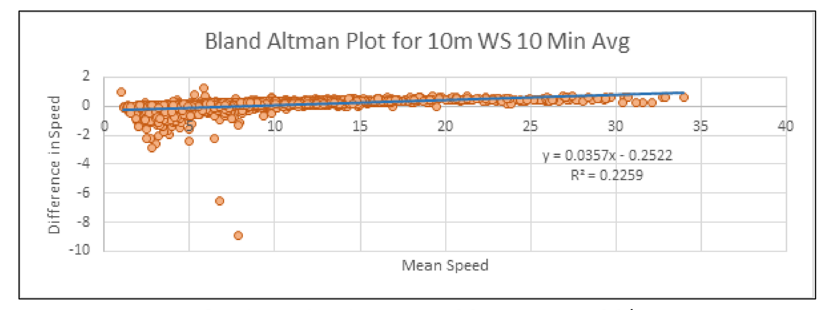
Sensor-specific DA was evaluated by calculating the percentage of non-missing, non-erroneous, and non-suppressed data from each sensor. Raw data was extracted from bulletin archives and decoded using the Station Configuration Interface (StaCI). Data suppression periods were applied based on StaCI remarks, and missing and erroneous values were manually flagged.

Results

Data Comparability: Results indicated that RMY 5108 readings were comparable to those of the RMY 5106.

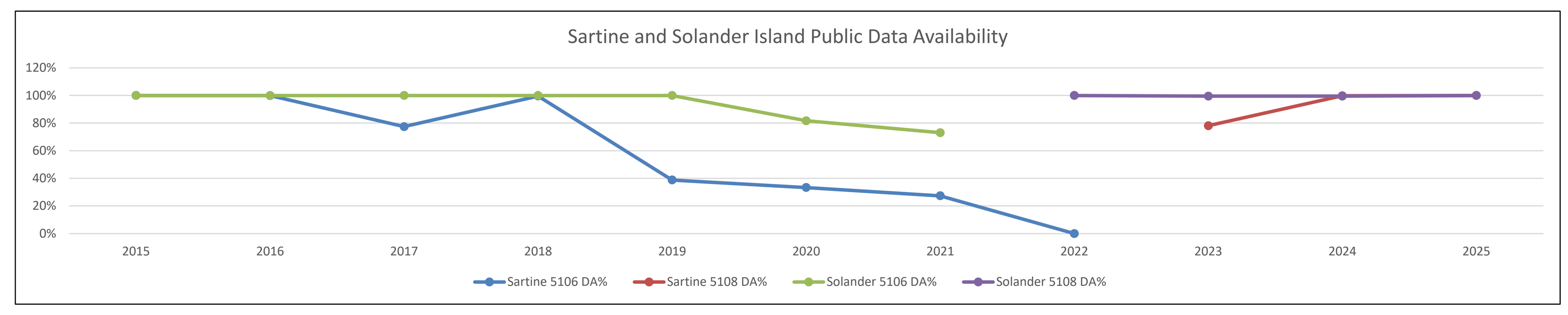


Solander Island RMY 5108 v RMY 5106[4]



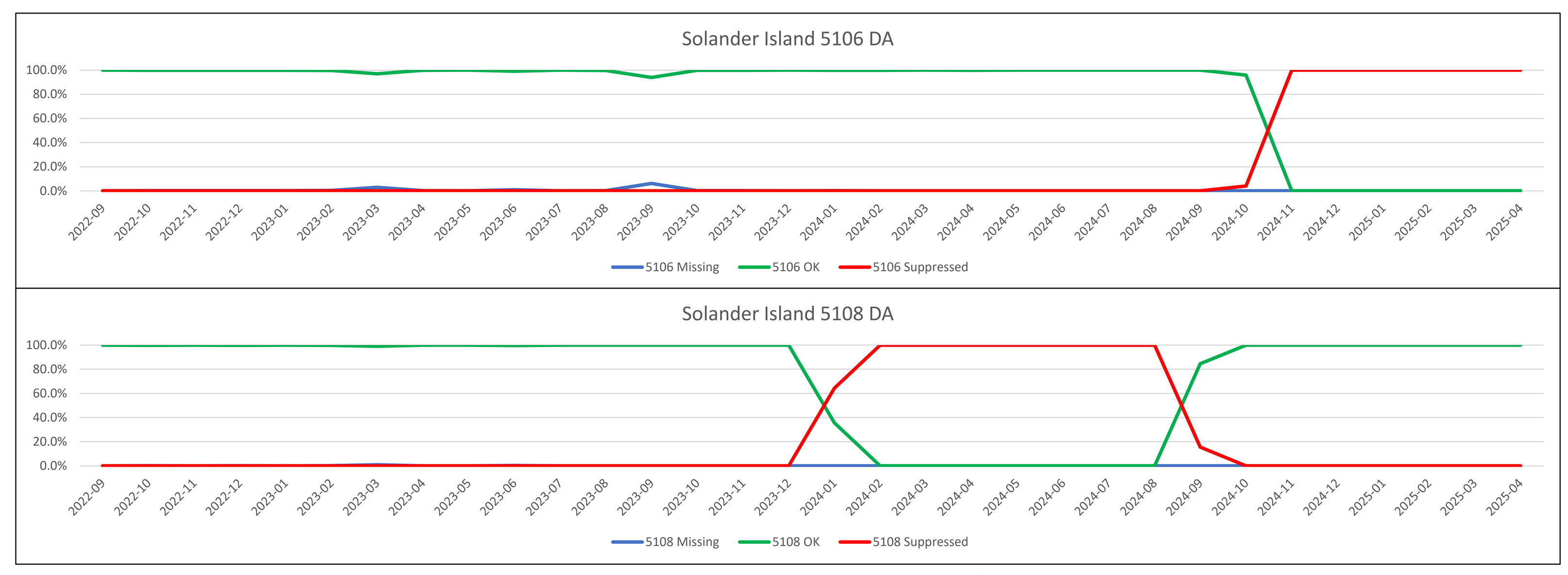
Sartine Island RMY 5108 v RMY 5106[4]

Public Facing DA: The annual DA combines RMY 5106 and 5108 data. Both stations showed improvement after the installation of the RMY 5108.



Apparent improvement in DA after installation of RMY5108s[5]

Sensor-Specific DA: At Sartine Island, both sensors remained intact and operational over the past two years. At Solander Island, the sensors failed at different times but still resulted in continuous data availability. This is a potential indicator the RMY 5108 does not offer additional survivability.



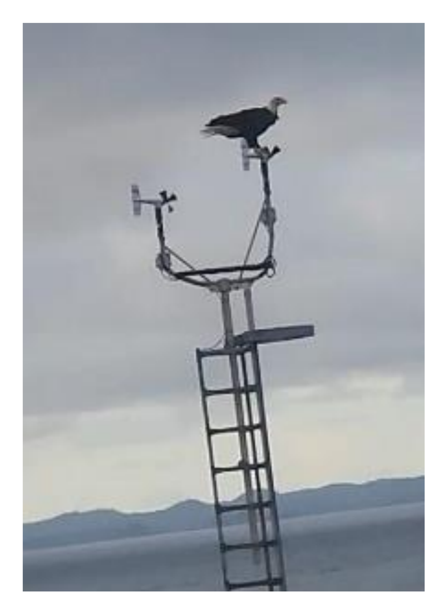
Staggered sensor failures at Solander Island[5]

Bird Interference

During the first annual inspection of the RMY 5108s, talon scratches—similar to those found on the older 5106 units—were observed, indicating damage from large raptors. Initially, raptor activity was considered unlikely on Sartine Island due to the presence of Cassin's Auklets, which have small, webbed feet incapable of causing such damage. However, the same markings on the 5108s confirmed raptors were also perching on the units.

Scratches and wearing on the RMY5108 body[1]


Cassin's Auklet Chick[6]


Bald eagle perching on sensor[1]

Discussion and Recommendations

1. The similar DA at Sartine Island and Solander Island indicates that the RMY 5108 is a serviceable replacement for the RMY 5106, but may not improve instrument survivability. More importantly, the observed damage on the RMY bodies shows that the RMY 5108 does not mitigate bird interference. Therefore, investing in bird deterrence measures is recommended.

2. To improve future sensor reliability, the assessment processes should be enhanced by refining performance metrics, standardizing metadata, and improving issue monitoring. Integrating diagnostics into network monitoring tools and updating asset metadata codes will better track damage and identify failure causes.

3. Improving communication with regional Technicians is also beneficial. While some Technicians were aware of raptors damaging RMYs, this information was not widely known across all regions.

References: **1)** MSC Technician photos, various; **2)** NSN, "MSC_AWS_Deviation_Procedure", internal document, 2023; **3)** RMY5106 Manufacturer's Manual; **4)** Summer Warren, "Solander_Sartin_Deviation_Analysis", internal document, 2023; **5)** NSN original research, 2025; **6)** https://www.hww.ca/wildlife/birds/cassins-auklet/

Acknowledgements: Many thanks to Jonathan Kwong, Gary Rink, Jason Lee, Sebastien Ouellette, Andy Campbell, Bijan Rasti, and all the MSC Technicians

Canada

On the Comparison Between Observations and Idealized Simulations of Liquid Core Pellets During a Winter Storm

Ann-Sophie Hoff*, Julie M. Thériault and Margaux Girouard

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1. Introduction

- Both freezing rain and ice pellets form when falling through a melting layer (T>0°C) aloft and a subfreezing layer (T<0°C) below it (e.g. Stewart et al., 2015). These atmospheric conditions can also produce liquid core pellets (Fig. 1), particles composed of a liquid water core surrounded by an ice shell.
- Liquid core pellets can form by the partial refreezing of liquid or mixed phase particles in the subfreezing layer (e.g. Thériault and Stewart, 2010). If these particles break upon impact with the surface, a coat of ice can form, leading to hazardous conditions.

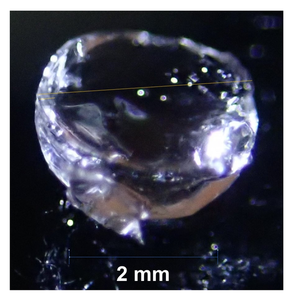

Fig. 1. Macrophotography of a possible liquid core pellet identified during a winter storm.

2. Objective

To compare observations and idealized simulations of liquid core pellets during a winter storm.

3. Methodology

A. Winter Storm : 22-23 February 2022

- Data from the 2022 *Winter Precipitation Type Research Multiscale Experiment* (WINTRE-MIX) field campaign, held in southern Quebec (Canada), were used (Minder et al., 2023). The data include atmospheric soundings, manual observations and macrophotography.
- Three periods were selected and analyzed on 22-23 Feb. 2022 : **Period 1 (P1),** 2200 to 2230 UTC, **Period 2 (P2),** 0000 to 0030 UTC and **Period 3 (P3),** 0200 to 0230 UTC.

B. Liquid Core Pellets Characteristics

1. Fractured particles with a visible ice shell were selected as liquid core pellets. Out of 600 analyzed particles, 175 were identified as liquid core pellets (Fig. 2).
2. The diameter and ice shell thickness of the liquid core pellets were measured manually.
3. The percentage of the frozen volume was computed according to the particles' diameter and their observed ice shell thickness.
4. Theoretical calculations based on the freezing time equation (Pruppacher and Klett, 2010; Kumjian et al., 2012) were conducted to compute the ice shell thickness of refreezing particles at different freezing levels.
5. These results were compared to surface observations.

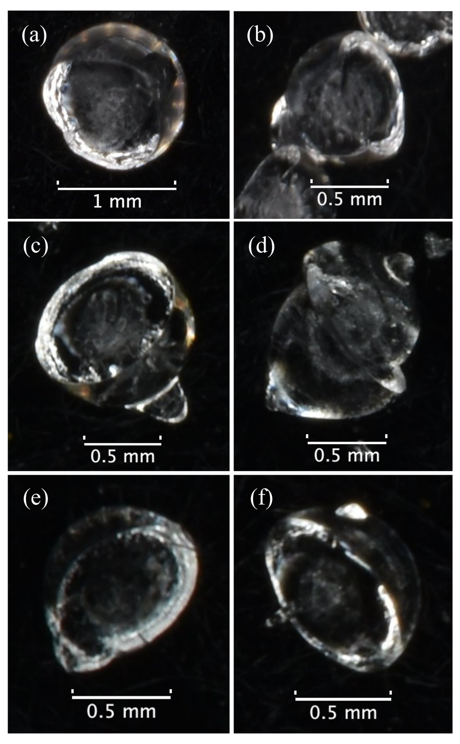

Fig. 2. Liquid core pellets from : (a), (b) P1; (c), (d) P2; (e), (f) P3.

4. Atmospheric Conditions

- Three vertical temperature structure (22-23 Feb. 2022; Fig. 3) were used to compute the ice shell thickness of refreezing particles at different freezing elevations.
- The thickness of the subfreezing layer varied from 448 m to 599 m, which is lower than the climatology (770 m) for mixed-phase observations (Stewart et al., 2015).

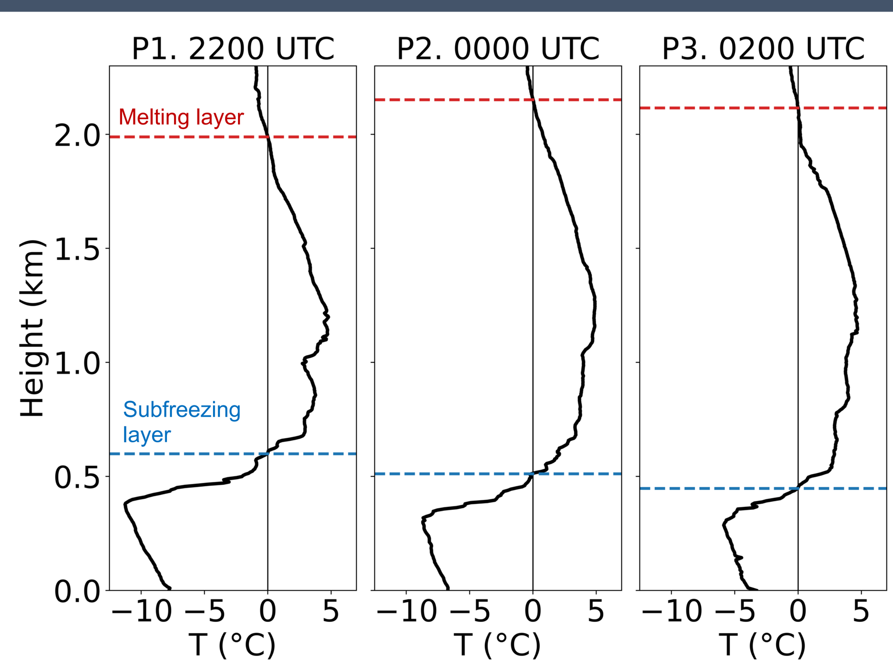

Fig. 3. Soundings from P1, P2 and P3.

5. Characteristics of Liquid Core Pellets

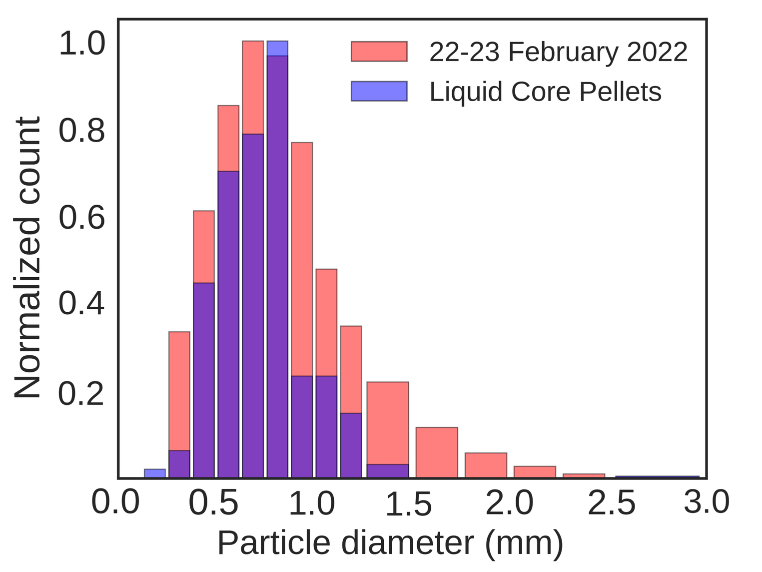

Fig. 4. Size distribution of liquid core pellets (blue) and other particles (red) during the winter storm.

- The size distribution of liquid core pellets was compared with that of particles measured by a laser-optical disdrometer during the winter storm (Fig. 4).
- The average diameter of the 175 identified liquid core pellets was 0.8 mm, with a range of 0.31 mm to 2.88 mm.

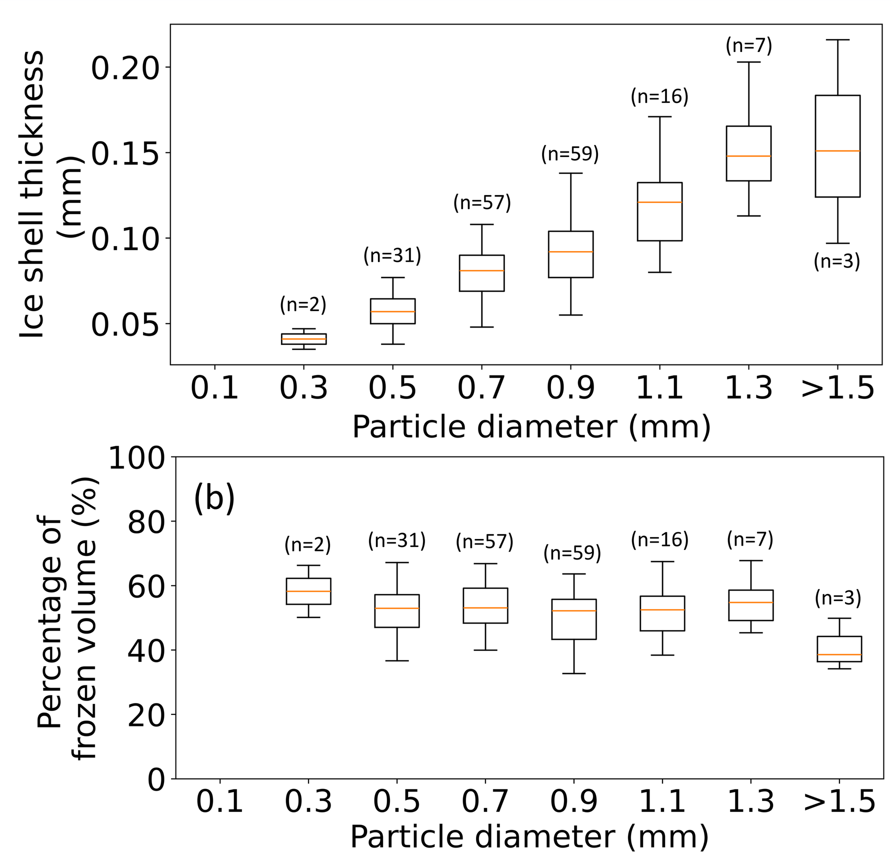

Fig. 5. (a) Ice shell thickness and (b) percentage of frozen volume of the observed liquid core pellets. Bins of 0.2 mm were used, and the middle size is presented on the figures.

- Given the thickness of the ice shell measured and the size of the particles, the liquid water available for icing on structure corresponds, on average, to 48% of the particles' volume (Fig. 5).

6. Freezing of Drops at the Top of the Subfreezing Layer

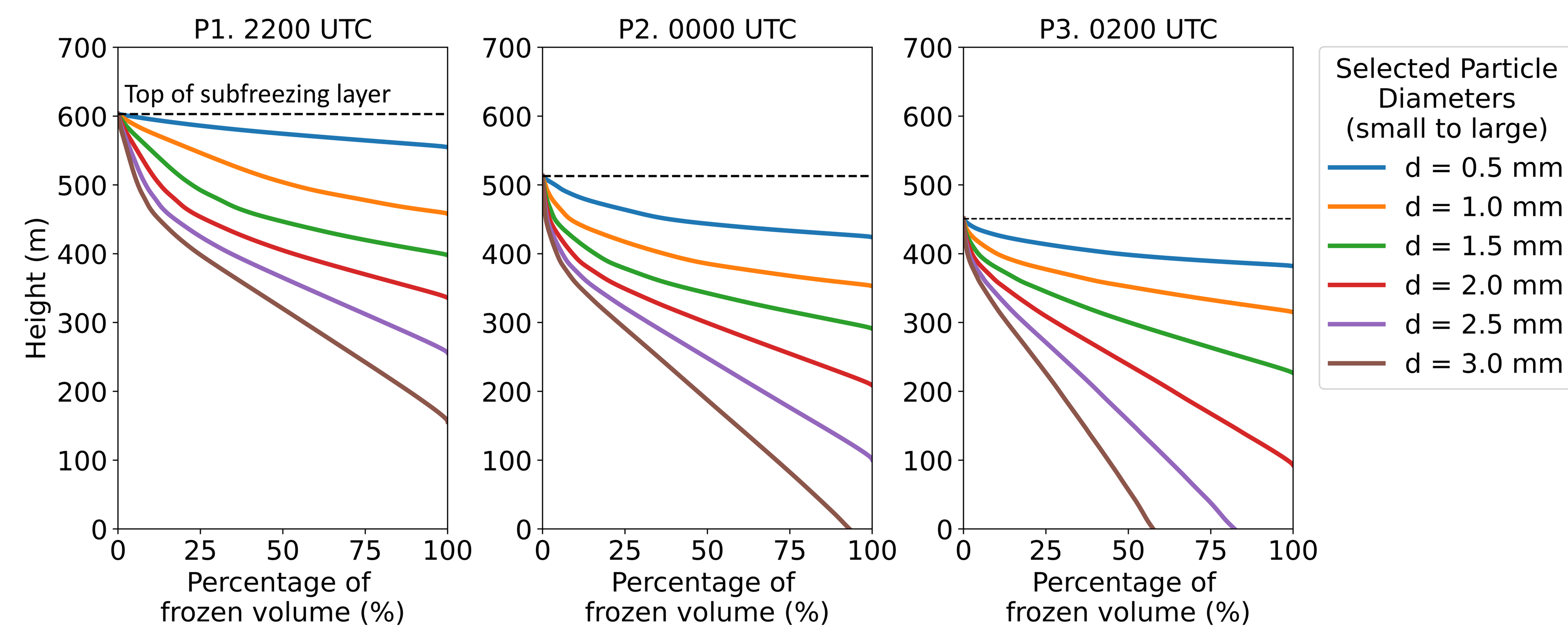

Fig. 6. Vertical evolution of the percentage of frozen volume of a drop distribution for P1, P2 and P3.

- The refreezing of drops was initiated at the top of the subfreezing layer using the freezing time equation for periods **P1**, **P2** and **P3** (Fig. 6).
- The theoretical calculations show that small drops freeze faster than larger ones.
- In **P2** and **P3**, larger precipitation particles reach the surface partially frozen.

7. Freezing of Supercooled Drops at Different Levels

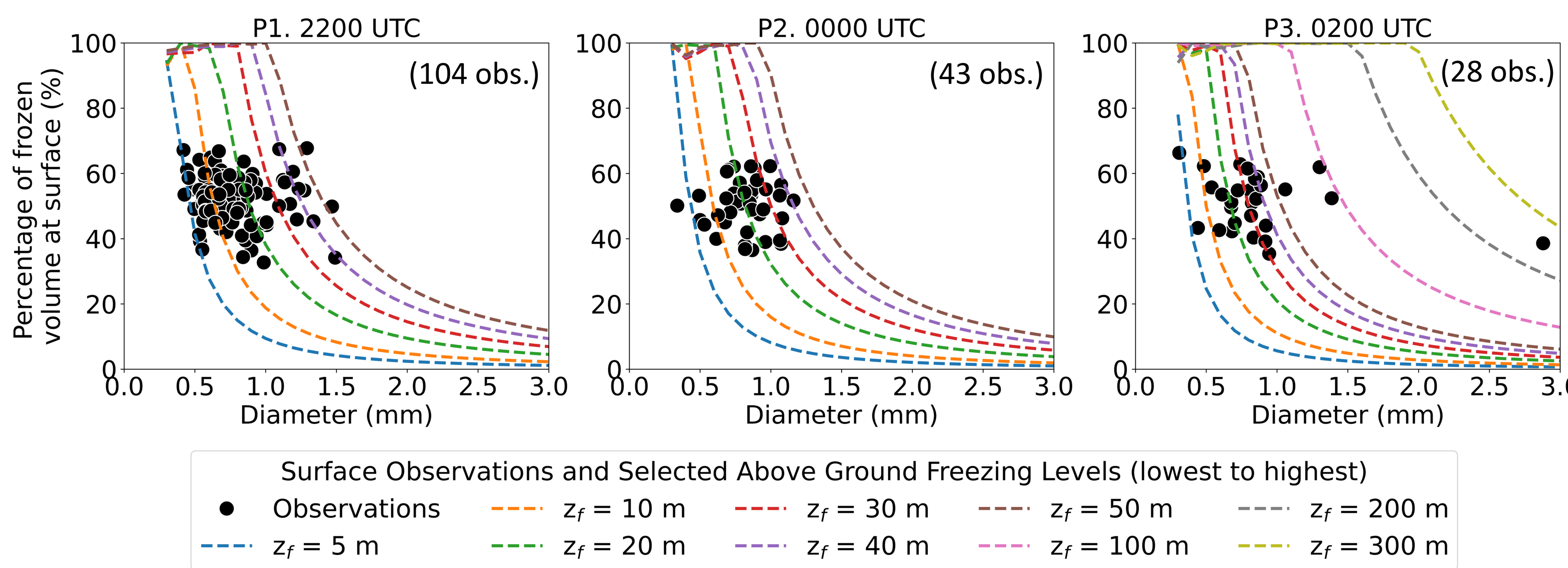

Fig. 7. Comparison between surface observations (black dots) and theoretical calculations (coloured dashed lines) for periods P1, P2 and P3.

- The percentage of frozen volume at the surface was computed for a size distribution of supercooled drops for various freezing levels z_f in the subfreezing layer. The theoretical calculations are compared to the surface observations for periods **P1**, **P2** and **P3** (Fig. 7).
- The observed liquid core pellets of **P1**, **P2** and **P3** suggest the presence of particles with a liquid water core ~40-60% of the particles' volume.
- Comparison between surface observations and theoretical calculations suggests freezing initiation levels up to 50 m above the surface for **P1** and **P2**, and freezing initiation levels up to 300 m above the surface for **P3**.

8. Conclusions

- Around 175 liquid core pellets were identified during a winter storm, with an average diameter of 0.8 mm, varying from 0.31 mm to 2.88 mm. The measured ice shell thickness and liquid core pellets' diameter suggested that the liquid water present within these particles corresponds, on average, to 48 % of their volume.
- Theoretical calculations of the freezing of drops initiated at the top of the subfreezing layer suggest that most of liquid core pellets might have reached the surface during **P3**, with a liquid water core up to ~40% of the particles' volume.
- The comparison between surface observations and the freezing of supercooled drops at different levels suggest the presence of freezing initiation levels close to the surface (lower than 100 m above the surface).

References

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Pruppacher, H. R., and J. D. Klett, 2010: *Microphysics of Clouds and Precipitation*. Springer Netherlands.

Stewart, R. E., J. M. Thériault, and W. Henson, 2015: On the Characteristics of and Processes Producing Winter Precipitation Types near 0°C. *Bull. Am. Meteorol. Soc.*, **96**, 623–639, https://doi.org/10.1175/BAMS-D-14-00032.1.

Thériault, J. M., and R. E. Stewart, 2010: A Parameterization of the Microphysical Processes Forming Many Types of Winter Precipitation. *J. Atmospheric Sci.*, **67**, 1492–1508, https://doi.org/10.1175/2009JAS3224.1.

Acknowledgements

We acknowledge the support of the Natural Sciences and Engineering Research Council of Canada (NSERC), the Fonds de recherche du Québec (FRQ), Environment and Climate Change Canada (ECCC), the Canada Research Chairs Program and the Canada Foundation for Innovation.

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Towards a better representation of snow interception by forest canopies in cold, wet climates

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[1] Department of Civil and Water Engineering, Laval University, Québec, Canada
[2] Meteorological Research Division, Environment and Climate Change Canada

Context

Snow is an essential component of the Canadian hydrological landscape. In forested areas, which are predominant in the country, **snow interception** by the canopy affects the surface energy and water balance[1,2,3]. Yet, this process remains **poorly documented** in **eastern Canada's cold, wet climate**[4].

Research Objective

Estimate **snow interception** by the forest canopy using **innovative experimental measurements.** This would help support the representation of interception in **numerical models** used in hydrometeorological forecasting.

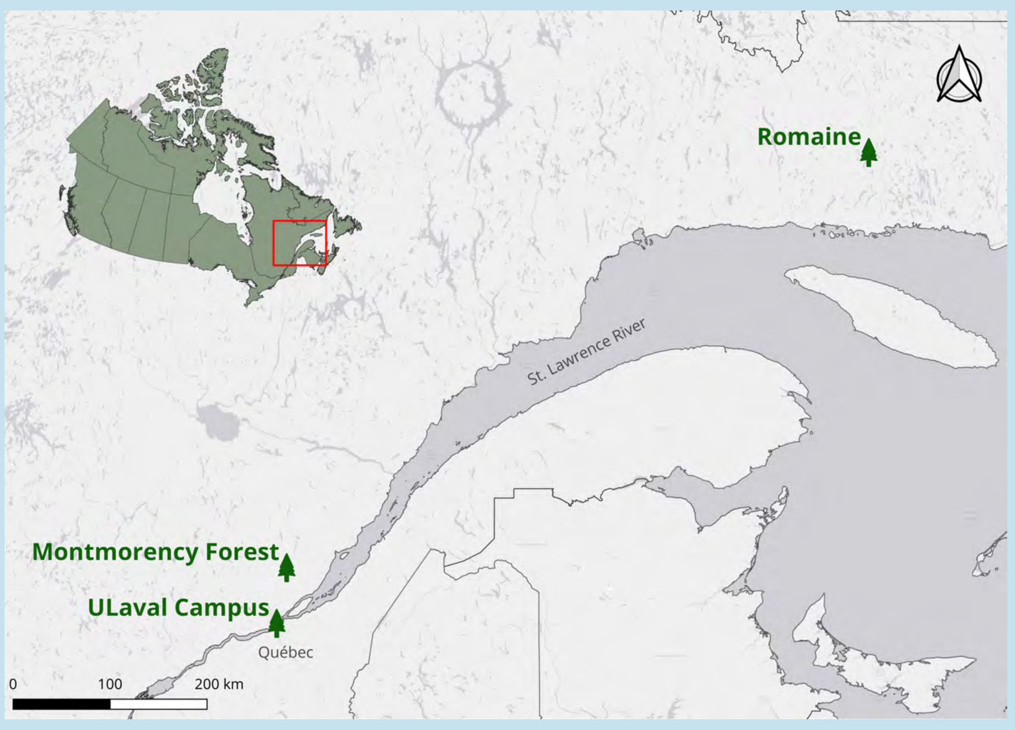


Figure 1 : Study Sites

Table 1 : Tree Caracteristics

Species : black spruce, white spruce, balsam fir	
Tree height	[5, 11.9] m
Accelerometer height	[3.5, 9.7] m
Crown base height	[0.2, 2] m
Crown diameter at base	[1.6, 4.8] m
Diameter at breast height	[8.9, 12] cm

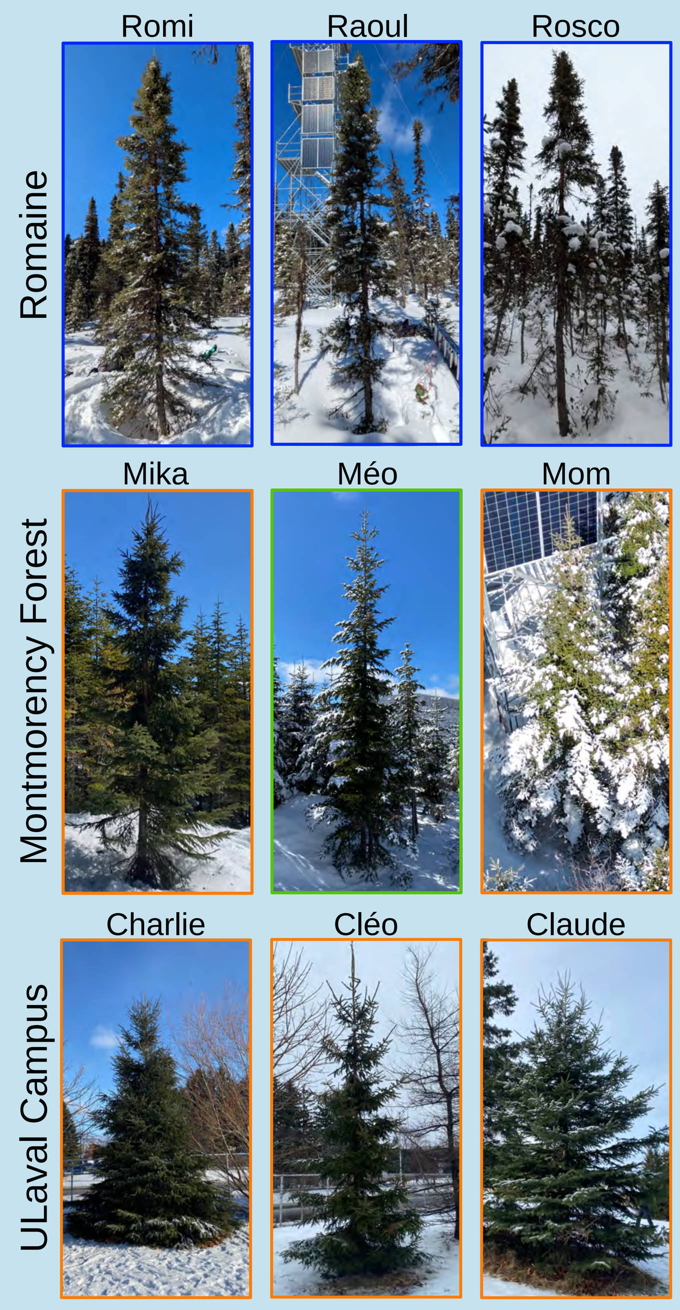
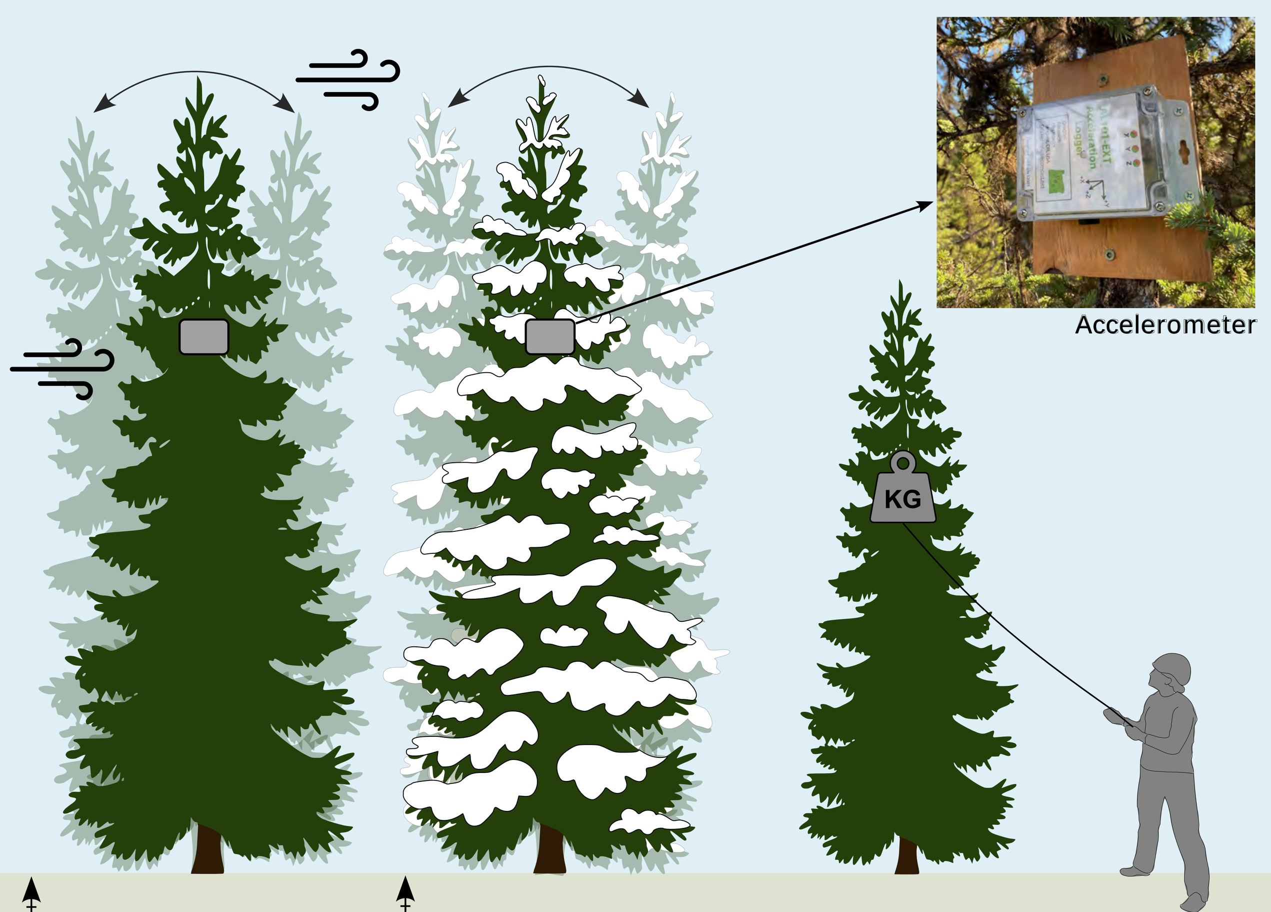


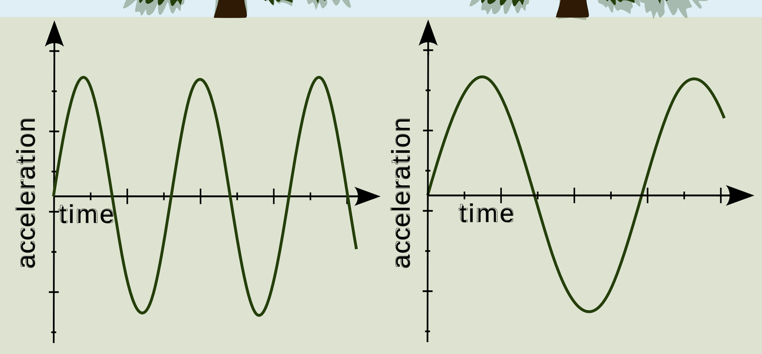
Figure 2 : Studied Trees

3 methods, 9 trees, 3 study sites

and 2 winters under study (2024-25 & 2025-26)

1. Wind-induced tree sway monitoring[5]





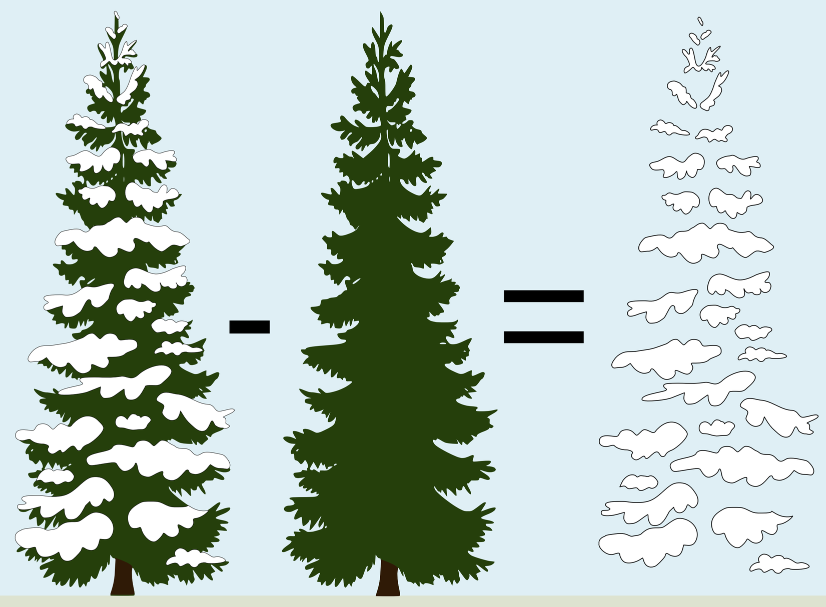
Each tree is calibrated with known weights and manual swaying to establish the relationship between changes in sway frequency and mass

snow interception = ↑ mass = ↓ sway frequency

2. Drone photogrammetry and terrestrial LiDAR scanning[6]

Snow volume estimation

Punctual measurements



This method will be implemented during the second winter under study (2025-26)

3. Hourly time-lapse photography

Qualitative observations of snow interception

Continuously measured meteorological variables

- Air temperature
- Air specific and relative humidity
- Wind speed and direction
- Radiation (in/out and short/long-wave)
- Precipitation (snow and rain)
- Atmospheric pressure

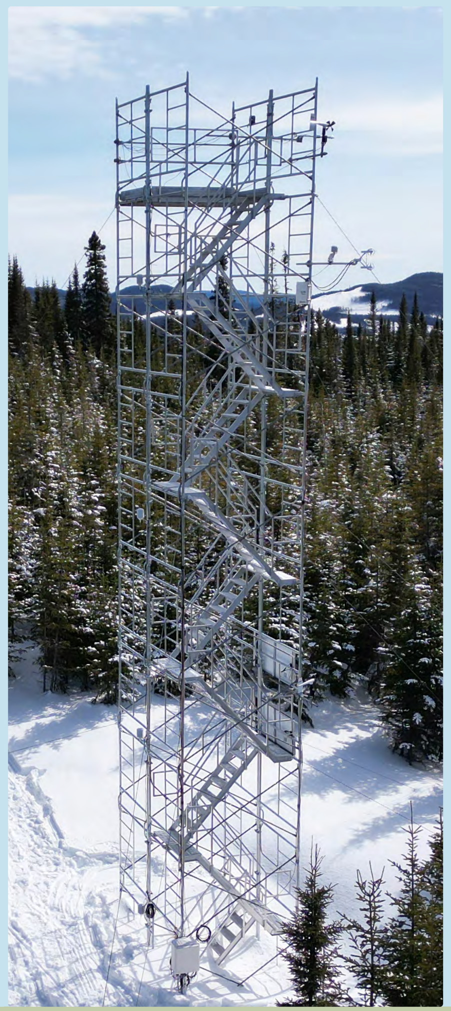


Figure 3 : Picture of flux tower at the Montmorency Forest site

Preliminary Results

- This is an example of **two calibration tests** that were carried out on a black spruce (Romi), at two different temperatures, **confirming the effect of mass and temperature on sway frequency**.

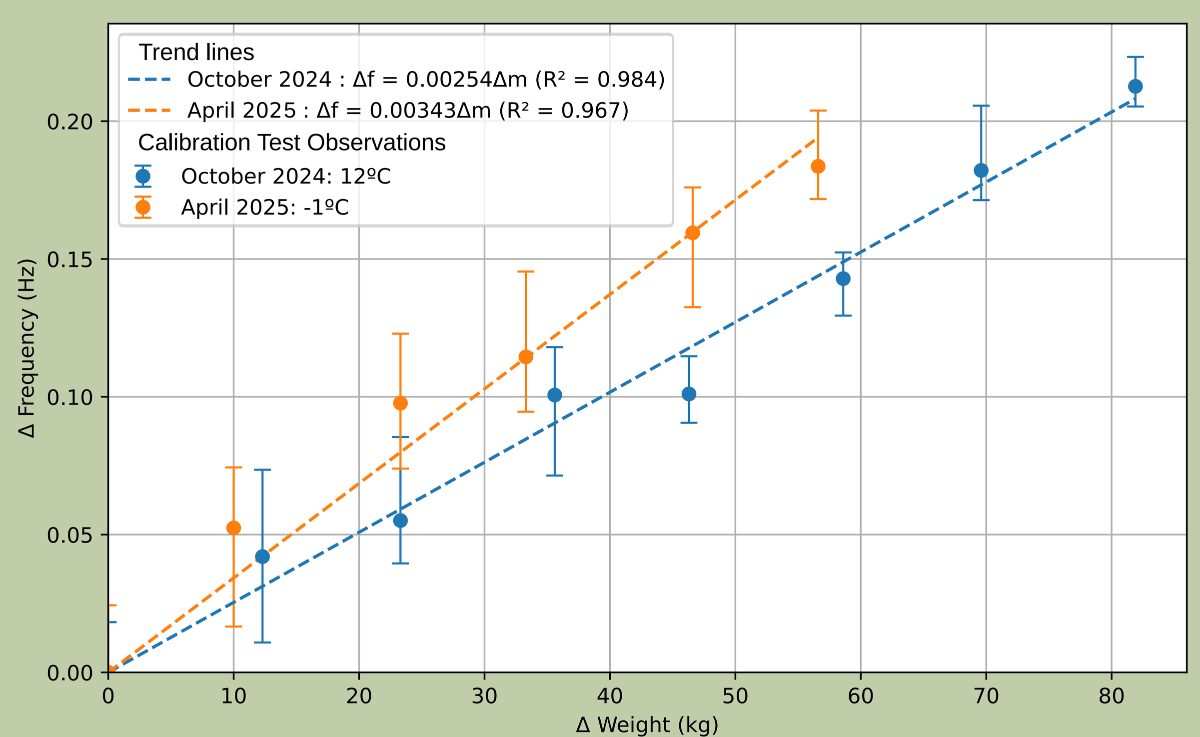


Figure 4 : Change in Frequency vs Change in Weight - Black Spruce

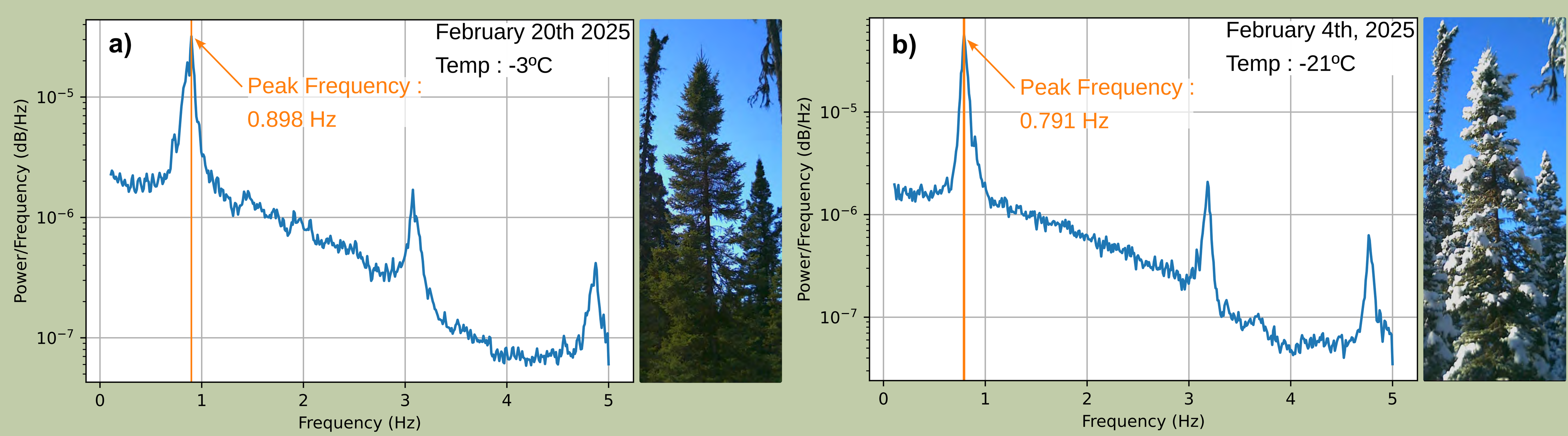
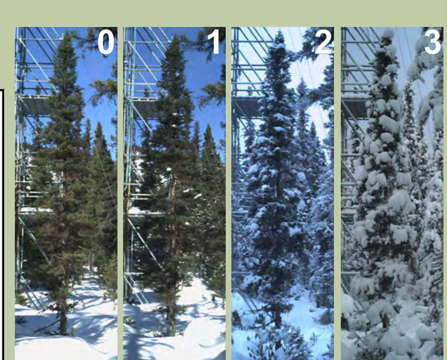


Figure 5 : Frequency Analysis on Snow-Free (a) and Snowy (b) Black Spruce (Romi)

- **Frequency analysis** conducted on one tree during **No Snow** and **Snow** episodes
- **Lower sway frequency** observed on the **snowy** tree, confirming the method's potential
- Two **opposing effects** identified:
  - **Lower temperature** during the **snowy** episode is expected to **increase** frequency (↓ temp = ↑ frequency)
  - The observed frequency **decrease** indicates the mass effect dominates (↑ mass = ↓ frequency)
- Further work needed to establish the effect of **temperature**

- **Timelapse** images will be used to **validate** if the sway method accurately represents **interception over time**.
- The interception level is **visually estimated** using a scale :



0 = no snow
1 = light snow
2 = moderate snow
3 = heavy snow

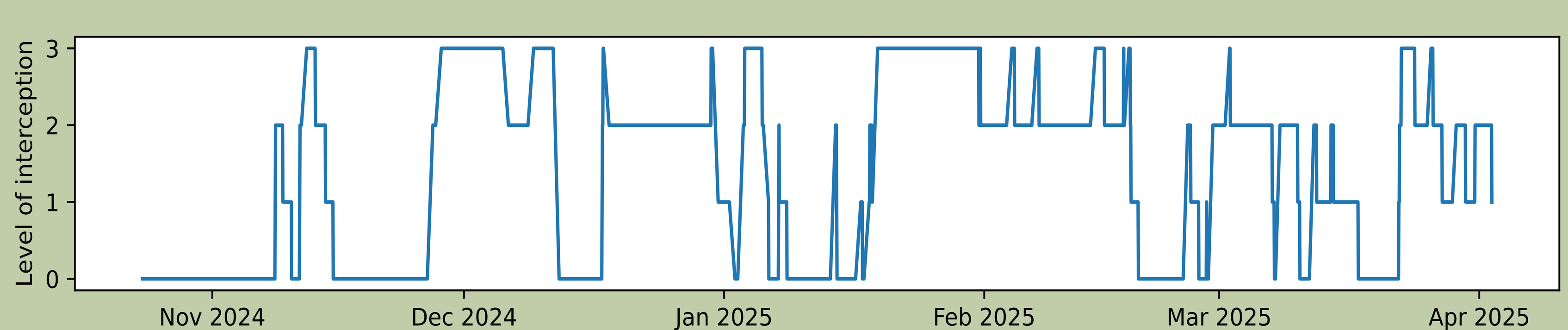


Figure 6 : Snow Amount Through Winter 2024-25 Determined from Timelapse Pictures - Black Spruce (Raoul)

Next Steps

- Second winter of field campaign (2025-26)
  - Accelerometer data aquisition
  - Photogrammetry and terrestrial LiDAR surveys
- Reconstruction of intercepted snow time series
- Analysis of meteorological conditions responsible for interception dynamics
- Development of an extensive evaluation dataset for the SVS2-Crocus land surface model used by Environment and Climate Change Canada

HYDRO NORD Laboratoire d'hydrologie des régions froides · UNIVERSITÉ LAVAL · Environment and Climate Change Canada · Environnement et Changement climatique Canada · CentrEau · Fonds de recherche Québec · CRSNG NSERC

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References

Acknowledgements : The HydroNord team (Thomas, Deirdre, Étienne, Dima, Antoine, Jérémie, Alexis, Marilou, Pierre-Erik, etc), Martin Lapointe, James Wagner from ORElectronics, Éric Boucher, Willian Ney-Cassol, Alexandre Lapointe, Amandine Pierre, Éric Dugual, William Levesque, Donald and Jonathan.

A Collaborative Canadian Prairies and U.S. High Plains Binational Seasonal Climate Bulletin

Erica Tetlock[1], Tommy Diep[2], Judy Kwan[2], Trevor Hadwen[3], David Lee[3], Andrew Palmer[4]

[1]Meteorological Service of Canada (MSC), Environment and Climate Change Canada (ECCC), Saskatoon, Saskatchewan, [2]MSC, ECCC, Vancouver, British Columbia, [3]Science and Technology Branch, Agriculture and Agri-Food Canada, Regina, Saskatchewan, [4]MSC, ECCC, Edmonton, Alberta

Overview

The Prairies and High Plains (PHP) binational seasonal climate bulletin is a collaborative series of quarterly climate impacts and outlook bulletins between Environment and Climate Change Canada (ECCC) and the National Oceanic Atmospheric Administration (NOAA), covering the shared Canada/U.S. border region in the center of the continent. Agriculture and Agri-Food Canada (AAFC) and ECCC work closely together each season to review and produce the bulletin collectively with the U.S. partners. This climate bulletin summarizes the past season's significant weather and climate events, highlights regional impacts to communities over the PHP region, and includes an outlook for the upcoming season. Unique to this bulletin is a section dedicated to drought monitoring and any agricultural impacts relevant to the region, given the economic significance of agriculture in the region and the sensitivity to changing climatic conditions, particularly those that lead to drought. The bulletin is produced four times a year, winter (DJF), spring (MAM), summer (JJA), and fall (SON).

Bulletin Development Process

Internal Preparation → Collaboration and Content Creation → Feedback Integration & Publication

Phase 1: Internal Preparation

- ECCC reviews seasonal weather patterns and events for the Canadian portion, preparing summaries of temperature and precipitation anomalies and outlooks within the domain. Staff collaboratively draft and validate initial bulletin content, ensuring consistency and accuracy, and agree on major events to highlight in partner discussions.

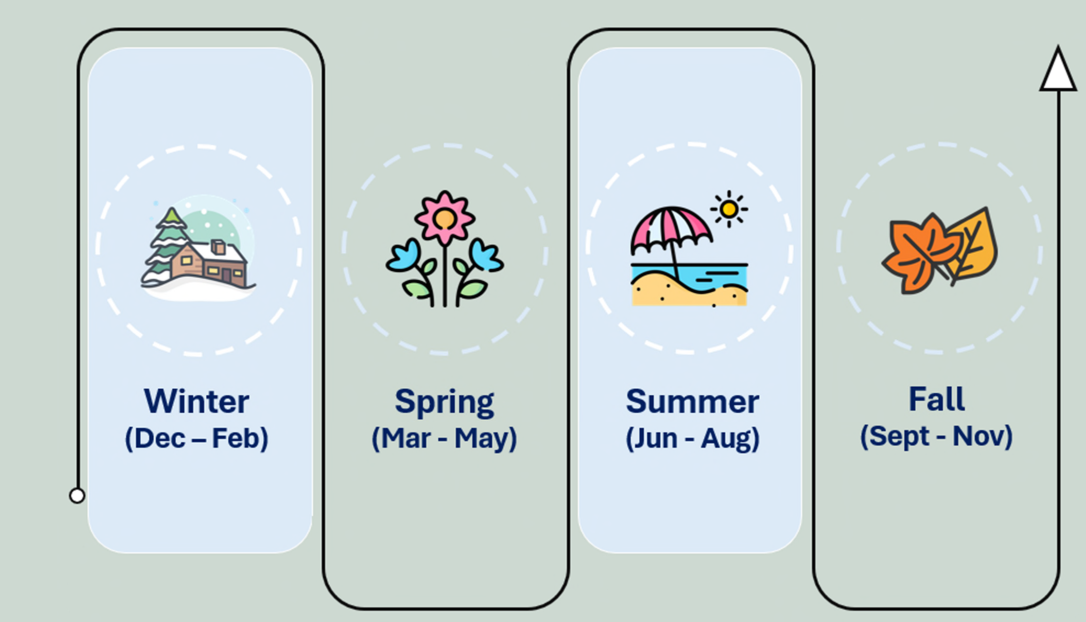
Phase 2: Collaboration and Content Creation

- Draft materials are shared with partners on collaborative platforms for review and feedback. U.S. partners contribute highlights from across the border, including regional stories and concerns. Comments are discussed in follow-up meetings, and revisions are integrated into updated document versions.

Phase 3: Review and Publication

- After final review and editing, the last steps of the process involve ensuring accessibility standards are met, sending the final product to NOAA (drought.gov) for online posting, and preparing a French version.

Published Quarterly



Images: Flation.com

Bulletin Content and Structure

Weather and Climate Highlights and Impacts

- The regional significant events map provides a clear seasonal overview of impacts at a glance. Together, both countries collaboratively decide on the most notable events to feature on the map. These can be both single-day events or longer duration patterns.

Regional Climate Overview

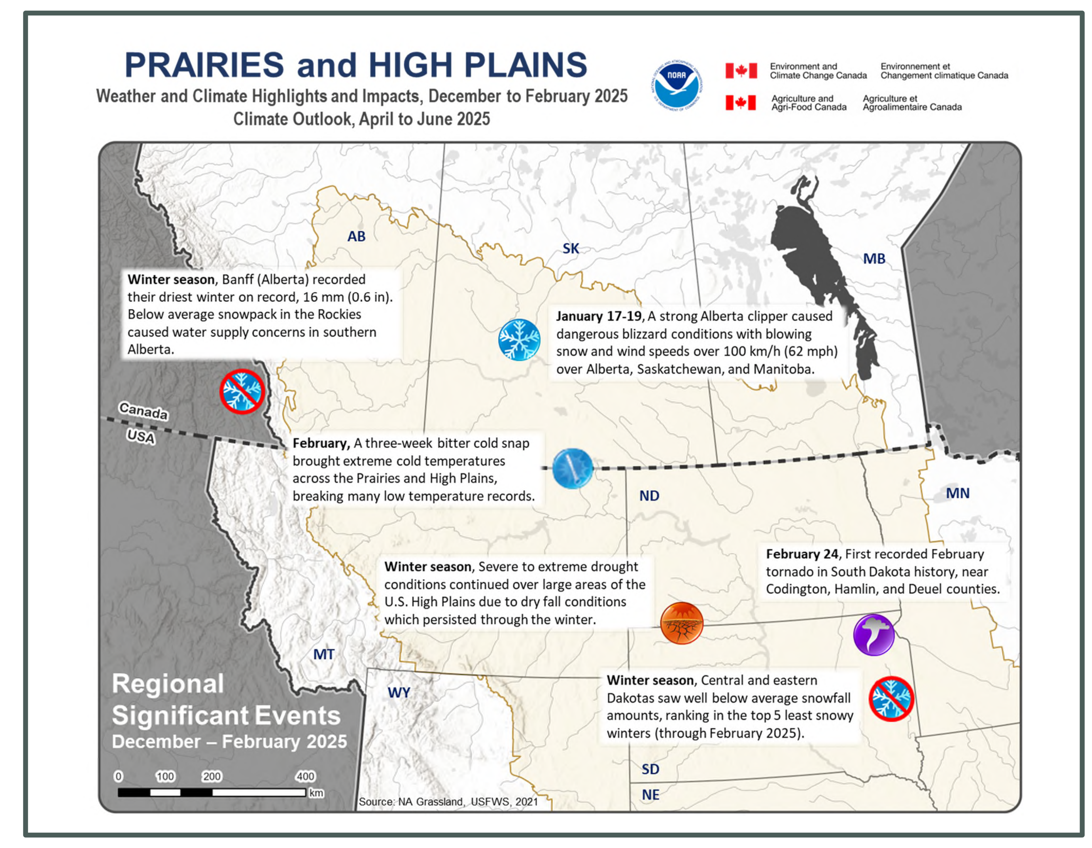
- **Seasonal Temperature and Precipitation:** Seasonal maps of departure from normal temperature and percent of normal precipitation alongside text summarizing the season, as well as monthly fluctuations, provide a comprehensive understanding of the season.
- **Drought Monitor:** The end-of-season drought conditions map is shown alongside the temperature and precipitation summary for perspective, as these are two of several factors that influence drought conditions. AAFC uses their drought monitor maps, combined with the US Drought Monitor, to summarize drought conditions and severity across the PHP region.

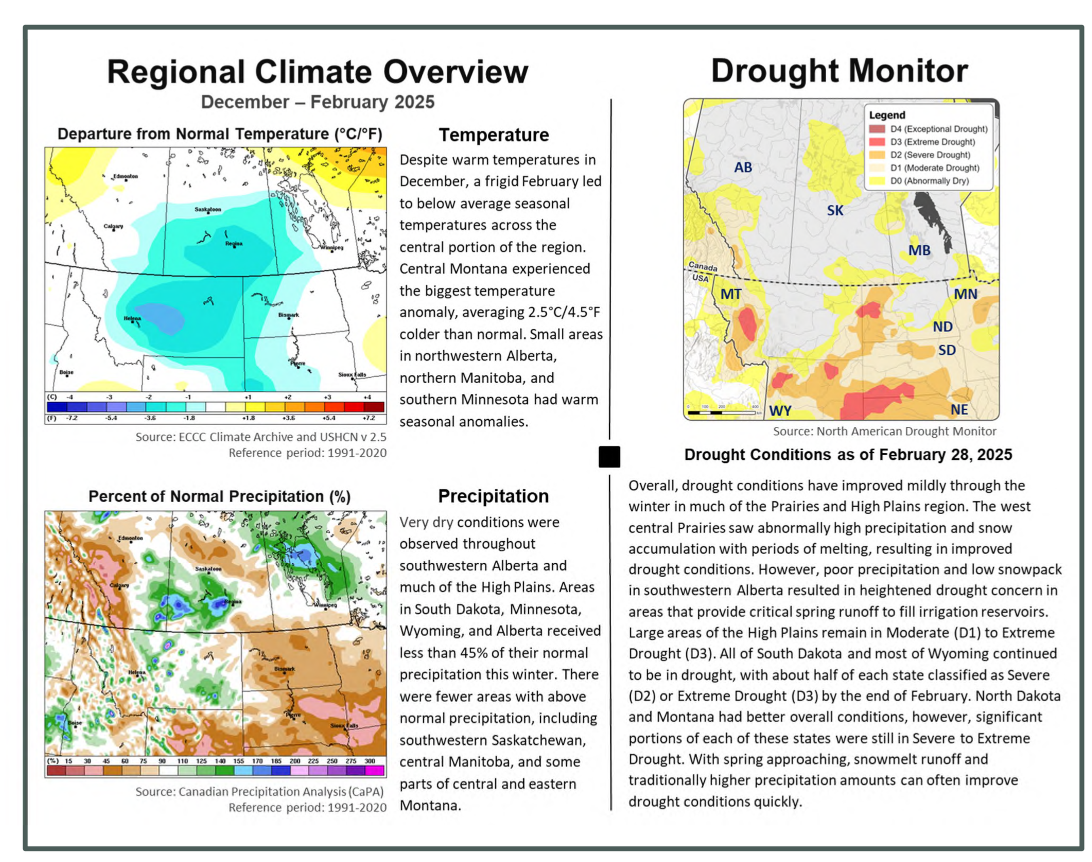
Regional Impacts

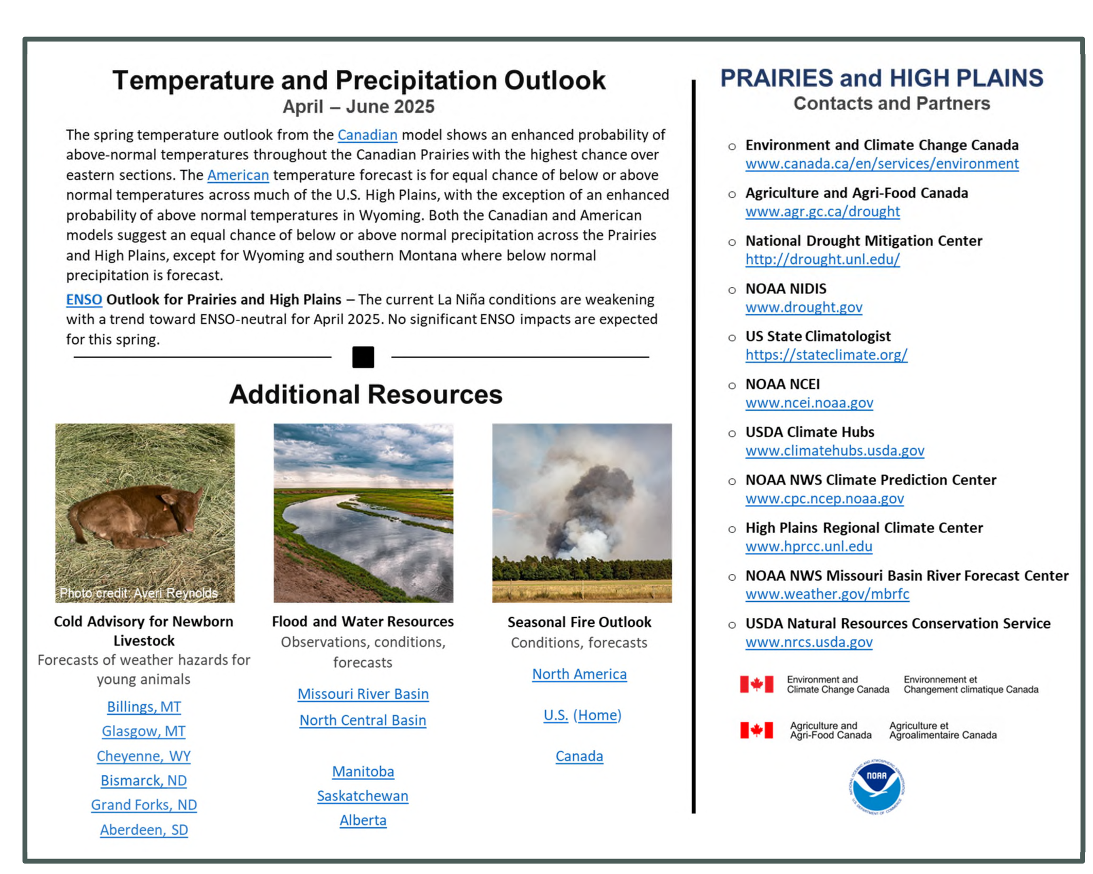
- Highlighting one or more seasonally relevant weather or climate related impact within the region, as identified in collaboration with partners. Stories are selected with a focus on impactful events that span both the U.S. and Canada. While challenges are often featured as a narrative, positive developments are also included when relevant. Additionally, a story highlighting agricultural impacts is typically included.

Outlook

- **Seasonal Temperature and Precipitation:** A summary of the seasonal temperature and precipitation outlook for the next three months using guidance from both the Canadian and U.S models. Although model signals can be limited, especially for precipitation, they still offer useful insight into potential trends across the region.
- **ENSO:** Highlights the current ENSO signal and its potential influence on regional temperature, precipitation, and drought conditions. This provides an early alert to possible impacts if current trends persist to help support preparedness across different sectors.



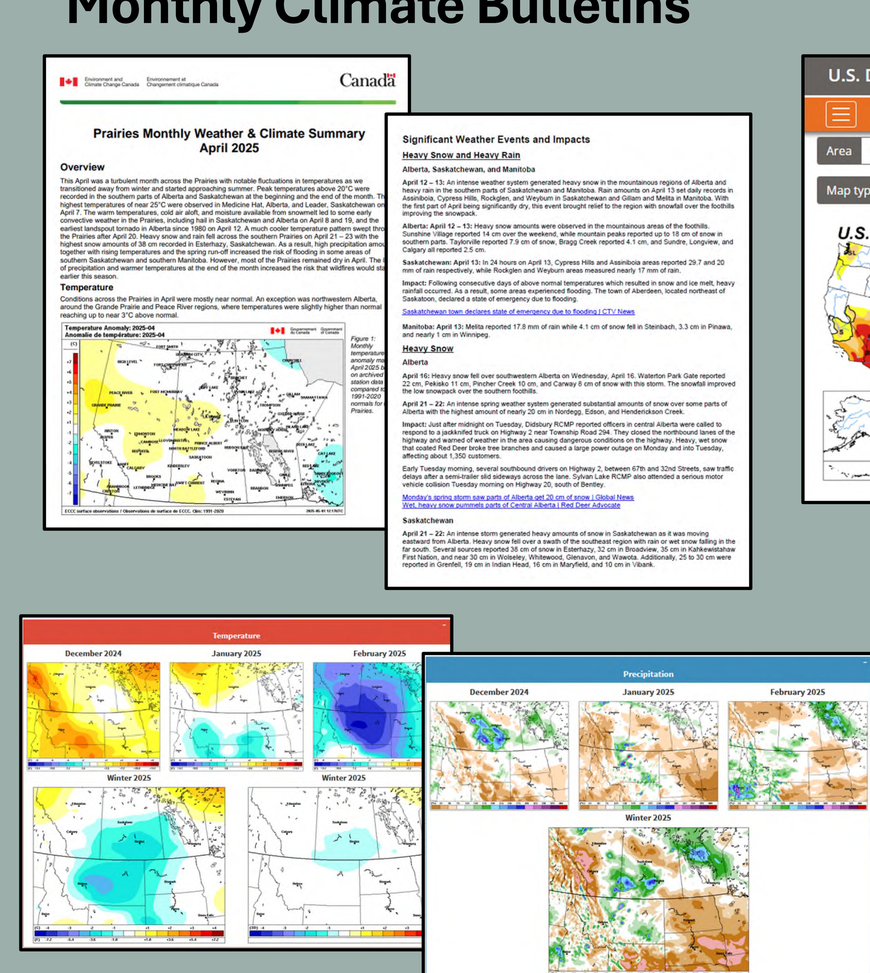




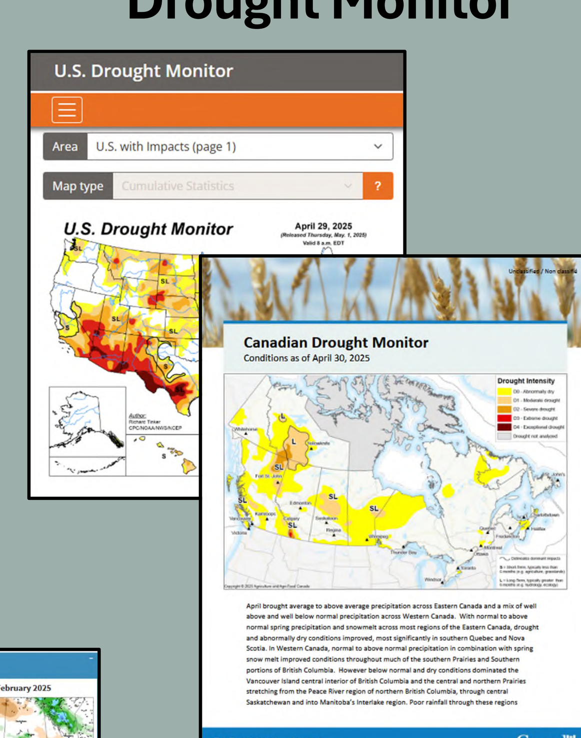
Supporting Data and Tools

Internal dashboards developed by ECCC provide seasonal statistics, broken records, and ranks using data from ECCC's Climate Archive. These seasonal highlights are supported by maps showing temperature departure from normal and precipitation as a percentage of normal, which are validated against U.S. ACIS data to ensure consistency and accuracy. Significant weather impacts are identified from ECCC's Prairie monthly climate bulletins and georeferenced into a GIS platform to visualize notable events. For drought conditions, AAFC experts provide insight using Canada/U.S. drought monitor data to evaluate severity and extent. Seasonal forecasts from ECCC and NOAA CPC models are used to provide potential insight into climate trends.

Monthly Climate Bulletins



Drought Monitor



Temperature & Precipitation Maps

Access and Download

Link: https://www.drought.gov/reports

Contacts:

ECCC: Erica.Tetlock@ec.gc.ca, Tommy.Diep@ec.gc.ca, Judy.Kwan@ec.gc.ca and Andrew.Palmer@ec.gc.ca

AAFC: Trevor.Hadwen@agr.gc.ca and David.Lee@agr.gc.ca

Environment and Climate Change Canada / Environnement et Changement climatique Canada

Agriculture and Agri-Food Canada / Agriculture et Agroalimentaire Canada

MAKING EXTREMES LOCAL:
Modelling extreme climate events with machine learning downscaling techniques

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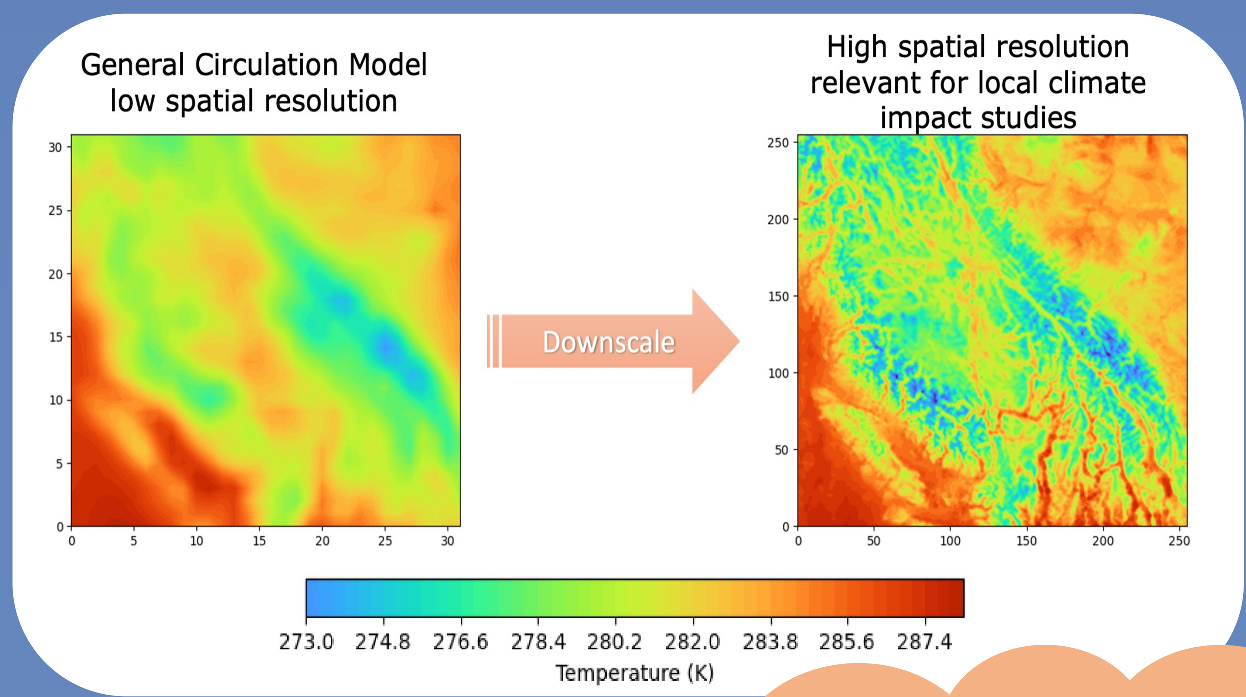
CLIMATEX

MOTIVATION

- Predicting extreme climate events
- Need higher resolutions for local planning
- Global Circulation Models
  - resolutions ~ 20-100 km
- Downscaling: transform low-resolution data into high-resolution climate fields
- Dynamical downscaling: computationally expensive
- New and efficient downscaling approaches: machine learning

Figure 1: Low and high-resolution fields. Domain of interest includes BC and extends into Alberta, Alaska, and the Yukon.



MODEL & DATA

- Convolutional Neural Network
- Generative Adversarial Network
  - Generator: produce convincing fields that "trick" the Critic
  - Critic: Determine if field is real (truth) or fake, i.e. "catch" the Generator
- Stochastic model
  - Noise input in the Generator
  - Multiple high-res. fields consistent with one low-res. input
- Low-res. data: ERA5 reanalysis (32 km)
- High-res. data: USask-WRF dynamically downscaled data (4 km) - Truth

How well can the machine learning downscaling models represent extremes?

What can we learn about the spatial dependence of extreme climate events?

Can the model capture high-impact compound events?

?

MODEL TEMPERATURE EXTREMES

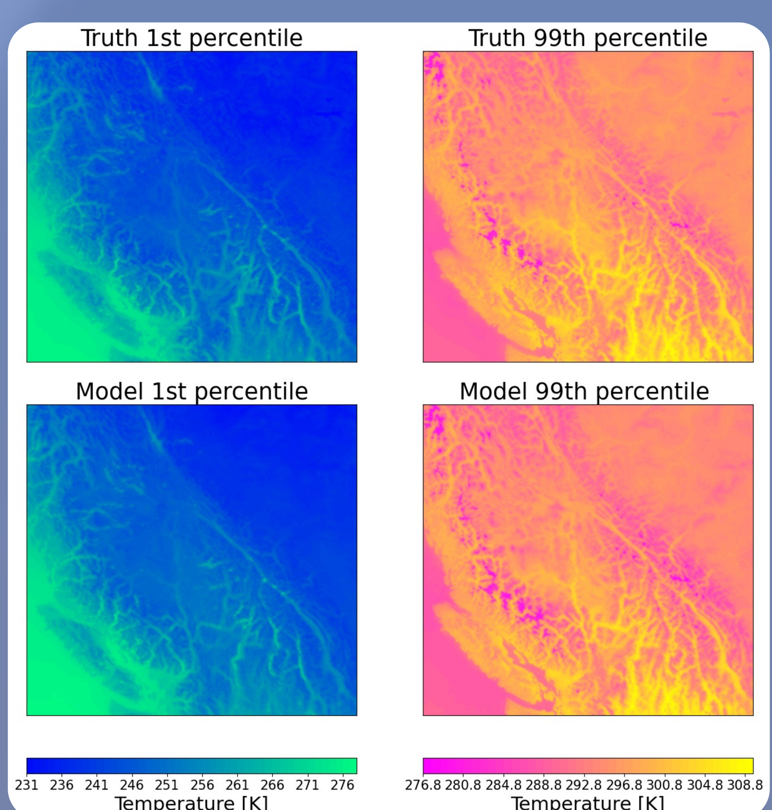


Figure 2: The 1st and 99th percentiles of the Truth WRF fields and Model generated fields. Only one model is shown.

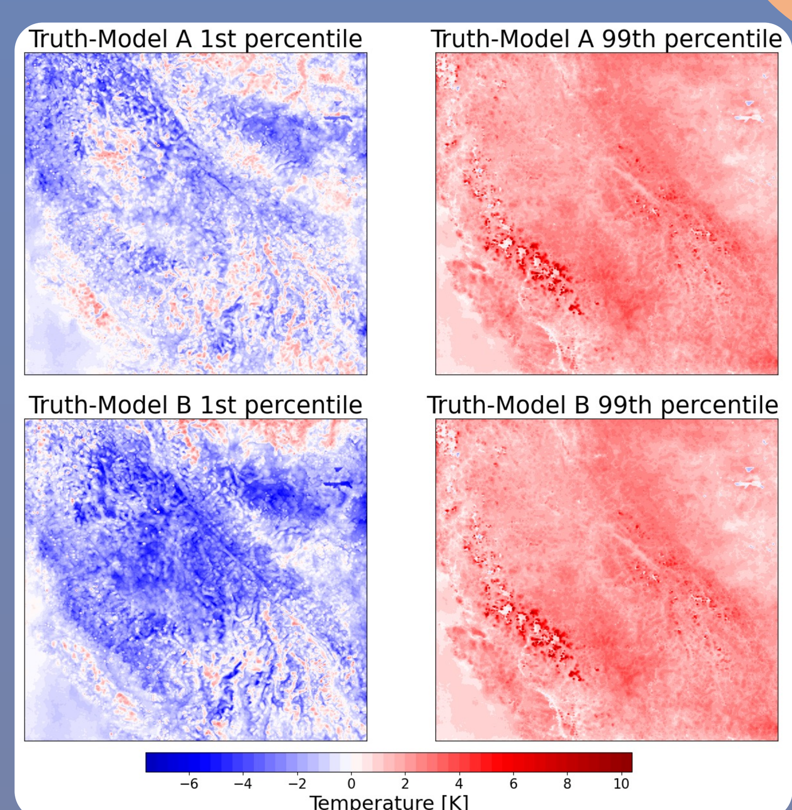


Figure 3: The differences between the 1st and 99th percentiles of the Truth WRF fields and Model generated fields. Two models are shown.

- Model percentiles are very similar to Truth percentiles over space
- Variability in representation of extremes between models
- Models are underpredicting alpine temperatures
  - Add snow cover representation to model?

Radially Averaged Power Spectral Density: quality of spatial features at various scales

- High-wavenumber high-power bias: grainy features
  - Improved with learning rate
- Later epochs have a low-power bias: blurry features not defined
- Improve small-scale features: add spatial gradients to the training process?

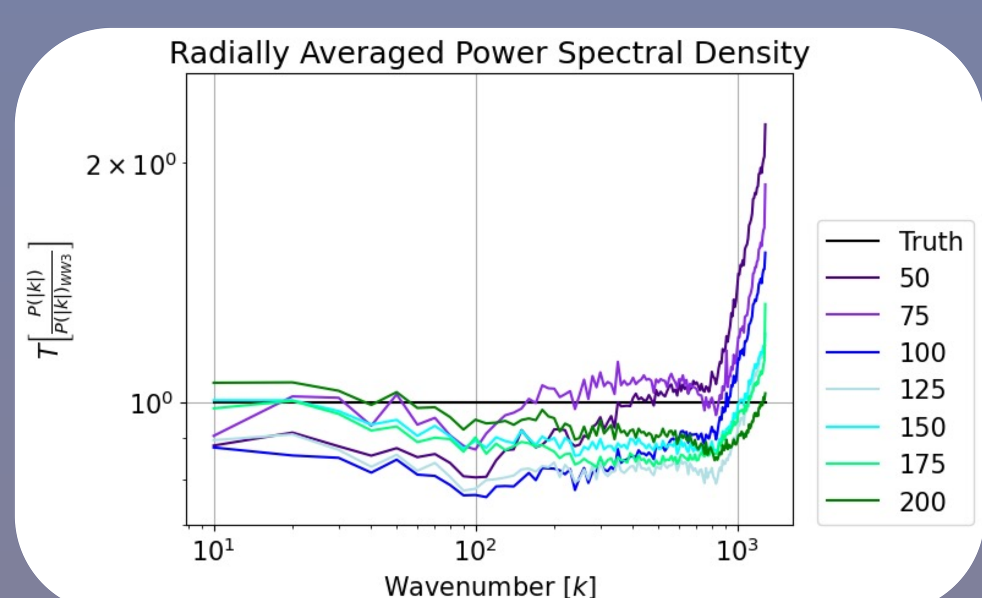


Figure 4: Radially Averaged Power Spectral Density of the Truth (black line) and a Model at different training epochs (coloured lines). High wavenumbers correspond to small-scale features. All Model values are normalized by the Truth values. A high-power bias occurs when values are above the Truth line, and vice versa for a low-power bias.

SPATIAL DEPENDENCE

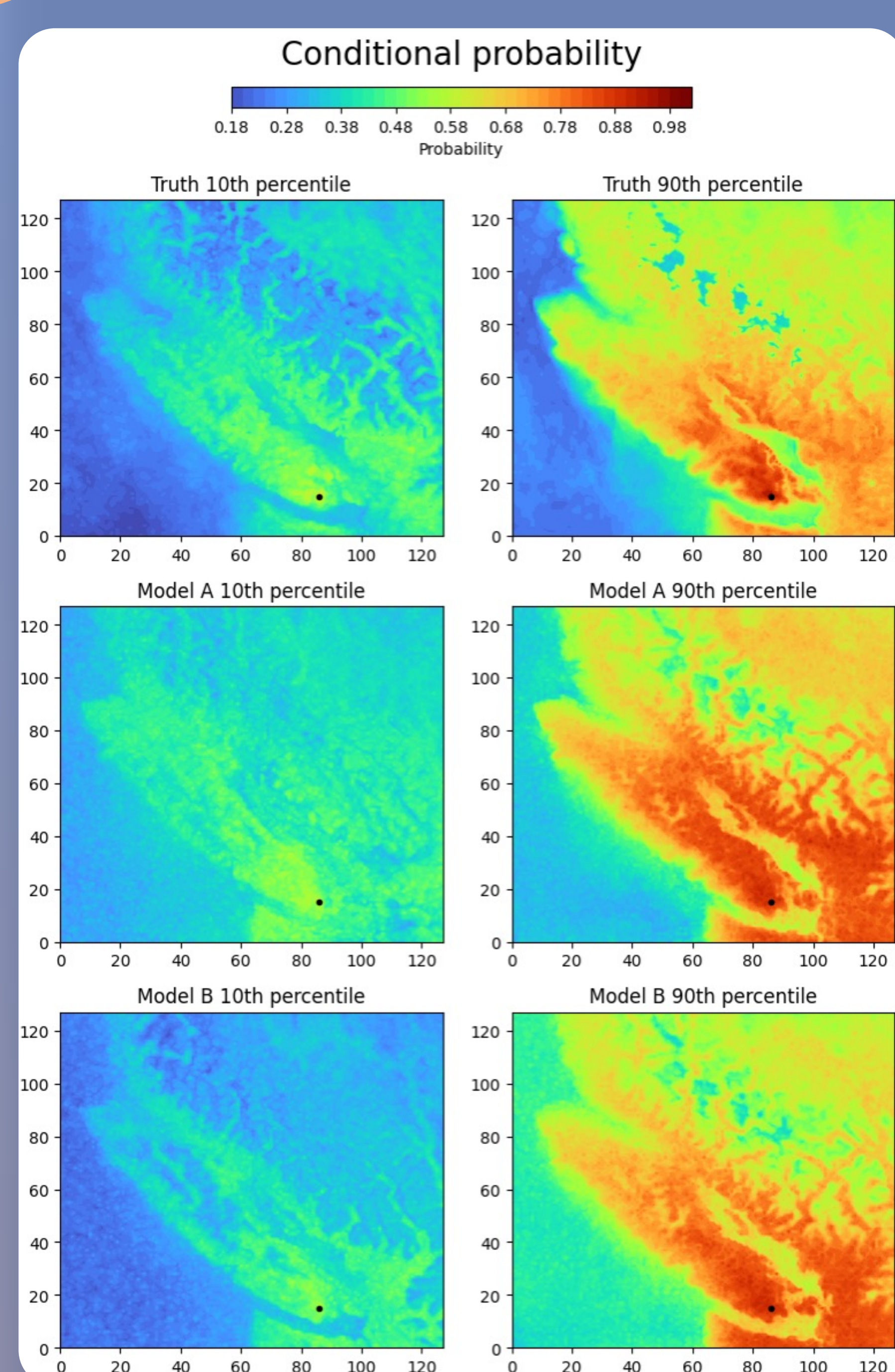


Figure 5: Conditional probability that grid points will be in the percentile given that Victoria (black dot) is in the percentile as well.
Data is deseasonalized. The lower 10th percentile is calculated using daily minimum temperatures while the upper 90th percentile is calculated using daily maximum temperatures.

- Asymmetry between upper (Tmax) and lower (Tmin) percentiles
- Higher spatial dependence for Tmax
  - Tmax may be governed by larger-scale weather processes
  - Tmin may be more localized
- Tmin has stronger topographical features
  - Stronger elevation dependence than Tmax
  - Not as present in models
- Dependence of Models > dependence of Truth
  - Blurry small-scale features (Fig. 4)
  - Less local features = increased large-scale dependence

FUTURE WORK

Other variables
- Relevant to extremes
- Precipitation, wind

Compound events
- High impact
- Wet and windy, hot and dry, hot and humid

Additional statistical tools
- Bulk and Tails model (Stein, 2020)
- Push further into the tails

Generalizability
- How does the performance change with different regions?
- Can the model produce appropriate extremes in different global warming scenarios?

Stein ML. A parametric model for distributions with flexible behavior in both tails. *Environmetrics*. 2021; 32:e2658. https://doi.org/10.1002/env.2658

Assessing the impacts of shifting planting dates on crop yields and irrigation demand under warming scenarios in Alberta, Canada

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d Department of Physics and Astronomy, Western University, 1151 Richmond Street, London, Ontario N6A 3K7, Canada

Motivation

- Climate Change Threatens Global Food SecurityBy 2100, the global population is projected to reach 10.4 billion. Climate change—through increased temperatures, droughts, and extreme weather—poses serious risks to agricultural productivity and irrigation resources, especially in water-scarce regions.
- Alberta: A Key Agricultural Region in CanadaAlberta accounts for 71% of Canada's irrigated land and is a major producer of spring wheat and canola. It features a semi-arid climate, with insufficient precipitation in the south, making irrigation essential for crop production.
- Shifting Planting Dates as a Practical Adaptation StrategyAmong various adaptation measures, adjusting planting dates is a low-cost and operational option that can optimize crop growth conditions under changing climate scenarios.

Study area

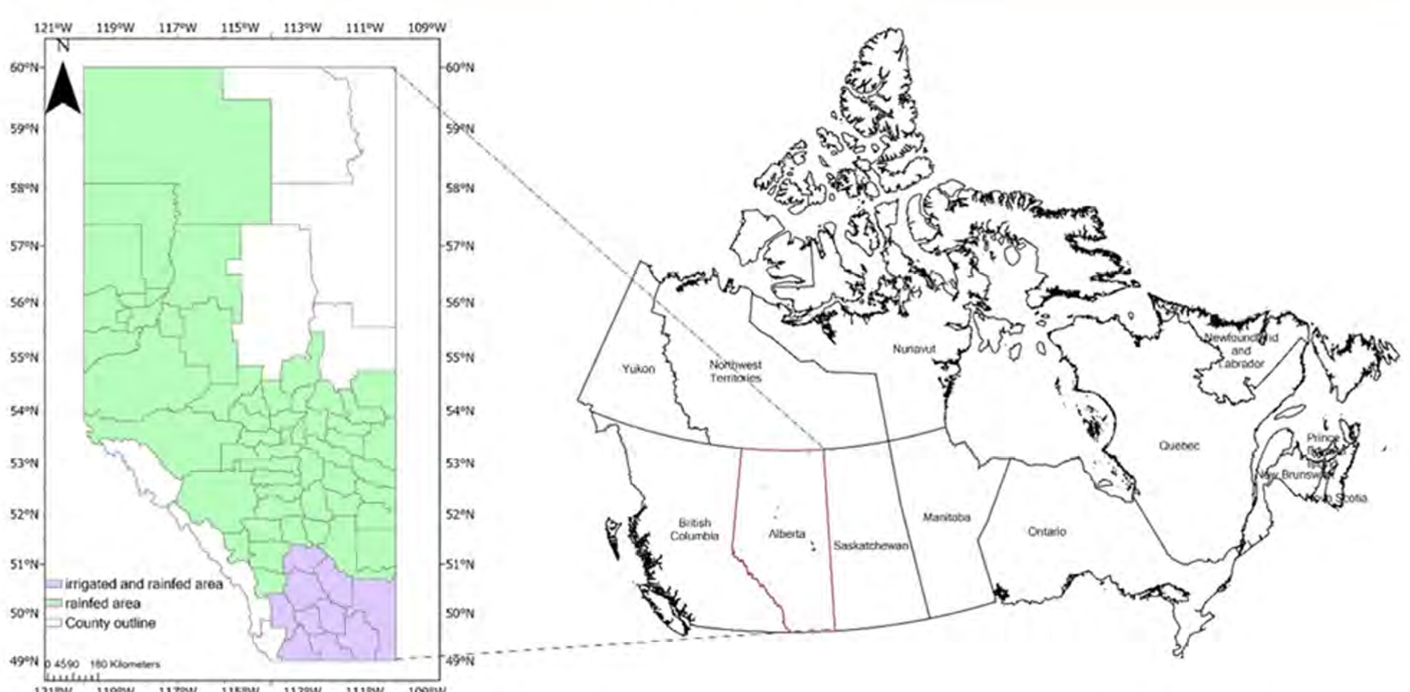

Figure 1. Study area and the distribution of irrigated and rainfed areas in Alberta, Canada

- Spring wheat and canola each cover ~22% of Alberta's farmland.
- Alberta holds 71% of Canada's irrigated land, mainly in the south.
- Over 41,500 farms span 49.2 million acres (22% of national total).
- Annual precipitation ranges from 296 mm (south) to 694 mm (north); southern areas rely on irrigation.
- Growing season temperature range 8.7–18.5°C; extreme heat events are rising under climate change.

Methodology

This study applied the AquaCrop-OS model, developed by the FAO, to simulate crop yield and irrigation water demand for spring wheat and canola under three climate scenarios (SSP126, SSP370, and SSP585). Simulations were conducted for 63 counties across Alberta from 2000 to 2100, using five fixed planting dates ranging from April 1 to May 30 to test the effects of early and late sowing. The model was calibrated and validated using county-level yield data from 2000–2019. Input datasets included weather variables, soil properties, crop distribution maps, and literature-based crop parameters.

Table 1 Description of simulations

Num	Period	Scenarios	Sowing date
1	2000-2019	history	May 15
2	2020-2100	SSP126	Apr 1, Apr 15, Apr 30, May 15, and May 30
3	2020-2100	SSP370	Apr 1, Apr 15, Apr 30, May 15, and May 30
4	2020-2100	SSP585	Apr 1, Apr 15, Apr 30, May 15, and May 30

Results

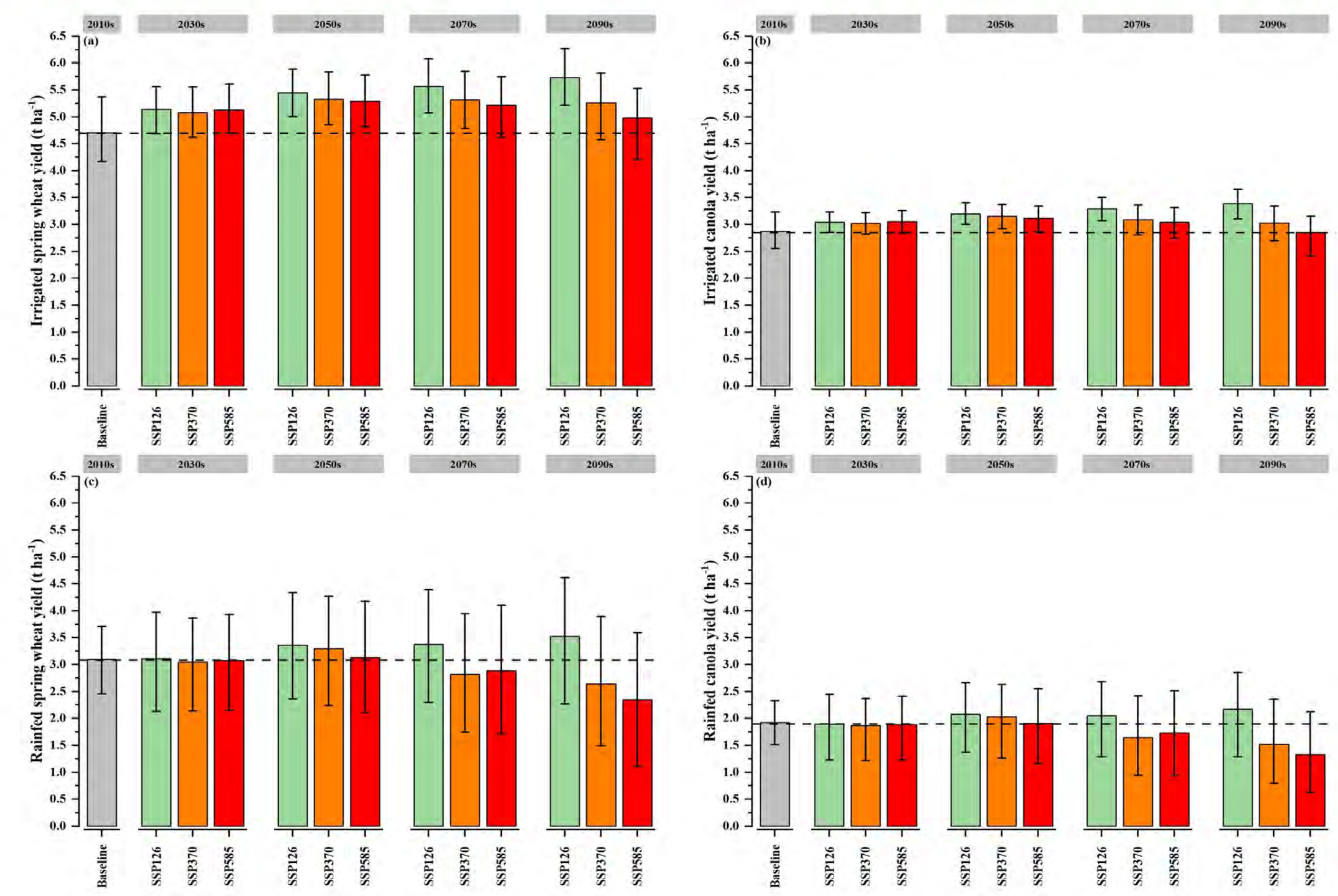

Figure 2: The rainfed and irrigated spring wheat and canola yield under three future scenarios (SSP126, SSP370, and SSP585). The simulation periods include baseline (2010s) and future period (2030s, 2050s, 2070s, and 2090s).

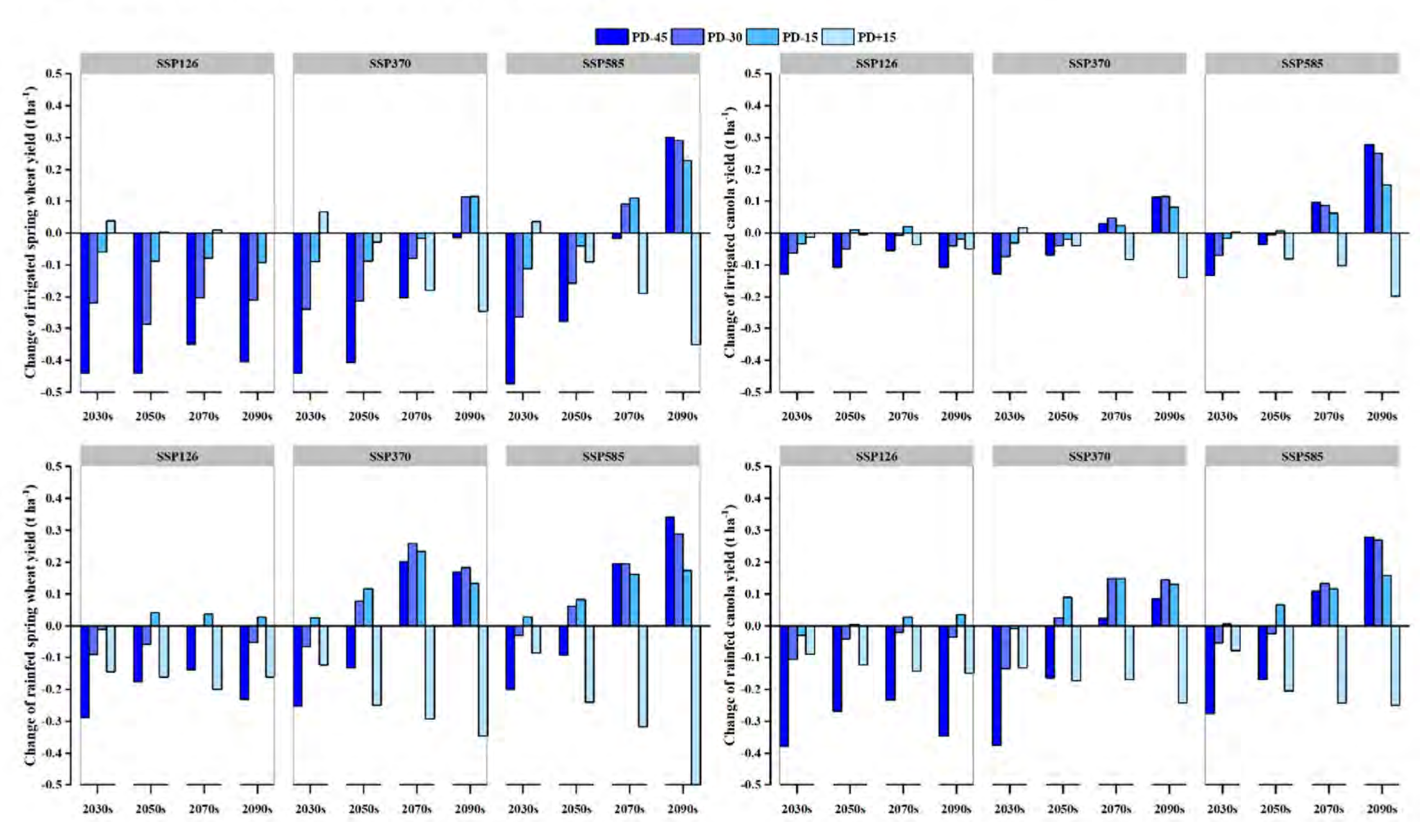

Figure 3: Changes in rainfed and irrigated spring wheat and canola yield with four planting dates (PD-45, PD-30, PD-15, and PD+15) compared with the default plant date (PD) under three future scenarios in four decades. PD representsMay 15; PD-45 represents Apirl 1, PD-30 represents Apirl 15; PD-15 represents Apirl 30; PD+15 representsMay 30.

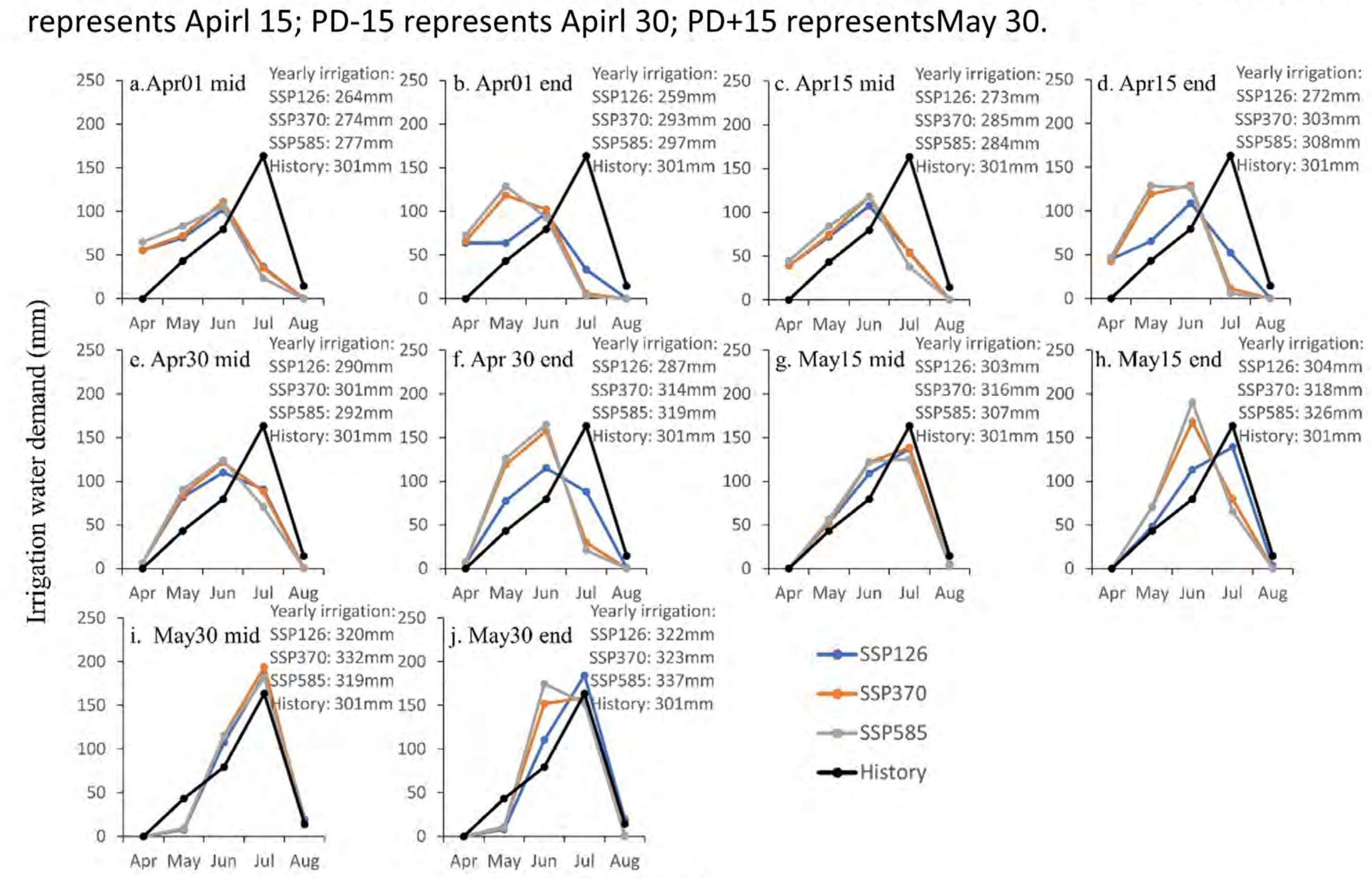

Figure 8. The monthly irrigation of spring wheat under three future scenarios (SSP126, SSP370, and SSP585) during the growing season. The dates (Apr 01, Apr 15, Apr 30, May 15, and May 30) are the seeding dates. Mid/end means the mid/end of the 21st Century.

- Fig. 2: Under all scenarios (SSP126, SSP370, SSP585), irrigated spring wheat and canola yields increase, especially due to reduced water stress. However, rainfed yields decrease under SSP370 and SSP585, mainly due to heat stress and shortened growth periods.
- Fig. 3: Advancing planting dates (e.g., April 1) improves yields for both irrigated and rainfed crops under SSP370 and SSP585, particularly during 2070s–2090s. This strategy helps avoid extreme heat in the late season and better utilize early rainfall.
- Fig. 4: Irrigation demand increases across all scenarios, with the seasonal peak shifting from July to June due to earlier crop development. Early sowing (April 1) reduces irrigation needs by up to 12%, especially under SSP585.

Conclusions

This study highlights the dual challenges of climate change for agriculture in Alberta: while irrigated crops may benefit from warming, rainfed yields are at risk, especially under high-emission scenarios. Shifting planting dates earlier—particularly before May—is an effective adaptation strategy that can boost yields and reduce irrigation water demand, especially in the latter half of the century.
The findings underscore the importance of flexible field management practices, such as optimizing sowing time, to cope with future climate variability. Moving forward, it is crucial to develop more efficient irrigation systems and integrate climate-smart planning into agricultural and water resource management.

Future works

Future research should focus on collecting more accurate and detailed irrigation data to better calibrate and validate irrigation demand simulations. Improving AquaCrop-OS by integrating it with the SHAW model could enhance soil water dynamics representation and increase the accuracy of irrigation water requirement estimates. Additionally, incorporating field management practices and conducting simulations at finer spatial scales would reduce uncertainty and better capture regional variability. Using multi-model ensembles can further improve robustness and reliability of projections under climate change.

Author information

I am a doctoral candidate about to graduate. My PhD research focuses primarily on regional crop modeling, including the impacts of climate change and agricultural adaptation measures on crop yield. My work combines crop models, machine learning methods, and various advanced remote sensing data to predict seasonal yields. During my master's studies, I mainly researched watershed hydrological modeling and regional drought assessment.
I look forward to establishing connections with experts in relevant fields.

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SPATIO-TEMPORAL VARIABILITY OF CO_2 AND CH_4 FLUXES IN WETLANDS ACROSS THE PRAIRIE POTHOLE REGION OF CANADA

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INTRODUCTION

- Wetlands are an important component of the global carbon cycle, functioning as both carbon sinks and sources of greenhouse gas (GHG) emissions.
- Wetlands in the Prairie Pothole Region (PPR) of Canada store large amounts of soil organic carbon but are among the most threatened ecosystems due to extensive land conversion and historical drainage.
- The spatial variability and temporal dynamics of GHG emissions from PPR wetlands remain poorly understood, limiting our ability to assess their contributions to regional and global carbon budgets.

OBJECTIVES

- To study the spatial and interannual variability (2021–2024) in net ecosystem exchange (NEE), methane flux (FCH4), and total GHG balance across three distinct wetland sites in the PPR, Canada

METHODS

INSTRUMENTATIONS

Eddy Covariance measurements

Meteorological data - Air temperature, Relative humidity, Radiation, Soil moisture, Water table depth

CONCLUSIONS

- The preliminary results indicate significant differences in NEE, FCH4, and GHG balance between the three wetlands.
- Differences in site characteristics likely contribute to the observed patterns in these fluxes.
- The study highlights that the wetlands can serve as strong carbon sinks, but methane emission can affect the overall net GHG balance.

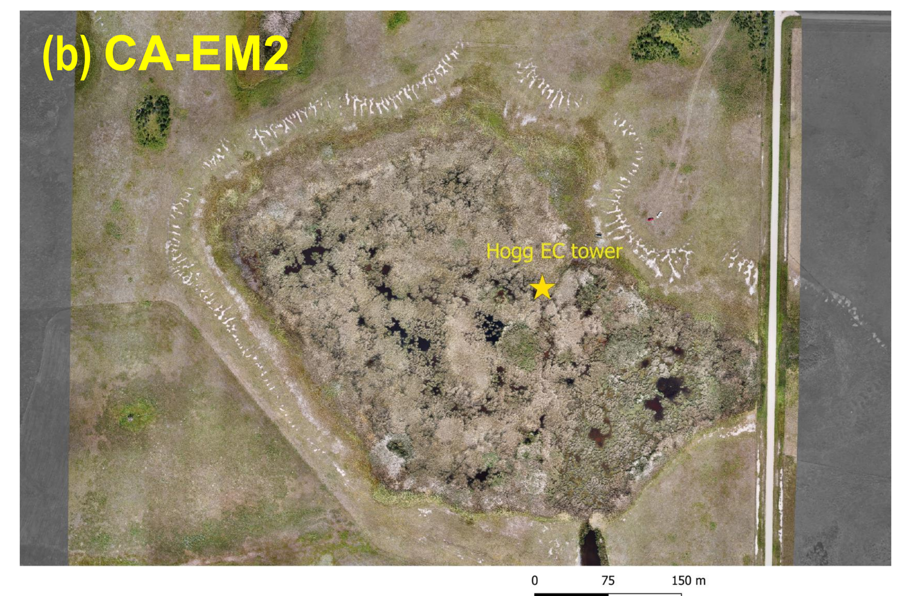
Environment and Climate Change Canada

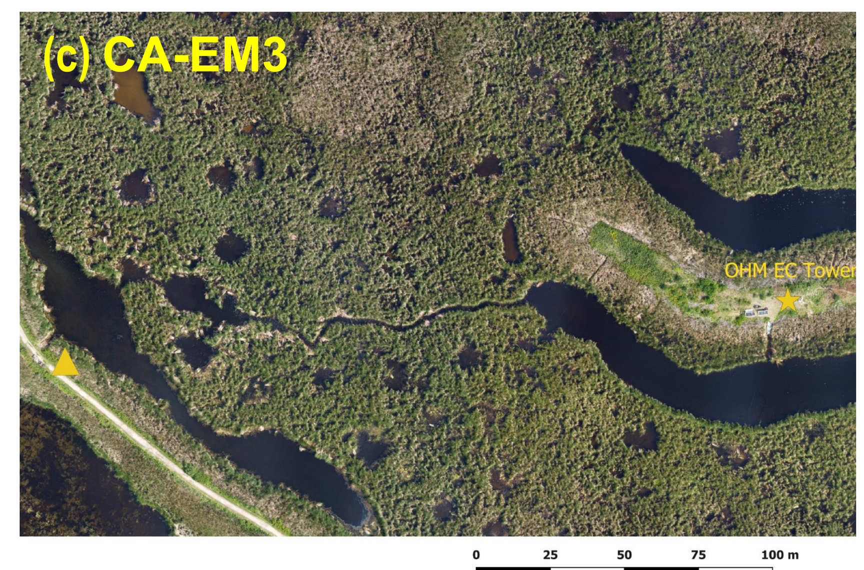
EcoFlux Lab

McGill UNIVERSITY

STUDY AREA

- The study was conducted at three wetland sites in the PPR region of Manitoba, Canada
- It comprises of (a) an isolated cropland marsh (CA-EM1), (b) an isolated grassland marsh (CA-EM2) and (c) a restored marsh (CA-EM3)





RESULTS

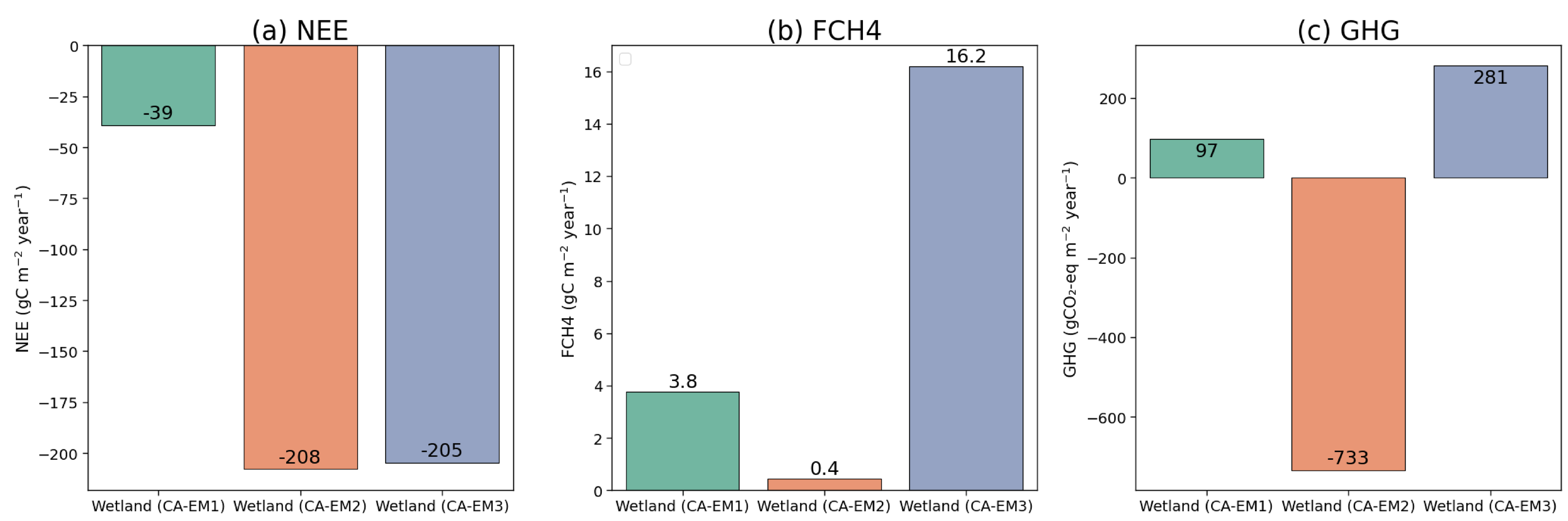


Figure 1 Annual sums of (a) NEE, (b) FCH4 and (c) greenhouse gas (GHG) fluxes at three wetland sites. Note: GHG is based on sustained global warming potential of CH_4 over the 100-year time horizon.

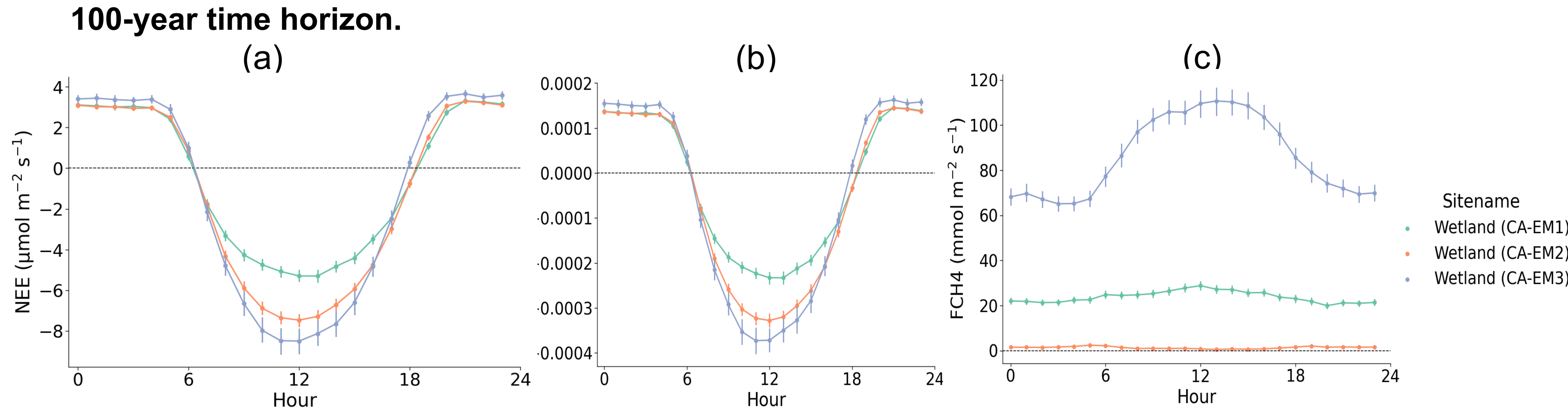


Figure 2 Mean diurnal pattern of (a) NEE (b) GHG and (c) FCH4 fluxes during the growing season at three wetland sites.

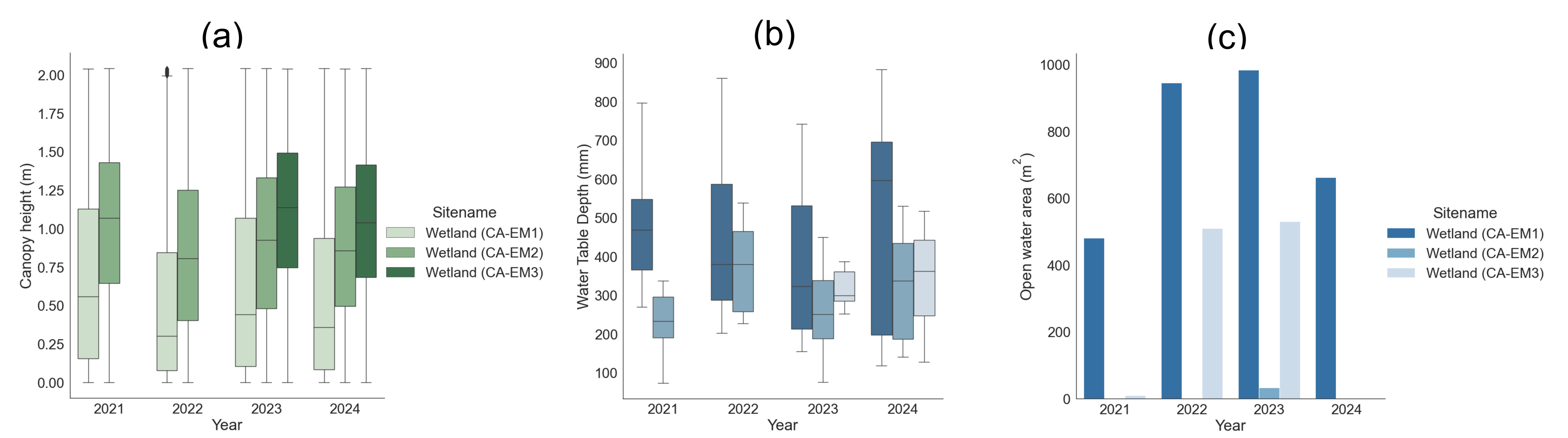


Figure 3 Site and inter-annual variability of (a) canopy height (b) water table depth and (c) open water surface area across three wetland sites.

ACKNOWLEDGEMENT

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Field Trials of Trace-Gas Analyzers for Eddy Covariance Flux of Methane (CH_4) and Nitrous Oxide (N_2O)

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Michael R. Schuppenhauer, Stephen W. Chan, Sebastien C. Biraud Lawrence Berkely National Laboratory, CA, USA

Campbell SCIENTIFIC

BERKELEY LAB

Introduction

The Eddy Covariance (EC) Gas Flux method makes challenging demands on the gas analyzers used in the field, particularly for the trace gasses CH_4 and N_2O. The analyzer must have sufficient frequency response, low noise, and measurement stability. For practicality, it must be field rugged, low power, and require minimal maintenance. The aerodynamic footprint of the instruments near the sample volume of the 3D anemometer is a paramount concern for quality science data.

Tunable diode laser absorption spectroscopy (TDLAS) is a proven method for measuring the low concentrations of trace gasses in natural air and is effective for EC (Somers and Sargent, 2015, Brown, et al, 2016). A closed-path TLDAS gas analyzer employs a low sample gas pressure to isolate the mid-infrared absorption lines while also providing sufficient flow rate to preserve instrument frequency response.

The TGA300 series of closed-path trace-gas analyzers is new instrumentation developed at Campbell Scientific specifically to meet the requirements of trace-gas EC flux measurements. This field study evaluated the TGA300s alongside other instruments used for the same purpose. The TGA310 measures methane (CH_4) and was compared alongside an LI-7700 open-path analyzer. The TGA320 measures nitrous oxide (N_2O) and was compared to a TGA200A closed-path analyzer. To complete the fluxes, the TGA300 instruments utilized sonic data from an IRGASON. The TGA200A and LI-7700 use a CSAT3B for sonic data. A Young 81000RE anemometer and a variety of additional sensors were also present.

Accuracy and Noise

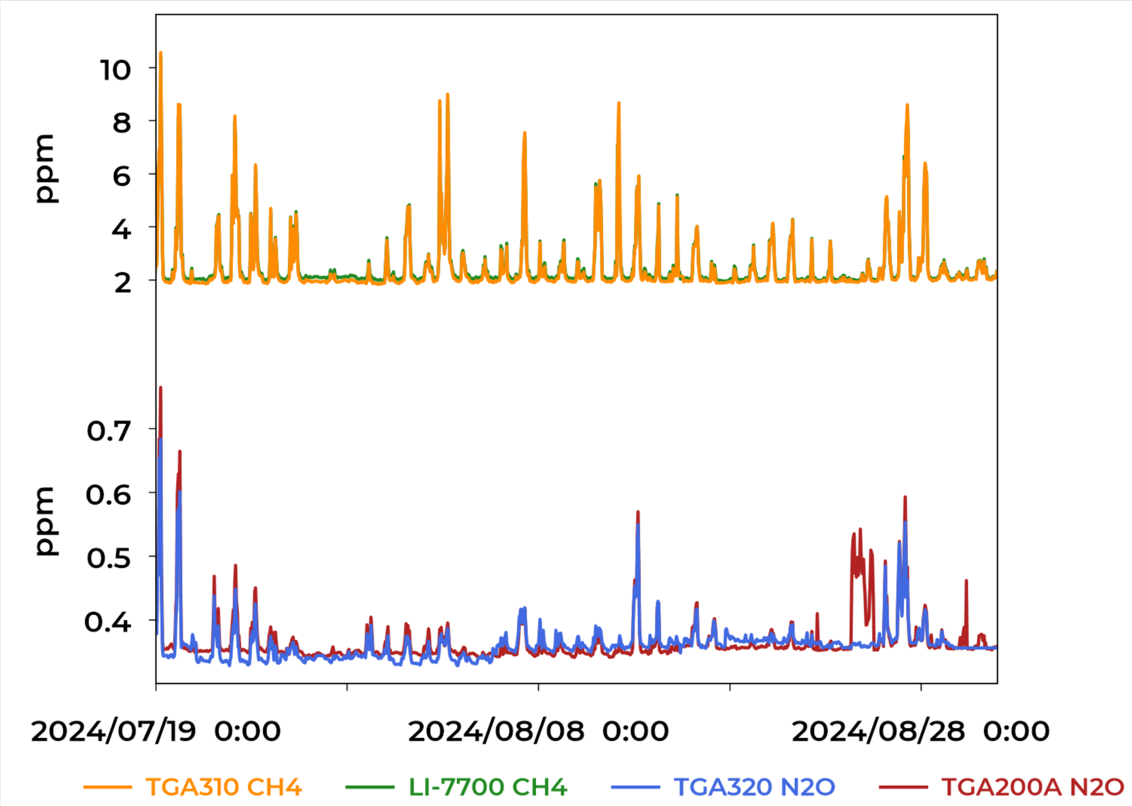

Figure 1: These plots show a times series of the scalar measurements of the gas analyzers over a period of a month. Plot A is CH_4 from the TGA310 and LI-7700. Plot B is N_2O from the TGA320 and TGA200A. For clarity of the image, the data has been smoothed with a 1-hour block average to illustrate the general correlation of absolute concentrations measured by the devices. Setting aside minor offset differences that do not impact the flux calculations, the amplitude gain is well correlated. The instruments all responded to dynamic cultivation activities. Data availability was similar between the open and closed path instruments at this site except for the regular window wash cycles of the LI-7700 every few hours. Missing data due to precipitation events was inconsequential because this site receives little rainfall and is flood irrigated.

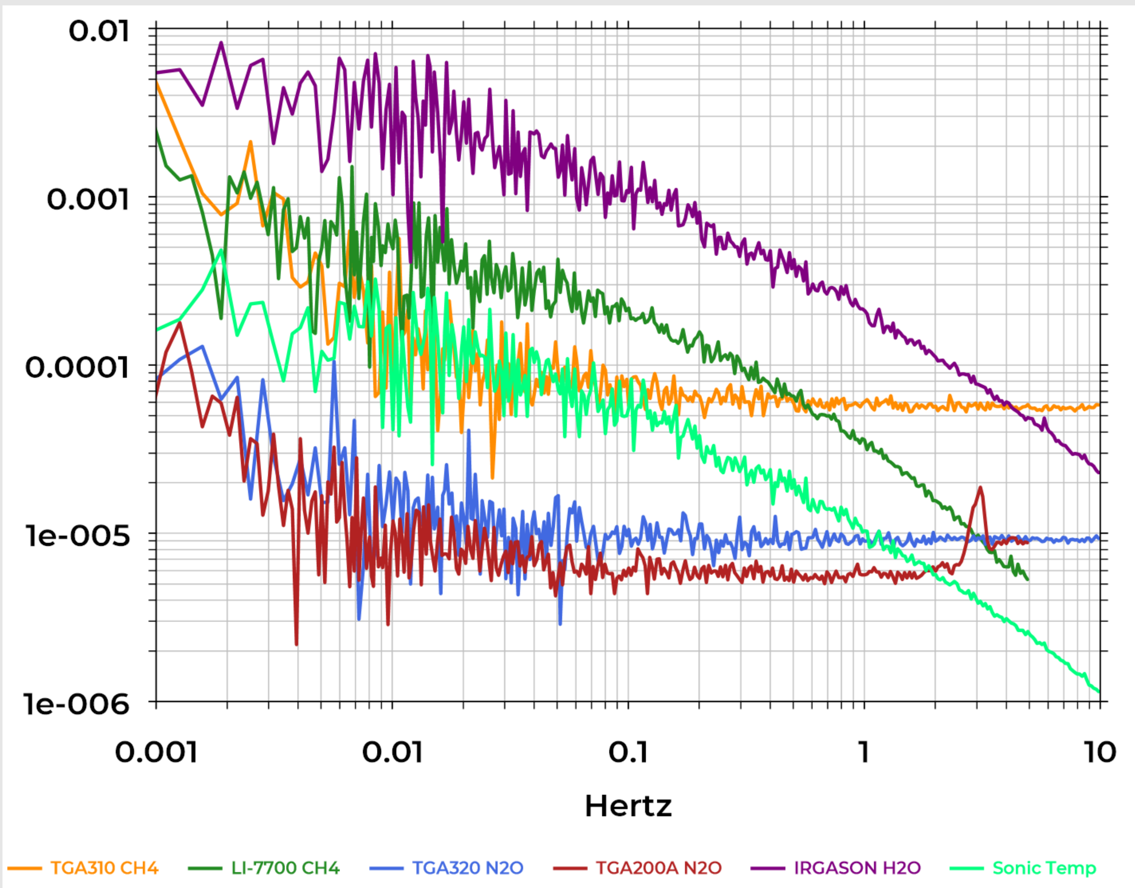

Figure 2: Normalized noise spectra of the primary output for all analyzers. Dry mixing ratio is shown for the TGAs and wet mixing ratio for the LI-7700. This data was from a 4-hour data sample taken during calm hours of the day with insignificant variations in CH_4 and N_2O concentration. The TGA instruments transition from 1/f noise to broadband white noise approximately around 0.02 Hz. The intake design of the TGA dampens the fluctuations of temperature and water yielding dry mixing ratio directly without corrections. The spectral profile of the sonic temperature and water vapor are also shown for substantiation. In this view, the LI-7700 exhibits elevated noise behavior because it lacks a collocated high-frequency-response air temperature measurement so temperature fluctuations could not be removed for the conversion to a mixing ratio.

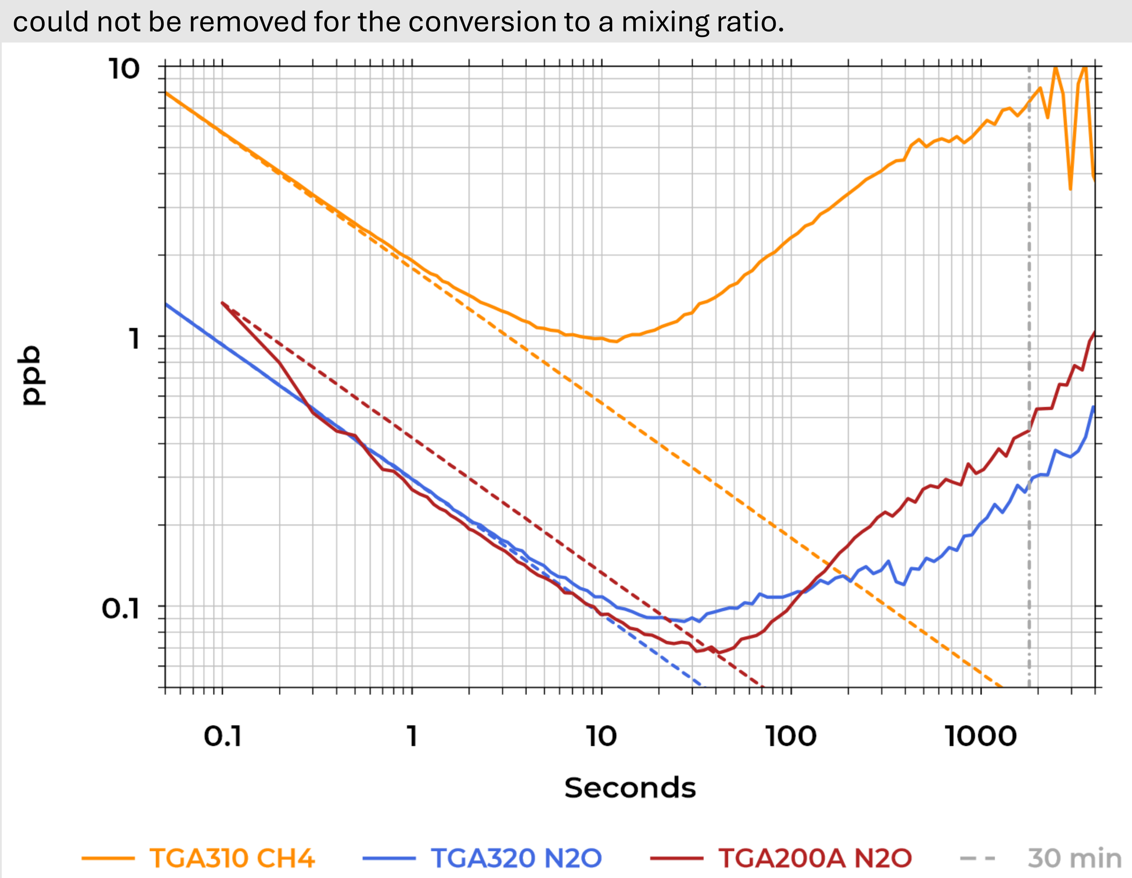

Figure 3: Allan deviations (Allen, 1966) computed to a 4-hour interval for all analyzers. The TGA instruments exhibit deviation smaller than the 10 Hz noise floor out to 30 minutes indicating stability for EC flux calculations.

Measurement Campaign

Figure 4: Test site located in San Joaquin Valley, CA. Campaign dates Aug 2023- Sept 2024. Crops were silage corn and winter wheat.

Figure 5: Test site equipment. TGA310, TGA320, TGA200A, CSAT3B, IRGASON, LI-7700, LI-7500, Young 81000RE, CR6, radiometers, soil sensors, etc.

Figure 6: Fully integrated instrument cluster measures N2O, CH4, CO2, H2O, and 3D sonic all with Campbell Scientific sensors

Figure 7:Hybrid instrument cluster measures N2O, CH4, CO2, H2O, and 3D sonic with Campbell Scientific, Li-Cor, and RM Young

Conclusions

1. The field trial has shown the TGA300 to be a significant advancement in the tools available for EC measurements of methane and nitrous oxide. The instruments met the critical benchmarks of noise, stability, frequency response, and aerodynamic footprint necessary for the technique. Practical features such as field installation, maintenance schedule, and power draw of the TGA300 surpassed other currently available instrumentation.
2. The effectiveness of the intake dryer assembly of the TGA was evident. It sufficiently removed fluctuations of air temperature and water vapor yielding dry mixing ratio without corrections. The field noise performance matched the results from testing in a controlled laboratory environment.

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Trace-Gas Analyzers: TGA300

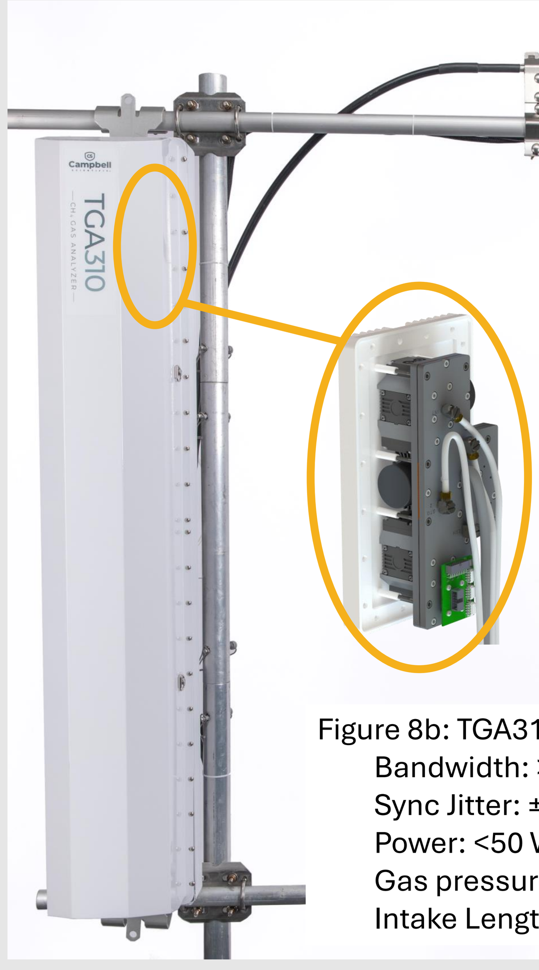

Figure 8a: The TGA300 operates at a higher sample cell pressure than earlier generations of TDLAS. Also, the gas pathways are designed with small diameters reducing the required volume of gas flow. The result is a miniaturized vacuum pump that is integrated inside the instrument and draws only a fraction of the power of its predecessors.

Figure 8b: TGA310/320 Specifications

Bandwidth: >3 Hz	Noise CH_4 : <7 ppb rms
Sync Jitter: ±10 ms	Noise N_2O : <1.5 ppb rms
Power: <50 W	λ CH_4 : 4534 nm
Gas pressure: 30 kPa	λ N_2O : 3221 nm
Intake Length: 5 m	

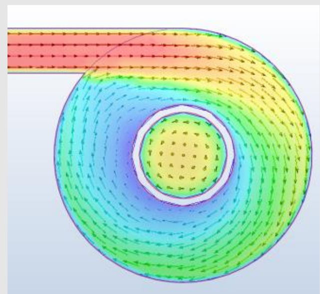

Figure 9: The vortex air cleaner reduces filter maintenance without impacting frequency response. Airborne particles are thrown to the outside of the vortex and carried away while the sample tube pulls cleaner air from the center of the vortex. (Burgon, et al. 2015)

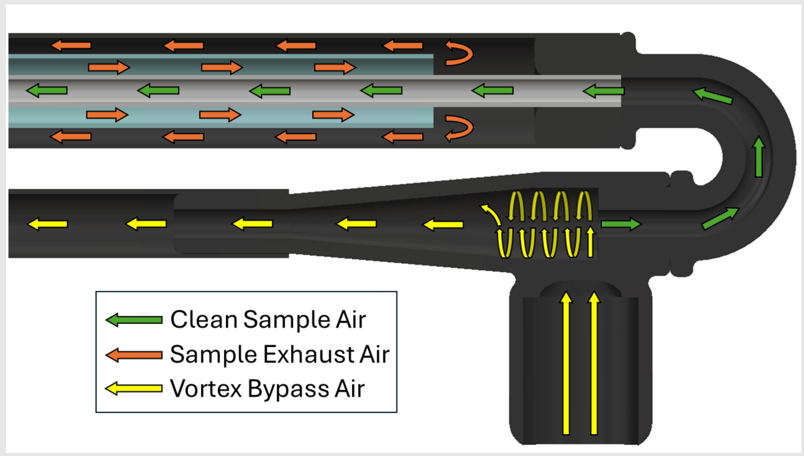

Figure 10: The external intake line houses a 4 m multi-layer dryer structure with a Nafion membrane tube at the center. After the vortex cleaner, sample air passes down the center of the Nafion tube. The opposite side of the tube has counterflow air provided by the exhaust sample air. The counterflow draws water out of the sample due to its lower pressure and higher temperature. More importantly, the dryer dampens the variations in water and temperature sufficiently to eliminate the need for a WPL correction. (Somers, et al. 2015)

Frequency Response and Fluxes

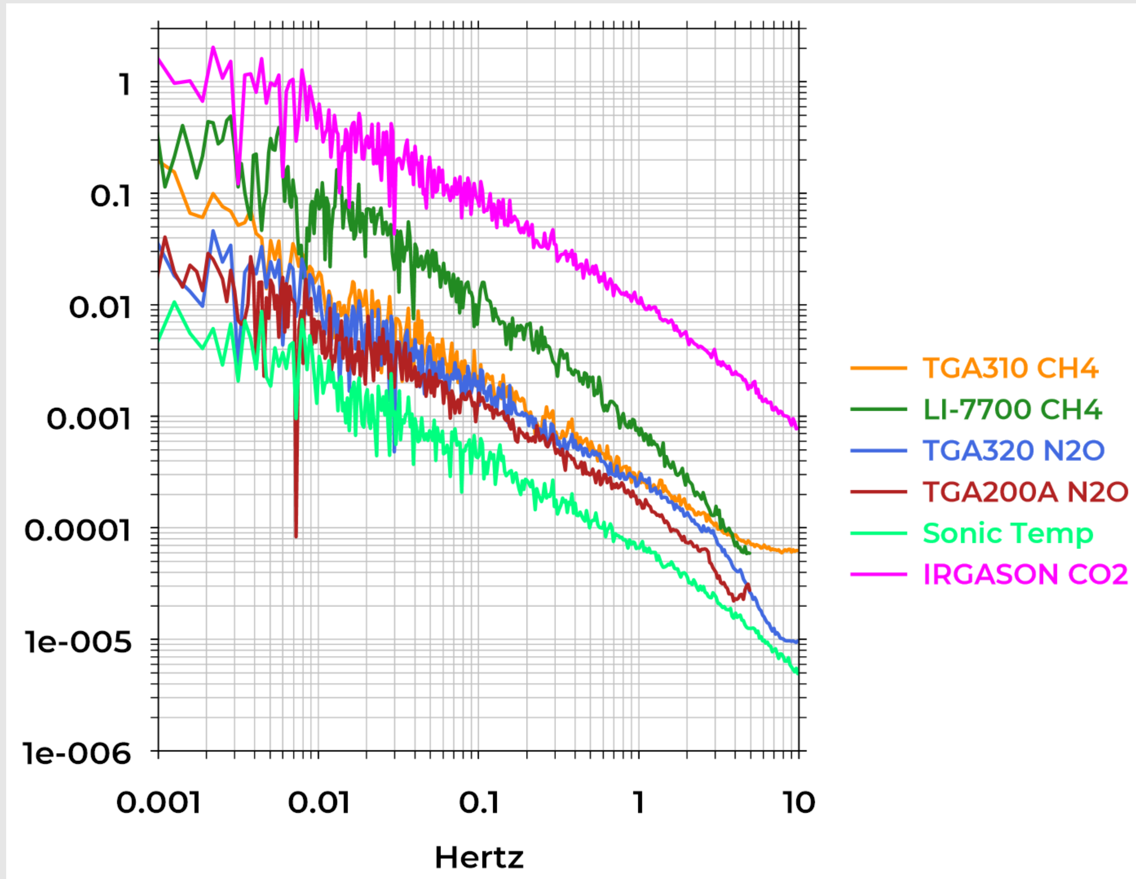

Figure 11: Normalized spectra for the gas analyzers and anemometer. This was examined during a period of high turbidity and available gas fluxes. For a spectral reference, the open-path IRGASON was used to measure sonic temperature and CO2 which both exhibit unattenuated frequency response to at least 10 Hz. The closed-path TGA300s show bandwidth beginning to roll off above 3-4 Hz. The response attenuation for the TGA200A becomes noticeable around 2.5 Hz. The LI-7700 starts attenuating around 0.5 Hz requiring a significant spectral correction to the fluxes.

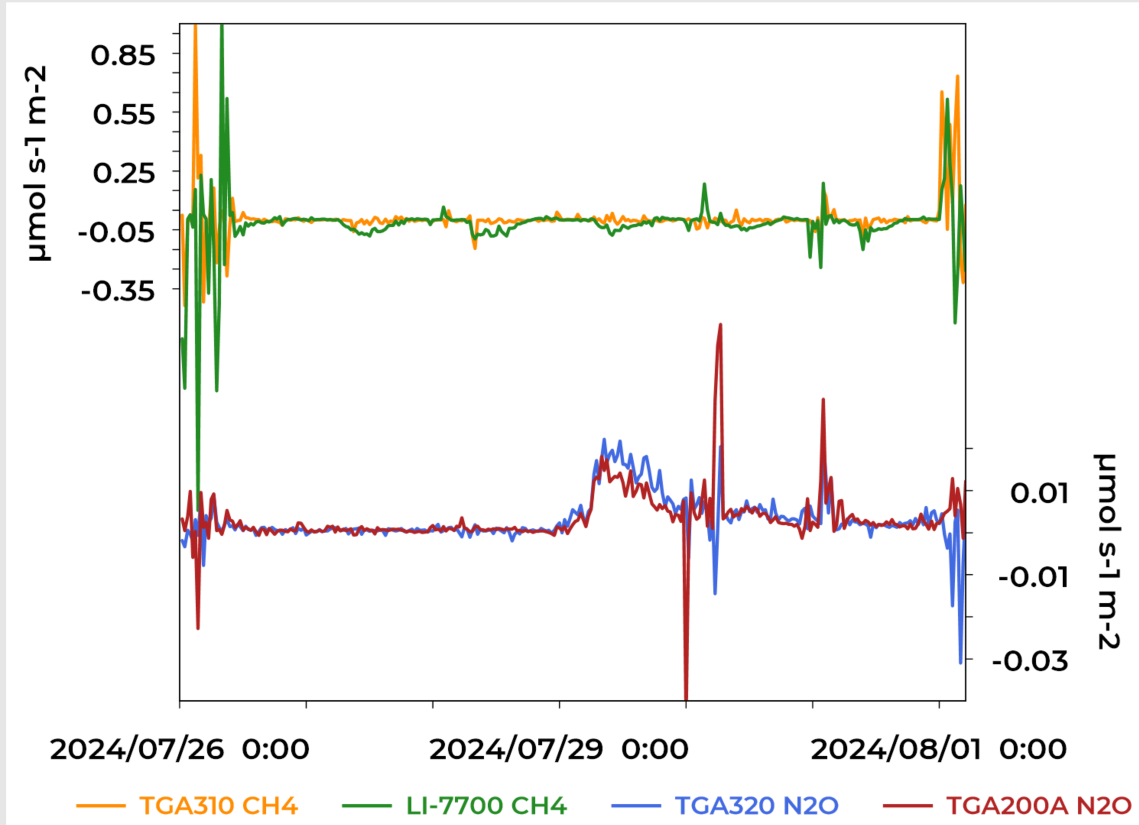

Figure 12: Shown is one week of fluxes calculated by each of the instruments. The TGA300s both used the IRGASON for the anemometer covariance, while the TGA200A and LI-7700 used the CSAT3B. This is given as a demonstration of reasonable flux results and the discrepancies between instruments can be largely attributed to a lack of refinement in the EddyPro processing setup. Detailed analysis of the flux data is the focus of separate studies.

WORLD METEOROLOGICAL ORGANIZATION

TECO 2024 Poster P3(8)

Testing the Application of a Novel Technology for Assessing Vine Health Using Spectrometry

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1. Introduction & Objectives

Solar radiation is reflected, absorbed, and transmitted through the leaves of a vine canopy, with each pigment in the leaf having a specific interaction pattern.[1] For instance, healthy vine leaves absorb red light in the electromagnetic spectrum due to their high chlorophyll content along with reflecting and transmitting near infrared (NIR) wavelengths.[2]

The Normalized Difference Vegetation Index (NDVI) can be used to assess the photosynthetic function of the vines using red and NIR light.[1,3] Decisions about interventions like irrigation and pesticide applications can be made quicker based on NDVI canopy values.[1,3] However, current research overlooks the potential of transmitted light in NDVI calculations, which can provide more accurate readings by focusing exclusively on the canopy.

TreeTalker Wine (TTW) is a novel sensor system that can be deployed in vineyards and allow for continuous, real-time monitoring using transmitted light. However, as the name suggests, this technology was first developed for use in forest settings and is untested in vineyards.

Therefore, the objective of the study is to determine if TTWs can collect spectral information on the light transmitted through the vineyard canopy, from which $NDVI_T$ (NDVI calculated with transmitted light) can be derived to monitor vine health.

2. Methods

This research was conducted in two commercial vineyards managed by the same winery in the Niagara Escarpment appellation. The first site is referred to as ON_VIN_01 and the second as ON_VIN_02.

Four TTW systems were deployed in Cabernet Franc blocks at both sites on May 9th, 2023 (Day of Year [DOY] 129), just before bud-break, and ran continuously, collecting hourly data until after the fruit was harvested (November 24th, 2023; DOY 328).

The daily maximum $NDVI_T$ value of each TTW was selected for each day, with the daily maximum $NDVI_T$ value of each sensor used to determine the average daily and weekly $NDVI_T$ for the block.

Figure 1: Progression of the Cabernet Franc vine growth through out the monitoring period.

3. Results

TTW $NDVI_T$

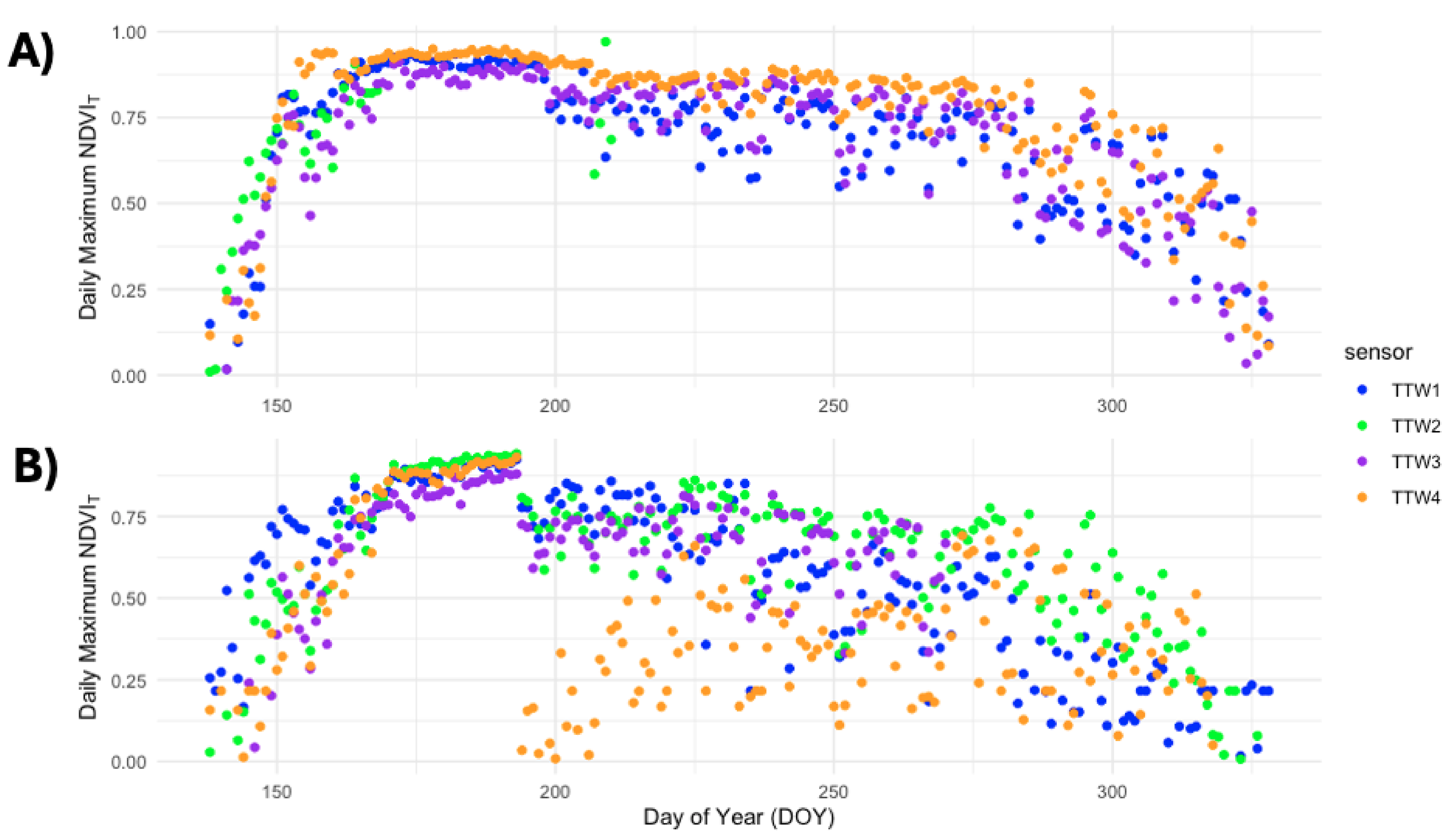

Figure 2: A) Daily maximum $NDVI_T$ for the 2023 growing season (May 9, 2023 – November 24, 2023) at TTW locations deployed at ON_VIN_01. TTW 1, TTW 2, TTW 3, and TTW 4 are represented by blue, green, purple, and orange dots, respectively. Decrease observed on DOY 199 aligns with vineyard maintenance of canopy hedging and pruning. **B)** Daily maximum $NDVI_T$ for the 2023 growing season (May 9, 2023 – November 24, 2023) at TTW locations deployed at ON_VIN_02. TTW 1, TTW 2, TTW 3, and TTW 4 are represented by blue, green, purple, and orange dots, respectively. Decrease observed on DOY 194 aligns with vineyard maintenance of canopy hedging and pruning.

TTW $NDVI_T$ & Weather Events

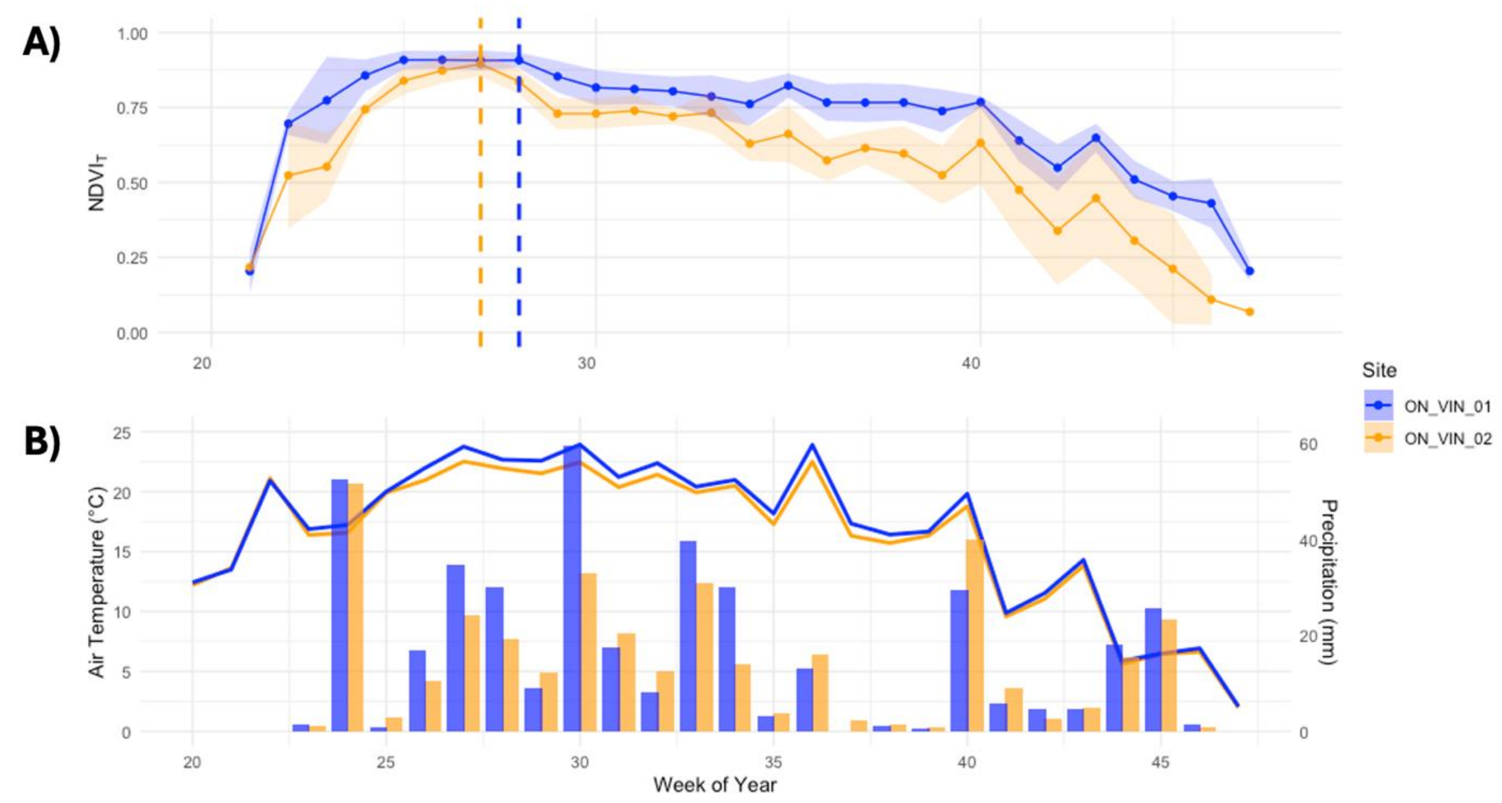

Figure 3: A) Weekly maximum $NDVI_T$ for the 2023 growing season at ON_VIN_01 (blue) and ON_VIN_02 (orange), spanning May 13, 2023, to November 24, 2023. The dashed line indicates when hedging and leave removal in the fruiting zone occurred at each study site, the colour corresponded to the location. **B)** Weather data for the 2023 growing season at both study sites, spanning May 13, 2023, to November 24, 2023. Average weekly Air Temperature (°C) is represented by the line on the primary y-axis, and weekly precipitation (mm) is shown as bars on the secondary y-axis. Colour represents the site, with ON_VIN_01 in blue and ON_VIN_02 in orange. Air temperature and precipitation data for ON_VIN_01, along with air temperature at ON_VIN_02 are from meteorological stations maintained on site. Precipitation data for ON_VIN_02 is from a nearby, government-maintained station in Vineland Station (Environment and Climate Change Canada, 2023).

TTW $NDVI_T$ vs. Traditional Satellite NDVI

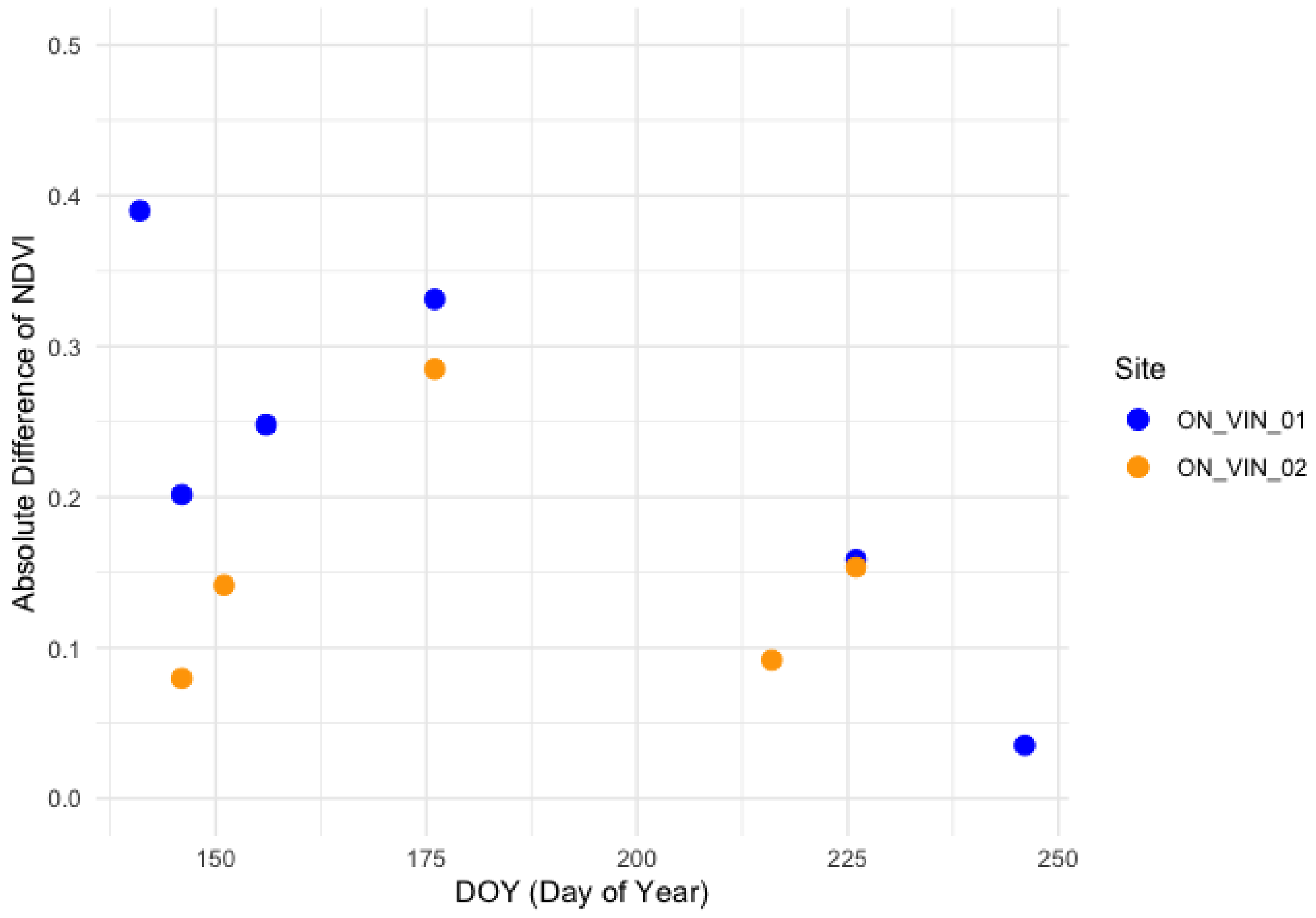

Figure 4: The absolute difference between $NDVI_T$ (calculated via TTW) and NDVI (calculated via Sentinel-2 satellite) during the 2023 growing season at ON_VIN_01 (blue) and ON_VIN_02 (orange), spanning from May 21st to September 3rd, 2023. Sentinel-2 satellite data was limited in 2023 due to the region being heavily impacted with wildfire smoke, reducing the collection of reliable Sentinel-2 satellite data.

4. Discussion & Conclusions

$NDVI_T$ values measured using TTWs throughout the growing season followed expected trends, remaining within normal ranges (>0.7 for the growing season), and were sensitive to changes caused by weather events (e.g., $NDVI_T$ increasing with temperature spikes and increased precipitation). However, TTW-derived $NDVI_T$ values were higher than NDVI values calculated by satellite. This difference can be attributed to satellite NDVI accounting for exposed soil and inter-row cover along with the vines, introducing external influences that lower NDVI values.[4] In contrast, TTW $NDVI_T$ focuses exclusively on the vines, minimizing interference from inter-row cover crops.

The ability of the TTWs to capture continuous, vine-level information throughout the vineyard presents an opportunity for producers to make accurate, timely responses to changing vineyard conditions. By enabling targeted management interventions, TTWs can ultimately support the optimization of vineyard performance in a changing climate.

Acknowledgements

Rosewood PELLER ESTATES NATURE4.0 SB SRL Ontario GRAPE & WINE RESEARCH Incorporated

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Assessing the effectiveness of ocean alkalinity enhancement on carbon sequestration and ocean acidification.

Katherine Martin, Andrew Weaver, Michael Eby, Anna Nickoloff, Leslie Moffat

University of Victoria
Earth & Ocean Sciences

Background

As atmospheric carbon dioxide (CO_2) levels continue to rise, increasing attention is being given to exploring mitigation techniques that could potentially enhance the natural drawdown of CO_2. One such mitigative intervention is Ocean Alkalinity Enhancement (OAE). OAE involves dissolving alkaline materials into ocean surface waters to increase its natural CO_2 buffering capacity. As the ocean currently absorbs about 2.8 Gt/yr (26%) of anthropogenic carbon emissions [1], it makes sense to explore the potential for and consequences of, artificially enhancing the natural process of oceanic CO_2 sequestration. Several minerals could be used for OAE, though few have the mining capabilities, global resource availability and current infrastructure readily available for increased production compared to limestone.

Here we address the question: If the entire global resources of limestone mining and production were used for OAE, and if limestone and/or lime were to fully disassociate in surface waters, would this be enough to reduce atmospheric carbon dioxide emissions significantly? That is, we provide an estimate of the maximum potential of OAE as a mitigative intervention to enhance CDR.

Carbonate Chemistry

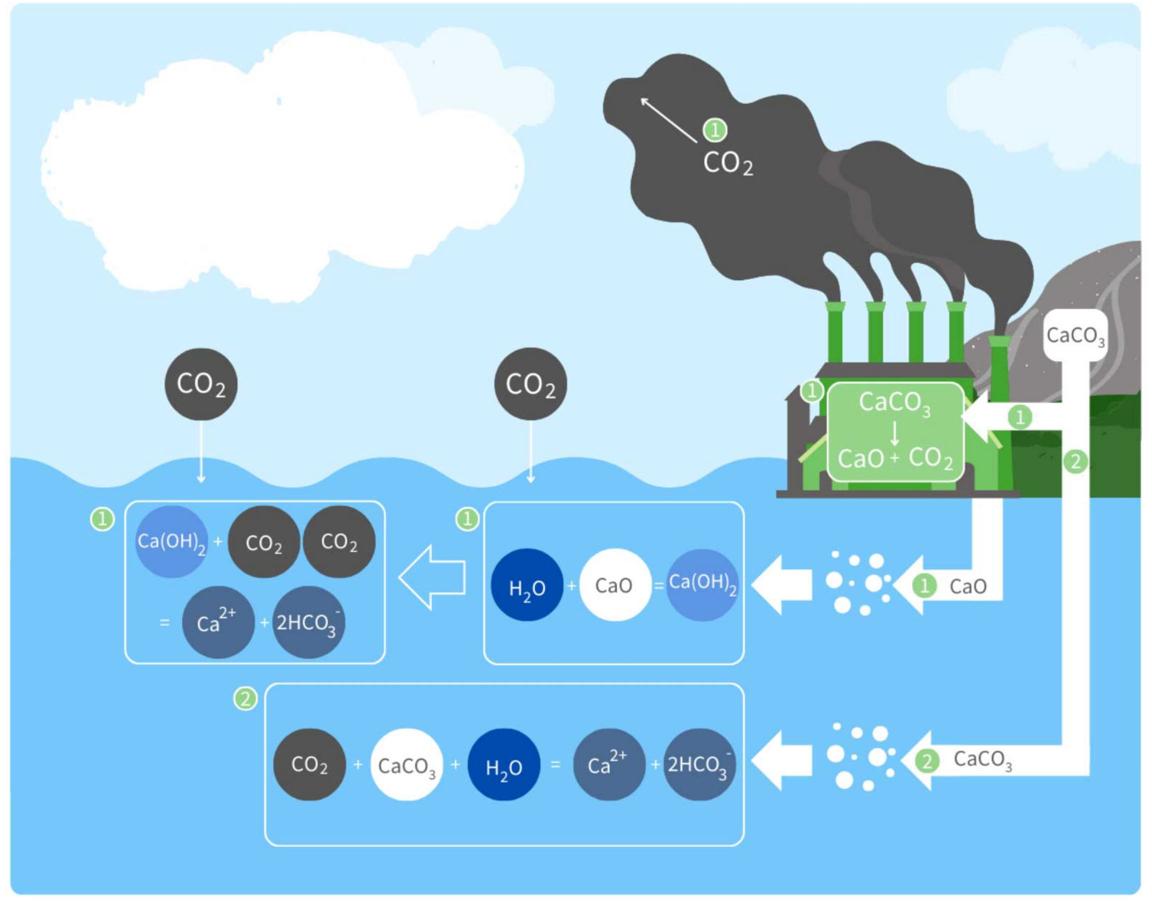

Figure 1.

1- Path where limestone is processed into lime, CO_2 is released into the atmosphere (unless sequestered and stored), lime is released into the ocean, creates calcium hydroxide when mixed with water, then reacts with CO_2 and dissociated into calcium ions and bicarbonate, increasing CO_2 uptake.

2- Path where limestone is directly released into the ocean where it reacts with water and CO_2 to dissociate into calcium ions and bicarbonate, increasing CO_2 uptake.

Methods

We use the UVic Earth System Climate Model to explore the potential of OAE interventions under representative concentration pathways (RCPs) 2.6, 4.5, 6.0, and 8.5. In total, we used the UVic ESCM for 16 separate experiments. In this study we use Version 2.9 of the UVic Earth System Climate Model (ESCM) comprising a two-dimensional atmospheric energy-moisture balance model [3] and a three-dimensional ocean general circulation model [2]. The model resolution is 3.6° (in the zonal direction) and 1.8° (in the meridional direction) and the ocean model has 19 vertical levels, with thickness varying from 50m near the surface to 500m in the deep ocean.

For each RCP, we undertake three OAE interventions under the assumptions;

1. *$CaCO_3$* - the global mean production of limestone (6.6 Gt/yr) was distributed uniformly over the entire ocean annually for 500 years. In doing so, it was assumed that all the calcium carbonate dissolved immediately once applied to the ocean surface thereby offering an upper bound estimate of OAE potential
2. *$CaO+CO_2$* - global annual mean limestone production was entirely converted to lime on land and this lime was then distributed uniformly over the entire ocean annually for 500 years. The CO_2 arising from the production of lime was added to the atmosphere.
3. *CaO* - we repeated the *$CaO+CO_2$* experiment but now assumed that all CO_2 produced in making lime was sequestered.

Global Average CO_2 Concentration (ppm)

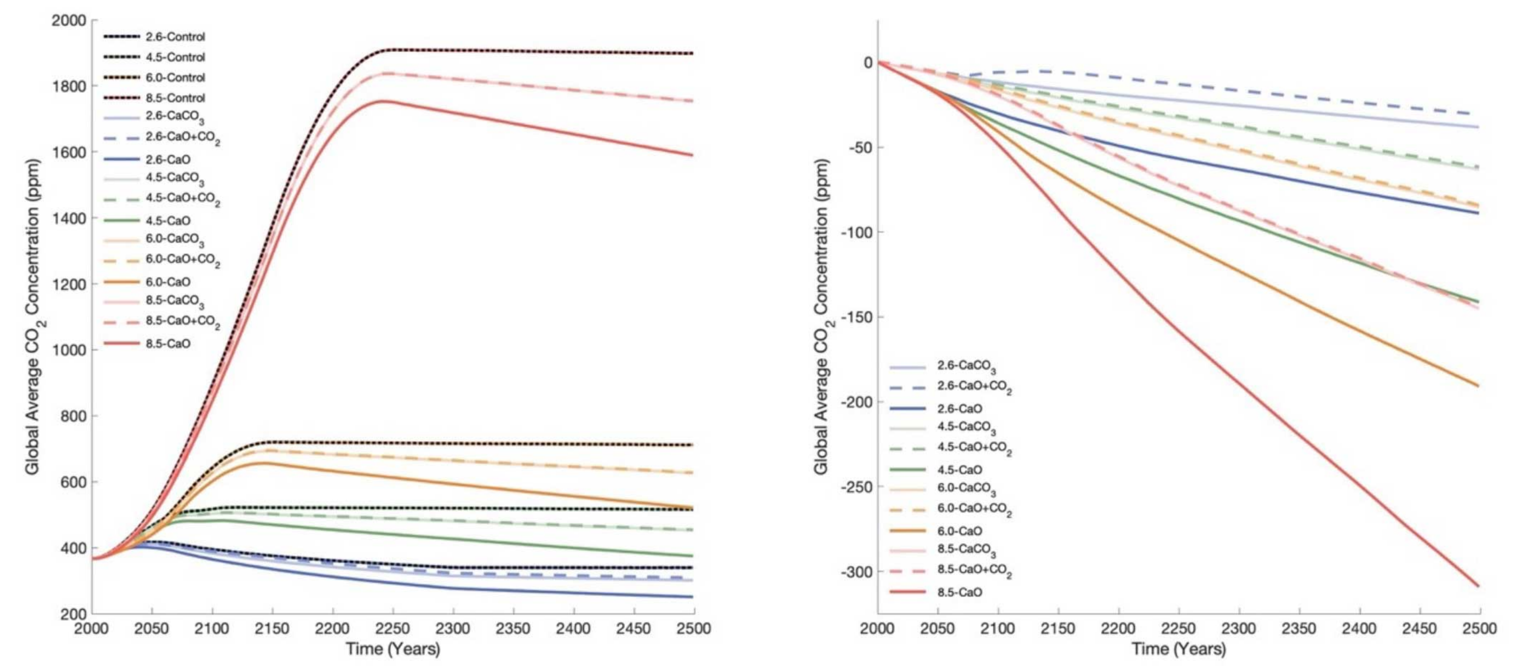

Figure 2 & 3. Left: Globally averaged atmospheric CO_2 concentrations (ppm) from year 2000 to year 2500 as simulated in the 16 simulations. Right: Simulated OAE experiments, shown as anomaly from each respective control simulation.

Global Average Surface Air Temperature (C)

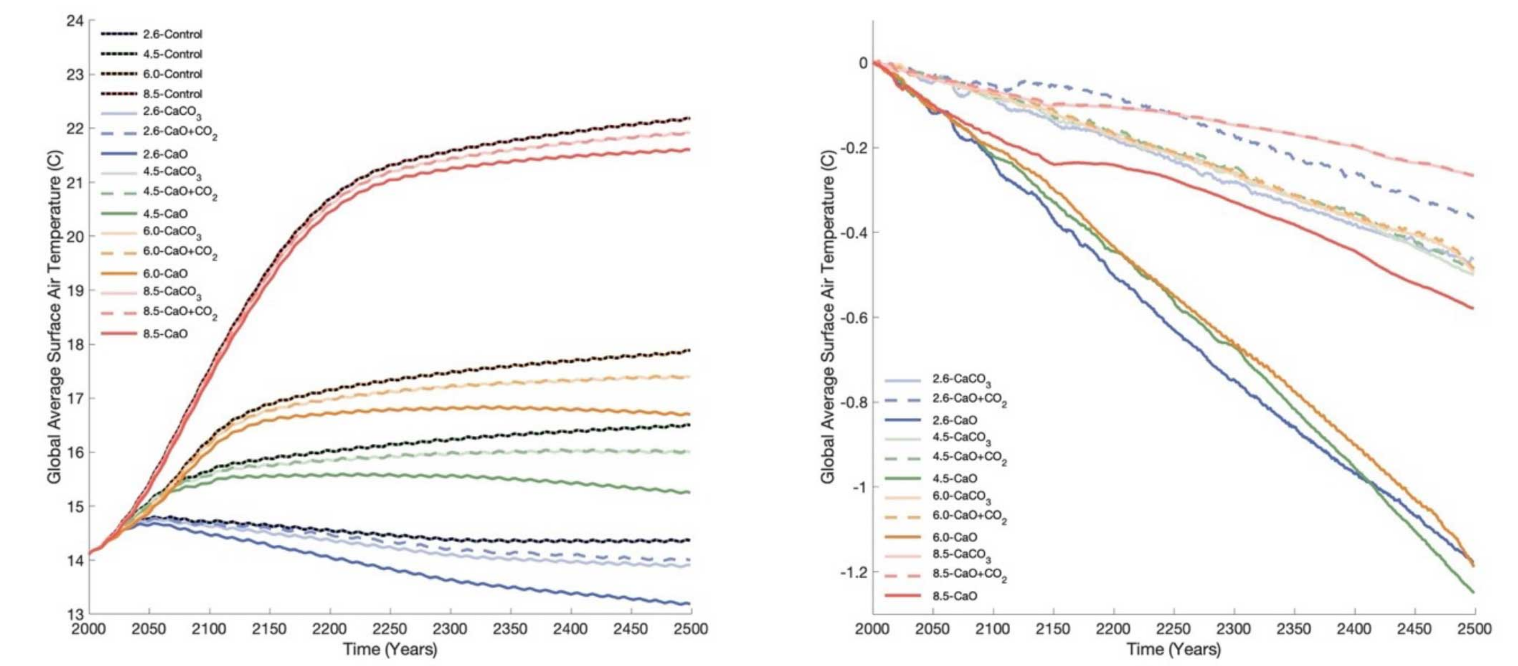

Figure 4 & 5. Left: Globally averaged surface air temperature (C) from year 2000 to year 2500 as simulated in the 16 simulations. Right: Simulated OAE experiments, shown as anomaly from each respective control simulation.

Global Average Sea Surface pH

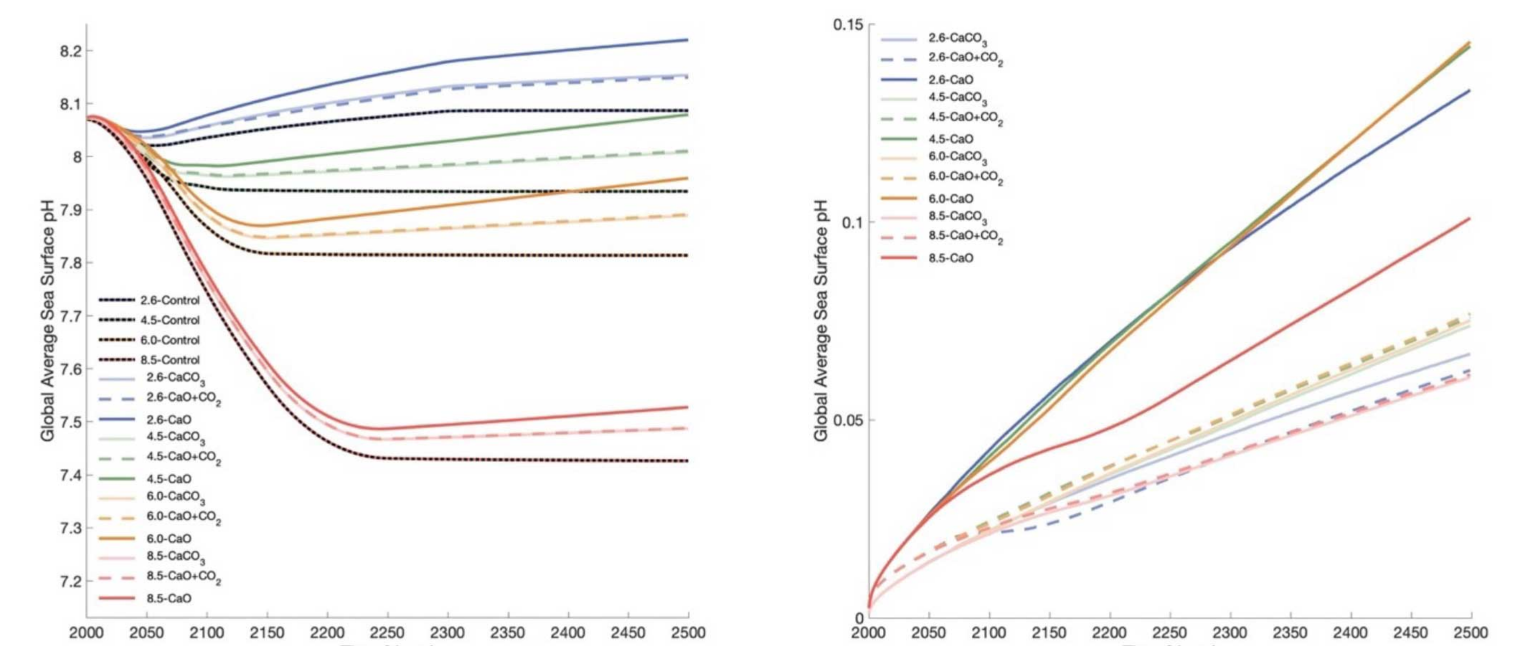

Figure 6 & 7. Left: Globally averaged sea surface pH from year 2000 to year 2500 as simulated in the 16 simulations. Right: Simulated OAE experiments, shown as anomaly from each respective control simulation.

Results

RCP 2.6								
Atmospheric CO_2 (ppm)			Surface air temperature (°C)			Sea surface pH		
$CaCO_3$	$CaO + CO_2$	CaO	$CaCO_3$	$CaO + CO_2$	CaO	$CaCO_3$	$CaO + CO_2$	CaO
-38	-31	-89	-046	-0.36	-1.2	0.066	0.062	0.13
RCP 4.5								
Atmospheric CO_2 (ppm)			Surface air temperature (°C)			Sea surface pH		
$CaCO_3$	$CaO + CO_2$	CaO	$CaCO_3$	$CaO + CO_2$	CaO	$CaCO_3$	$CaO + CO_2$	CaO
-63	-62	-141	-0.50	-0.49	-1.3	0.073	0.075	0.14
RCP 6.0								
Atmospheric CO_2 (ppm)			Surface air temperature (°C)			Sea surface pH		
$CaCO_3$	$CaO + CO_2$	CaO	$CaCO_3$	$CaO + CO_2$	CaO	$CaCO_3$	$CaO + CO_2$	CaO
-86	-84	-191	-0.49	-0.49	-1.2	0.075	0.076	0.15
RCP 8.5								
Atmospheric CO_2 (ppm)			Surface air temperature (°C)			Sea surface pH		
$CaCO_3$	$CaO + CO_2$	CaO	$CaCO_3$	$CaO + CO_2$	CaO	$CaCO_3$	$CaO + CO_2$	CaO
-145	-144	-309	-0.27	-0.26	-0.58	0.060	0.061	0.10

Table 1. Annually averaged global mean atmospheric CO_2, surface air temperature and sea surface pH changes from the RCP 2.6, 4.5, 6.0 and 8.5 control integrations at year 2500, 500 years after the mitigative interventions were initiated.

$CaCO_3$

The net effect after 500 years was the reduction of atmospheric CO_2 concentration by 38-145ppm (depending on the RCP) from the control simulation. Surface temperatures responded by being 0.27-0.49°C cooler, and the ocean surface pH became 0.06-0.075 higher, than the control simulation, depending on the RCP.

$CaO+CO_2$

After 500 years and relative to the respective RCP control runs, the *$CaO+CO_2$* experiments led to a reduction in atmospheric CO_2 of 31-144ppm (depending on the RCP), a reduction in surface air temperature between 0.26 and 0.49°C, and an increase of surface pH of 0.061-0.076.

CaO

After 500 years and relative to the respective RCP control runs the *CaO* OAE experiments led to a reduction in atmospheric CO_2 of 89-309ppm (depending on the RCP), a reduction in surface air temperature between 0.58 and 1.3°C, and an increase of surface pH of 0.10-0.15

Conclusions

Does OAE represent a viable CDR solution to global warming? Our analysis suggests that it does not. The overstated promise that this intervention poses a viable solution to global warming is a distraction from the reality that to stabilize the atmospheric level of CO_2 at any level, humanity needs to transition rapidly to zero-emitting energy systems. If the entire world production of limestone was somehow mined, transported, shipped and distributed throughout the ocean's surface waters without emitting any greenhouse gases for 500 years, and if all the $CaCO_3$ dissolved in the surface waters with none of it precipitating to greater depths, then only about a 0.5°C reduction in an otherwise 3-5°C warming above preindustrial levels would be realized. The 1.2-1.3°C reduction of warming while significant, would still be small relative to the overall 3-5°C warming above preindustrial levels that would be otherwise realized. That's not to say that these interventions aren't part of a collection of solutions, but tinkering with the natural carbon cycle alone will not keep warming to below 2°C above preindustrial levels. In fact, we argue that investments in these areas would be better utilized towards decarbonizing energy systems which are the cause of global warming.

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The Potential of Ocean Thermal Energy Conversion and Carbon Sequestration

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Earth & Ocean Sciences

What is Ocean Thermal Energy Conversion?

Ocean Thermal Energy Conversion (OTEC) is a form of marine renewable energy that harnesses the solar energy stored in the vertical water column. The thermal gradient between warm surface water (around 25m depth) and deep cold water (around 1000m depth) drives a heat engine. Mixed discharge is released and settles to a depth of neutral buoyancy. OTEC power can be coupled with direct air capture and marine carbon sequestration to create a non-emitting form of negative emissions.

OTEC requires a minimum thermal gradient of about 18°C to be considered effective. Consequently, the most efficient locations for its implementation are in equatorial waters, where the thermal gradient is the largest.

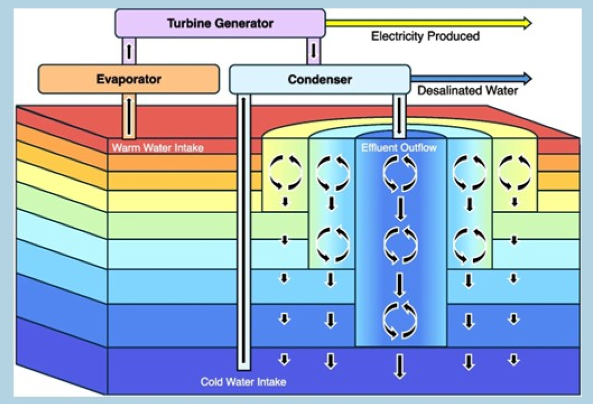

Figure 1: Diagram of OTEC power generation process[2]

Figure 1

Motivation

The Intergovernmental Panel on Climate Change has identified the need for negative emission technologies to limit the increase in global mean surface air temperature to 2°C above pre-industrial levels[1]. A promising avenue to power these technologies is OTEC, a non-polluting and safe form of electricity generation uninhibited by season or time of day.

Previous research has projected the global maximum power produceable by OTEC technology to be approximately 10TW and proposes it be used to replace fossil fuels power production[2] (Scenario OTEC10). However, this magnitude of OTEC implementation would likely cause major environmental effects.

Figure 2 – Atmospheric CO_2 Concentration

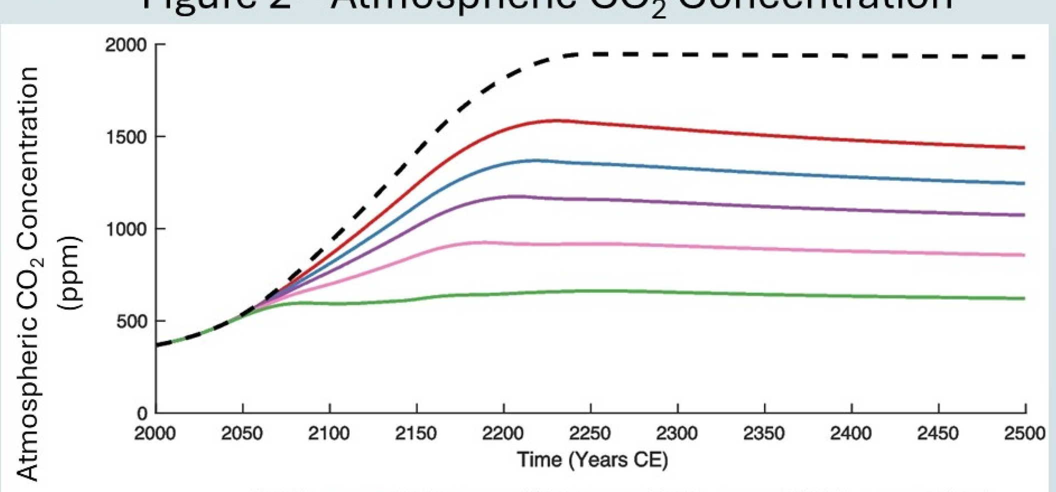

Figure 2: Globally averaged atmospheric CO_2 concentration in ppm. The black dashed, red, blue, violet, pink, and green solid lines denote OTEC power production of 0TW, 3TW, 5TW, 7TW, 10TW, and 15TW, respectively[2].

Figure 3 – CO_2 Sequestration Sites

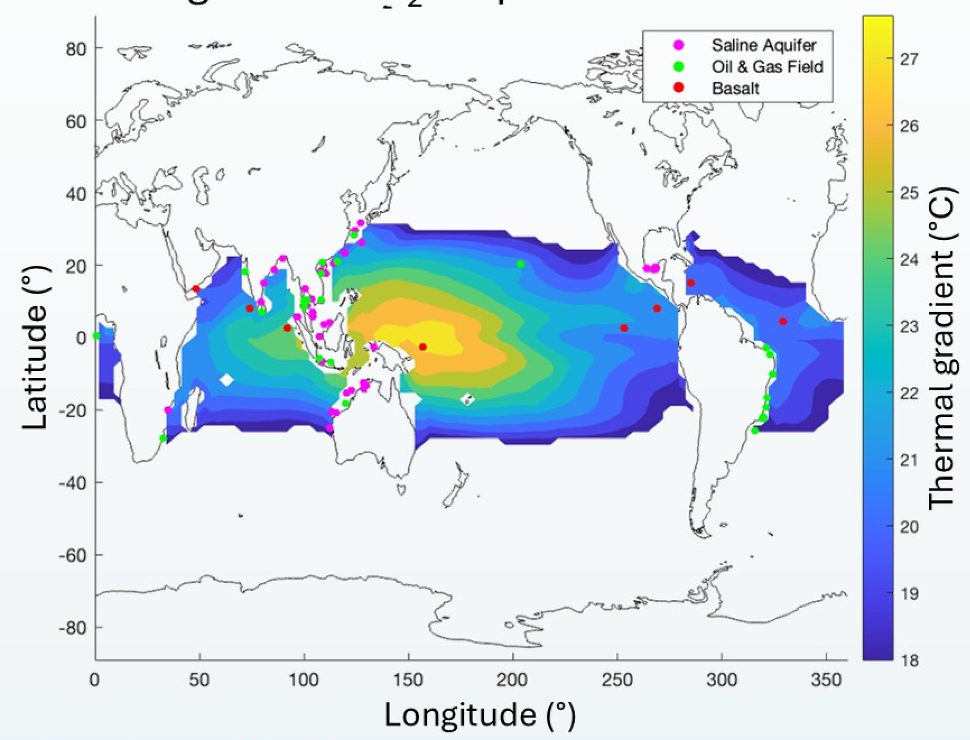

Figure 3: Potential CO_2 sequestration site locations and top 1000m ocean thermal gradient in 2030 under RCP8.5.

Figure 4 – Surface Air Temperature Reduction

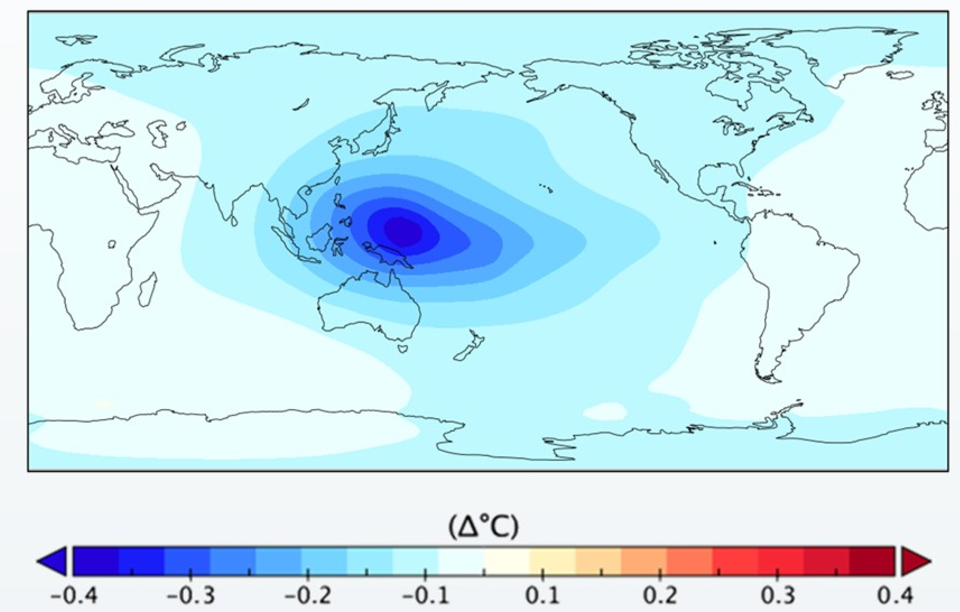

Figure 4: Difference in surface air temperature in OTEC1 from control run without OTEC implementation in 2100 under RCP8.5.

Methodology

The UVic Earth System Climate Model version 2.9 was used to deploy OTEC plants to produce 1TW of power. (Scenario OTEC1) Plants were deployed in proximity to ocean basins capable of sequestering CO_2 and that lie within the region of adequate thermal gradient (Figure 3). These basins include, depleted oil and gas reservoirs, saline aquifers, and basalt formations.

OTEC power generation was initiated in 2030, peaking at 1TW in 2100 and then held constant until 2500 under three Concentration Pathways (RCP): RCP4.5, RCP6.0, and RCP8.5[3]. Initially, the OTEC scenario was run without applying atmospheric CO_2 reductions in an effort to investigate the environmental effects.

Results

The projected environmental effects of the OTEC1 scenario under all RCPs show similar results to those of OTEC10. However, surface air temperature reduction, ocean surface cooling, and deep ocean warming are all projected to occur in decreased magnitude in the OTEC1 scenario.

1. Atmospheric cooling

   OTEC cools the ocean surface resulting in heat passing from the atmosphere to the ocean. This flux acts to reduce surface air temperature, with peak reduction occurring over regions of OTEC implementation (Figure 4).

2. Ocean Surface Cooling:

   Localized ocean surface cooling is observed in regions of OTEC implementation (Figure 5). Cooling occurs due to OTEC induced artificial upwelling of deep cold water. Under the OTEC10 scenario, OTEC could cause surface warming at high latitudes over long time scales[4]. Significant ocean surface warming not been projected in the OTEC1 scenario.

3. Deep Ocean Warming:

   Global ocean warming at the depth of OTEC cold water intake results from artificial downing of warm surface water While surface air temperature reduction and ocean surface cooling have been considered by some as positive side effects of OTEC implementation, deep ocean warming is a concern. This consequence is significantly reduced in the OTEC1 scenario (Figure 6)

Figure 5 – Ocean Surface Cooling

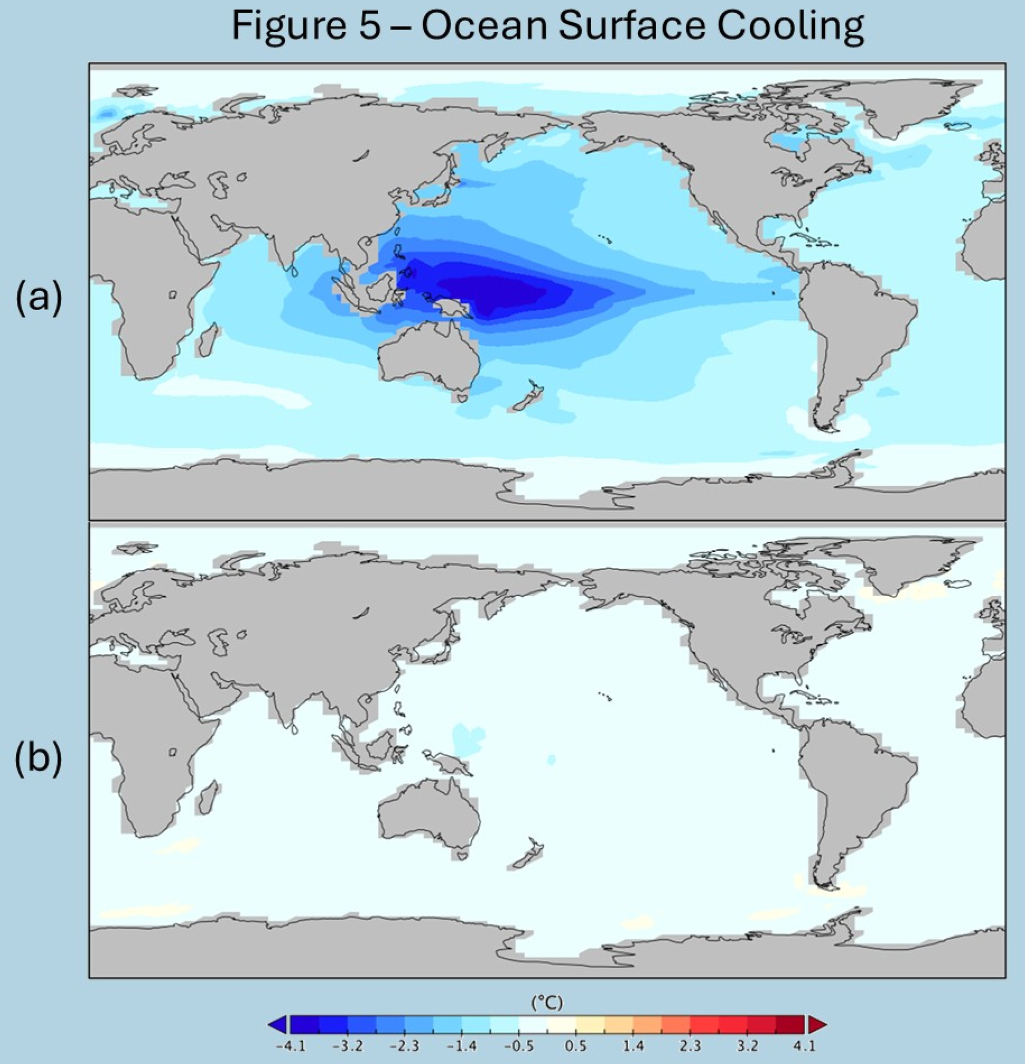

Figure 5:Difference in ocean surface temperature from control run without OTEC implementation for (a) OTEC10 and (b) OTEC1 in 2100 under RCP8.5.

Figure 6 – Deep Ocean Warming

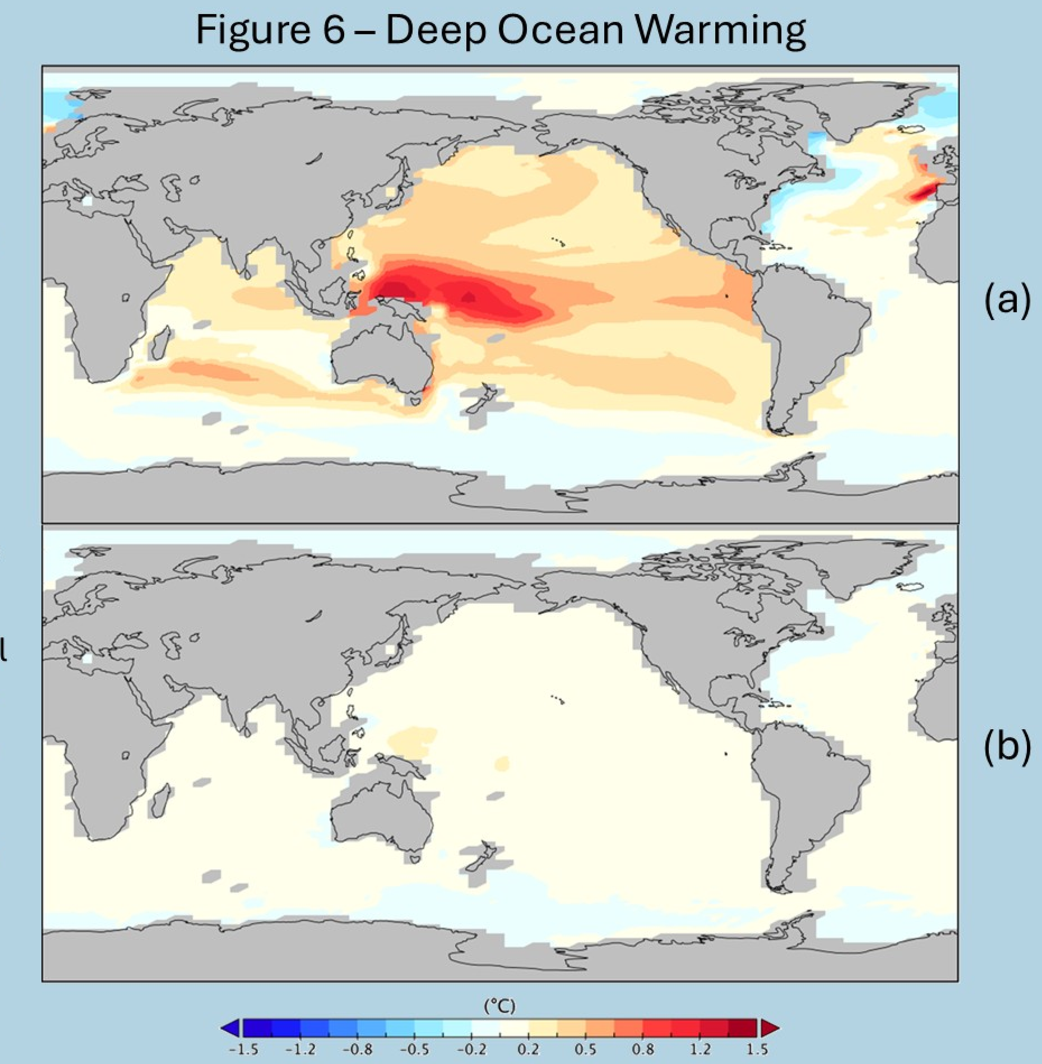

Figure 6: Difference in ocean temperature at level of OTEC cold water intake from control run without OTEC implementation for (a) OTEC10 and (b) OTEC1 in 2100 under RCP8.5.

Conclusions

With potential environmental effects of OTEC reduced under the OTEC1 scenario, it shows a promising and less disruptive pathway for OTEC implementation. The resulting reduced deep ocean warming and ocean surface warming at high latitudes is particularly significant if OTEC is to be considered for large scale deployment.

Future research will include projecting the atmospheric CO_2 concentration reduction that results from using OTEC power to support direct air capture and marine carbon sequestration. Additionally, the environmental effects of the CO_2 concentration reduction will be investigated.

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Enhancing WETMETH for Peatland Simulation in UVic ESCM

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Abstract

Peatlands store approximately 30% of the world's soil carbon and play a dual role as both carbon sinks and methane sources in the global climate system. However, current Earth system models lack detailed representation of peatland-specific processes in their wetland modules, particularly the unique characteristics of peat soils and their associated biogeochemical cycles. Here we enhance the WETMETH module in UVic ESCM through two main developments: (i) integration of high-resolution peatland distribution datasets and (ii) updating of the soil module to better account for thermal and hydraulic properties specific to peat soils. Building upon UVic ESCM's existing multi-layer soil model with representations of permafrost carbon and soil anoxia-methane processes, the enhanced model will be used to assess climate change impacts on Canada's peatlands and evaluate potential restoration strategies through modifications of soil drainage parameters.

Introduction

Peatlands store approximately 30% of the world's soil carbon despite covering only 3% of the global land surface, making them one of the most effective long-term carbon reservoirs (Chaudhary, 2021). The dual role of peatlands as both carbon sinks and methane sources presents a complex component in the global climate system (Frolking et al., 2011). Current Earth System Models (ESMs) lack detailed representation of peatland-specific processes, particularly the unique characteristics of peat soils and their associated biogeochemical cycles.

Northern peatlands are particularly vulnerable to climate change, with temperatures projected to increase by 2-8° C by 2100 in these regions (DeBeer et al., 2016). This warming, combined with shifting precipitation patterns and permafrost thaw, threatens to release an estimated 120±85 PgC globally by 2100 (Turetsky et al., 2020). In Canada, peatlands store approximately 147 PgC (Tarnocai, 2009), making their management critical for national carbon budgets and climate mitigation strategies.

Background: Peatland

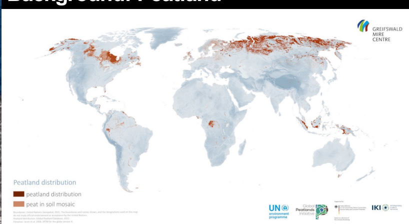

Figure 1: Global peat-dominated area estimated using a bottom-up methodology, as reported by UNEP (2022)

Methods Summary

1) **Peatland Distribution Processing**
   - Process high-resolution global peatland datasets
   - Resample peatland distribution to model grid resolution (3.6° × 1.8°)
   - Convert continuous coverage data to binary (1,0) presence/absence format
   - Develop algorithms to distinguish between peatland and non-peatland wetlands
2) **Enhance model with peatland-specific components**
   - Update soil module to reflect thermal properties of peat soils
   - Modify hydraulic parameters to better represent peatland hydrology
   - Integrate high-resolution peatland distribution data
   - Run model to equilibrium after implementation

Methods: Peatland Distribution

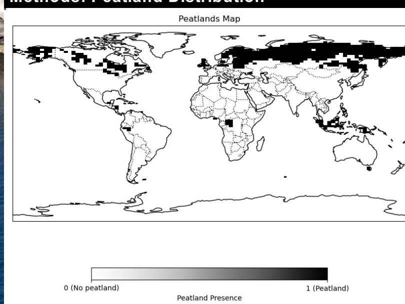

Figure 2: Global peatland distribution (binary) from UNEP Global Peatland Map 2.0 (2022), using a 5% coverage threshold.

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Methods: UVic ESCM

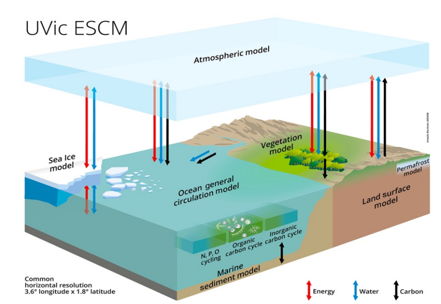

Figure 3: Schematic of UVic ESCM, an intermediate complexity climate model with a simplified atmosphere and full three dimensional ocean GCM. The model has a full representation of the global carbon cycle.

Results: PeatEF Parameter vs. Peatland Carbon

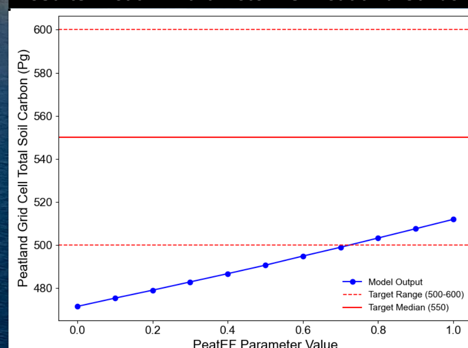

Figure 4: Sensitivity of modeled peatland soil carbon (Pg) to the PeatEF parameter.

The red target line (500-600 Pg C) represents the estimated global peatland carbon stock, as reported in the IPCC Sixth Assessment Report (AR6, WGIII, Chapter 7 & AR6, WGII, Chapter 2). The solid red line marks the median of this range (550 Pg C).To assess model performance against observational estimates, we varied the PeatEF parameter—which reduces soil respiration in peatland grid cells—and ran the model for 5000 years to allow carbon pools to stabilize. Model output shows a gradual increase in peatland soil carbon with higher PeatEF values, but further tuning or extended simulation time may be needed to fully reach the target.

Results: FCH4_Peat Parameter vs. Wetland CH4

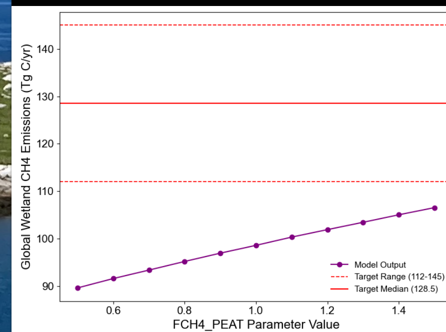

Figure 5: Effect of the FCH_4_PEAT parameter on modeled wetland CH_4 emissions (Tg C yr^{-1}).

The red dashed lines (112–145 Tg C/yr) show the estimated global wetland methane emission range (Saunois et al., 2020), with the solid red line indicating the median (128.5 Tg C/yr). Varying the FCH4_PEAT parameter, which scales CH_4 emissions in peatland grid cells, produces a near-linear response. Current model outputs fall below the observational range, suggesting further tuning is needed.

Next Steps:

1) **Refine parameter settings to improve model fit** against observed CH_4 emissions, particularly within the global wetland methane emission range
2) **Run historical and future climate scenarios** using the enhanced peatland-enabled UVic ESCM to establish baseline CH_4 and CO_2 fluxes globally, with a focus on Canadian peatlands
3) **Implement drainage and rewetting scenarios** to simulate restoration interventions and hydrological changes
4) **Analyze carbon balance trade-offs** between methane emissions and carbon dioxide uptake under different climate and management pathways
5) **Identify high-priority regions** for peatland conservation and expansion based on model sensitivity and mitigation potential
6) **Develop science-based recommendations** for peatland management strategies to support national and international climate targets

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Analysis of Gap Winds in Bute Inlet, British Columbia, Using ERA5 Reanalysis and WRF Modeling

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Introduction

- Along the northern Pacific coast of North America, the coastal mountain ranges act as a barrier between cold continental arctic air and warmer maritime air, creating ideal conditions for gap winds (Jackson, 1996).
- Bakri et al. (2017) noted that the movement of a cold arctic air mass, along with its associated anticyclone, shifts southward from Alaska toward BC. When paired with low surface pressure over the northeastern Pacific, this generates a strong pressure gradient directed toward the ocean, triggering wintertime outflow winds.
- With over 50 inlets along the British Columbia (BC) coast, several act as natural channels for outflow winds which flow from the interior toward the coast.
- This study investigates four arctic outflow wind events in Bute Inlet, BC, during February 2019 using weather station observations, the ERA5 reanalysis dataset, and the Weather Research and Forecasting (WRF) model.

Methodology

- The WRF model was employed to conduct numerical simulations for the distinct case. The objective of utilizing the WRF model was to better resolve the flow in Bute Inlet in both space and time compared to the results obtained from the ERA5 reanalysis.
- For the initial and boundary conditions, the 6-hour interval analysis fields from the GFS 0.25° model were used, and the simulation was conducted for three domains at resolutions of 9, 3, and 1 km.
- The physical parameterizations used in the WRF model are outlined in Table 1.

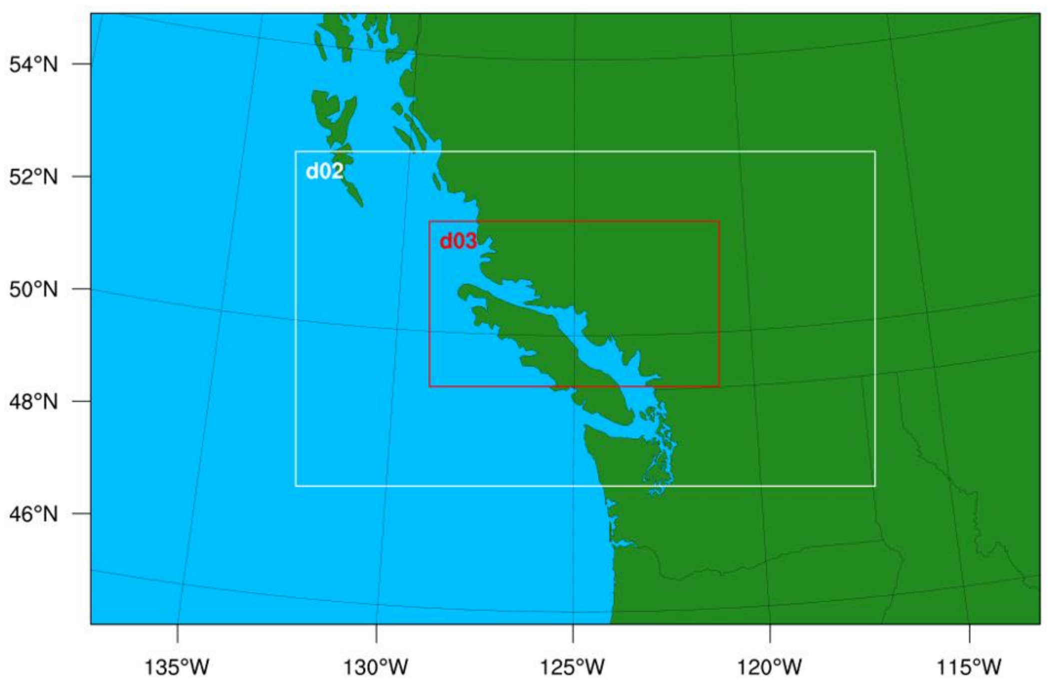


Figure 1. WPS model Configuration

Figure 2. Location of Homathko Station

Table 1. Physics configuration used to run the WRF model

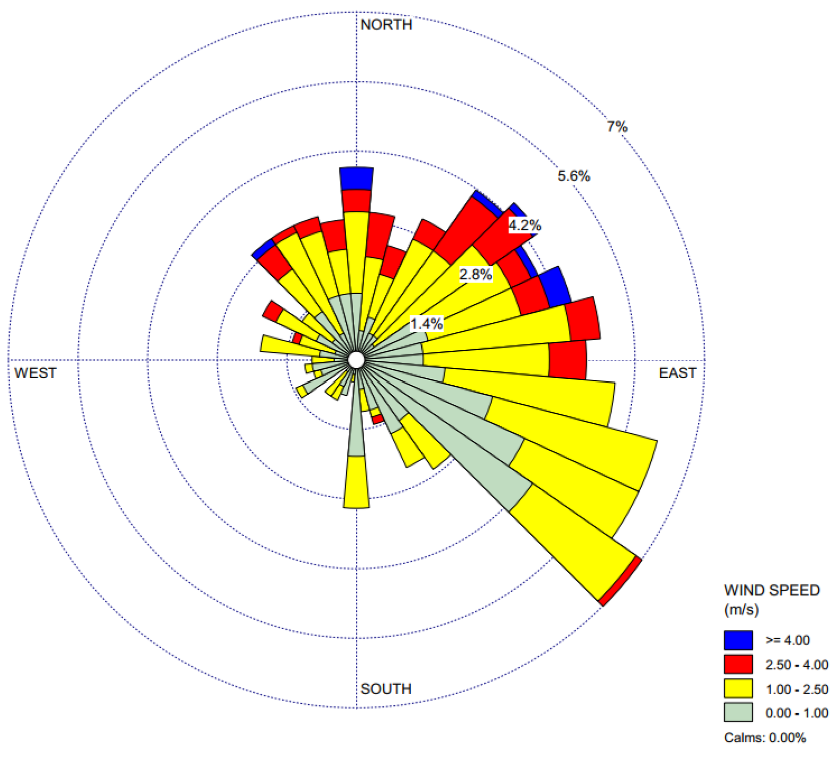
Physics	Microphysics	Cumulus	Longwave/Shortwave Radiation	PBL[1]	Surface Layer[2]	LSM[3]
Scheme	Thompson	Tiedtke	RRTMG	MYJ	Eta Similarity	Noah

[1]Planetary Boundary Layer [2]Mellor-Yamada-Janjic [3]Land Surface Model

Results

Figure 3. Wind rose for Homathko Station, February 2019

- The direction of high-speed winds aligns with outflow events resulting from the pressure gradient between high pressure over inland areas and low pressure over the Pacific Ocean (Fig. 3).



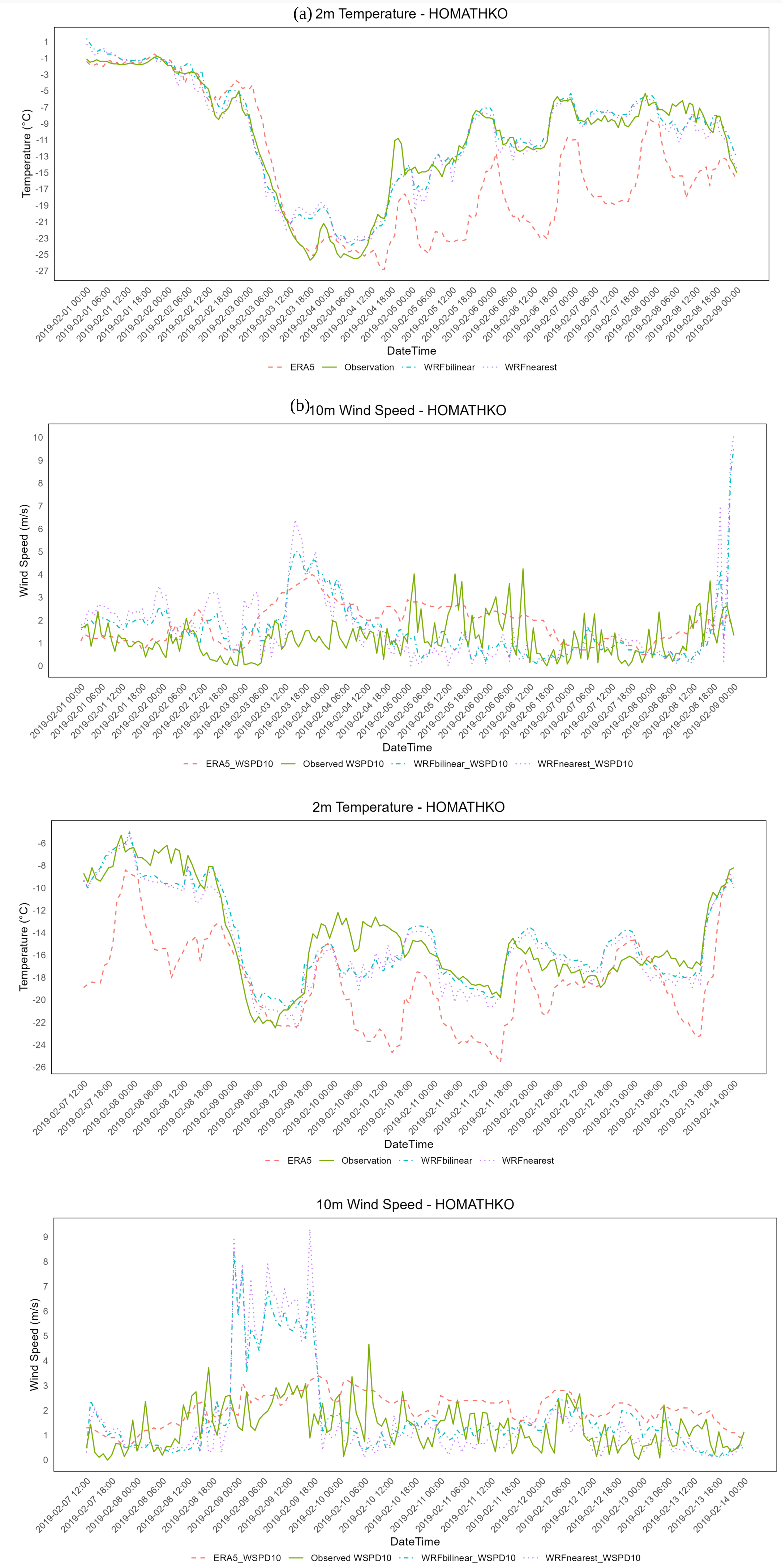


Figure 4. Time Series of 2 m Temperature, and 10 m Wind Speed at Homathko Station.

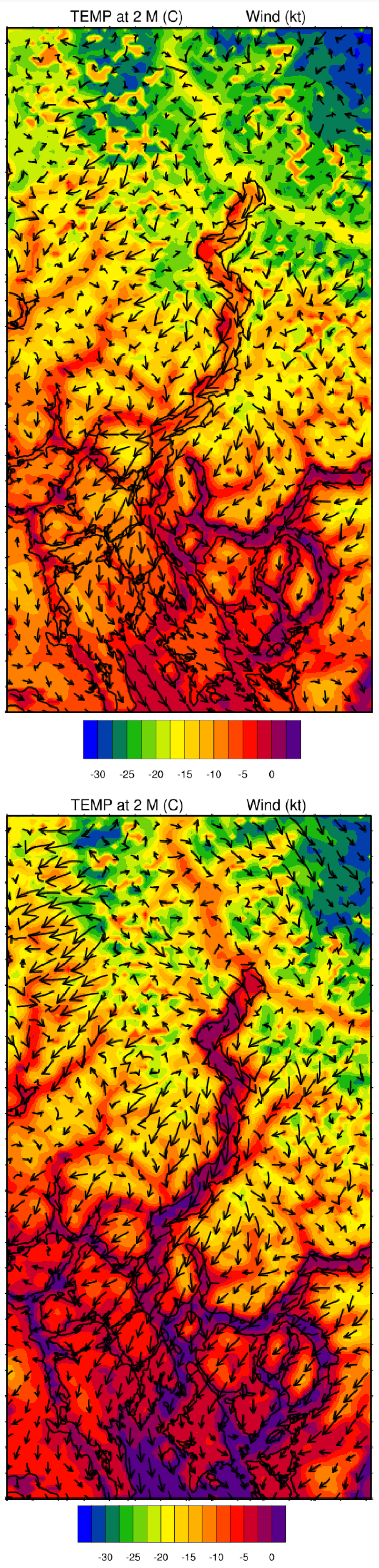


Figure 5. 2 m Temperature and 10 m Wind Speed from WRF output at 10:00 UTC on February 4 (top), and February 9 (bottom), 2019.

- A sharp temperature drop below -20°C was observed on February 3–4 and 8-9, indicating the possible intrusion of an Arctic front (Fig. 4).
- Bilinear interpolation and the closest grid value method yield insignificant differences in WRF data.
- The WRF model more accurately tracks changes in observational data compared to ERA5.
- The WRF model effectively simulates channelized wind behavior and the potential for outflow events (Fig. 5).

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Estimating Biogeochemical Transports through Arctic Ocean Gateways with High Resolution Modelling

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1 Introduction

- Shifting physical baselines in the Arctic Ocean and northern latitude oceans are already driving changes in the biogeochemical cycling of nutrients and carbon [1].
- Resolving nutrient inputs at Arctic gateways over a full annual cycle, and quantifying interannual variability is important for understanding how primary productivity may change in the Arctic Ocean [1].
- High resolution ocean models, such as NEMO, can be used to estimate these processes on long timescales (i.e. decades) at the main Arctic gateway straits (*Fig 1*).

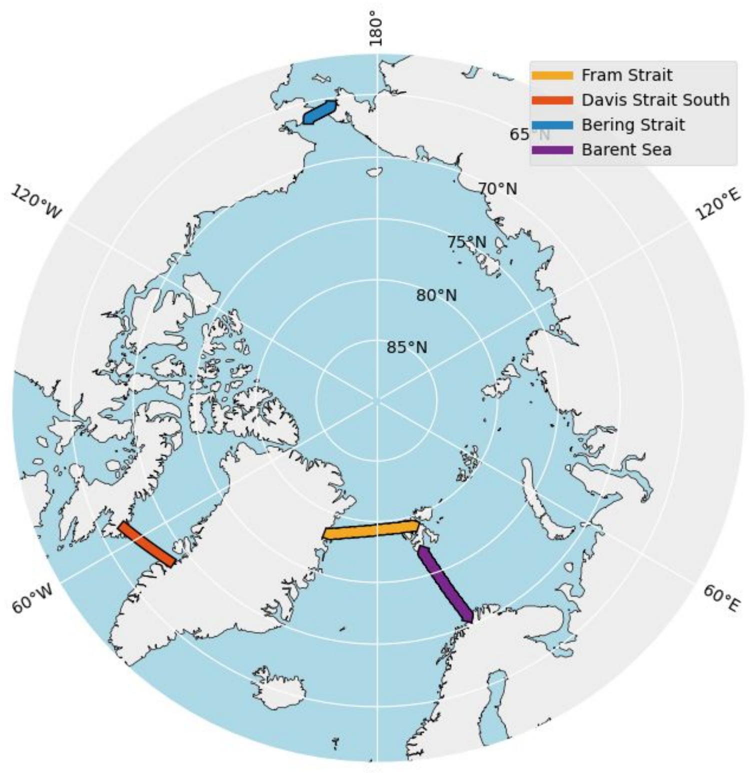


Figure 1. *Location of four Arctic gateway straits.*

2 Models

- We used two NEMO (*Nucleus for European Modelling of the Oceans*) simulations coupled with BLINGv0+DIC:
  - BLING (*Biogeochemistry with Light, Iron, Nutrients and Gas*) is a phosphate-limited biogeochemical module of steady-state phytoplankton dynamics which empirically calculates community production and simulates the biogeochemical cycles of carbon, oxygen, phosphate and iron [2].

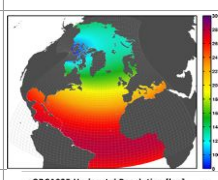
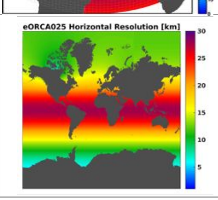
CONFIGURATION	Time	Sea Ice Model	Initial Condition	Atmospheric Forcing	Notes	Domain
ANHA4	2002-2022	LIM2	GLORYS2v3	CGRF	Tides, *BLING*, Icebergs, 7 tracers	
eORCA025	2005-2016	LIM3	GLORYS2v4	ERA5	Tides, *BLING*, Icebergs	

Table 1. *NEMO configurations used.*

3 Hydrochemical Data

- We use the following variables from NEMO output (*Fig. 2*) (they have a time dimension, depth, latitude and longitude):
  - Phosphate (PO_4) in mol m-3,
  - Dissolved iron (Fe) in mol m-3,
  - Dissolved oxygen (O_2) in mol m-3,
  - Chlorophyll *a* in *ug* m-3.
- Modelled phosphate values follow typical distributions: 1) low concentrations in upper sunlit layers, and 2) increasing concentrations with depth due to remineralization and/or dissolution of sinking particles [3] (*Fig. 3*).

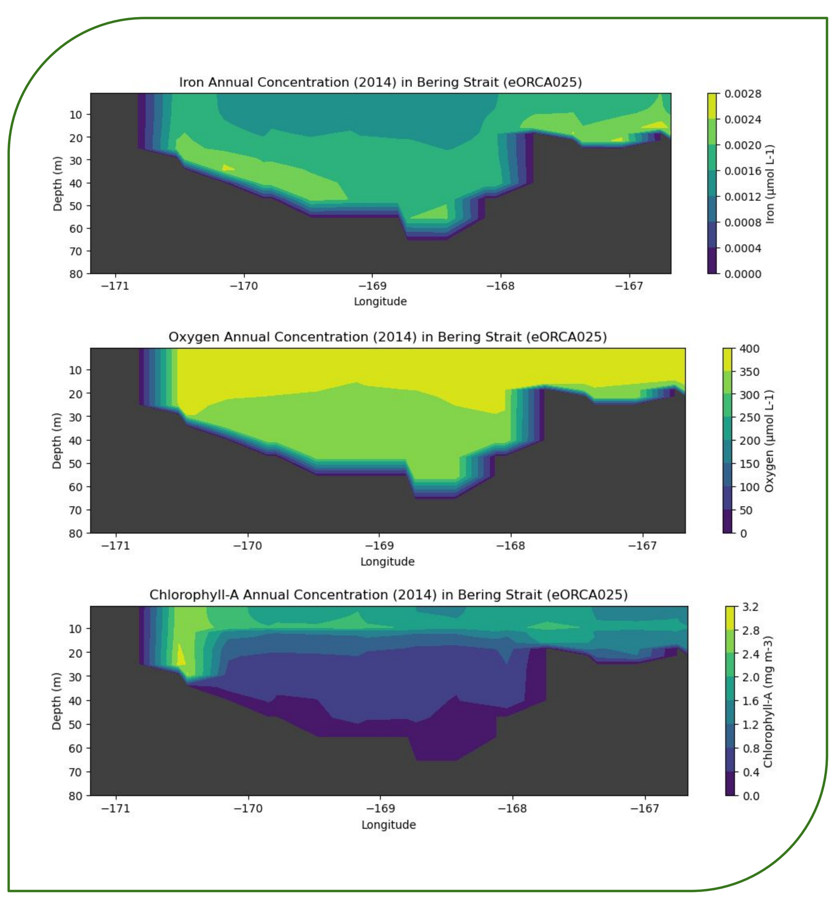


Figure 2. *2014 averages of biogeochemical fields as cross-sections across the Bering Strait.*

Phosphate Distributions

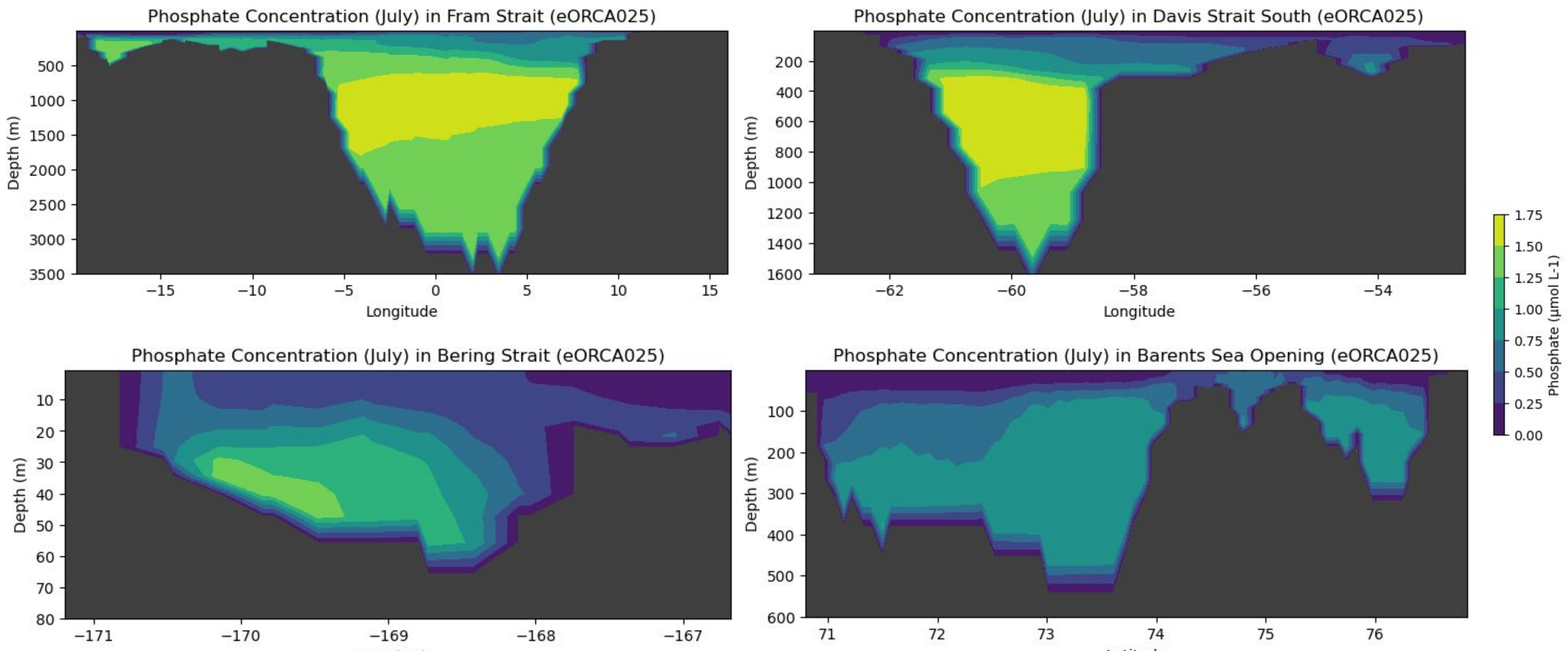


Figure 3. *Phosphate distributions across four gateway straits from the global eORCA025 NEMO run (July 2004).*

4 Volume Transports

- Transport of water across various Arctic gateway sections has been measured for decades [4]. The observed measurements are:
  - Bering Strait: **1.0 ± 0.1 Sv** from 2000-2015 [5]
  - Fram Strait: **-2.2 ± 2.1 Sv** from 1998-2011 [6]
  - Davis Strait South: **-1.8 ± 0.3 Sv** from 2005-2009 [7].
  - BSO: **2.1 ± 0.4 Sv** from 1998-2016 [4]
- *Fig. 4* shows the volume transports calculated from each NEMO configuration described in Table 1 for each gateway strait.

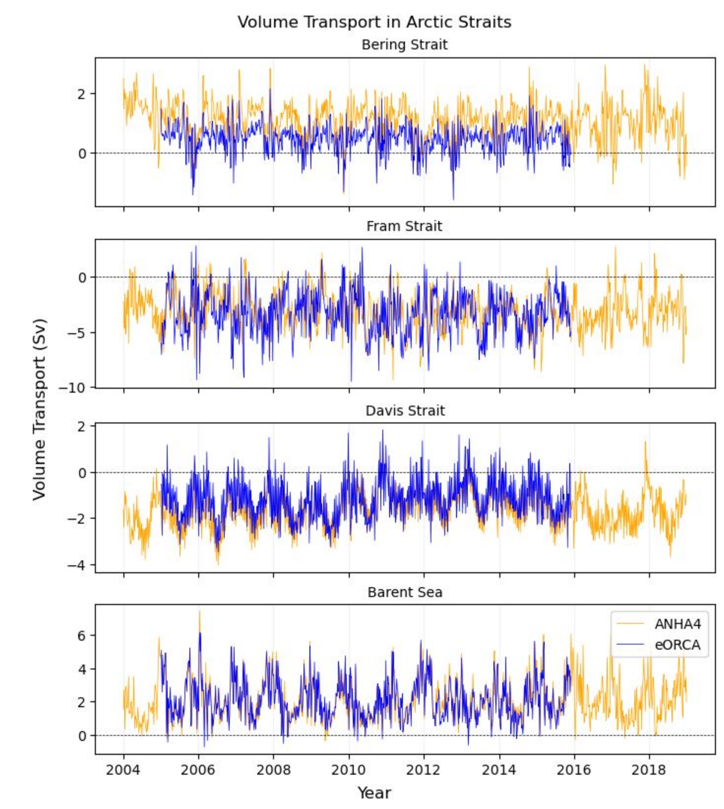


Figure 4. *Total volume transports in the main Arctic gateways; Bering Strait, Fram Strait, Davis Strait, and Barents Sea Opening, for regional NEMO run (yellow) and global NEMO run (blue).*

5 Biogeochemical Transports

- *Fig. 5* presents total phosphate transports for each model configuration, while *Table 2* presents total averaged biogeochemical transports for each strait and model configuration. Inflow of phosphate through Fram Strait reduces after 2014 in both simulations.

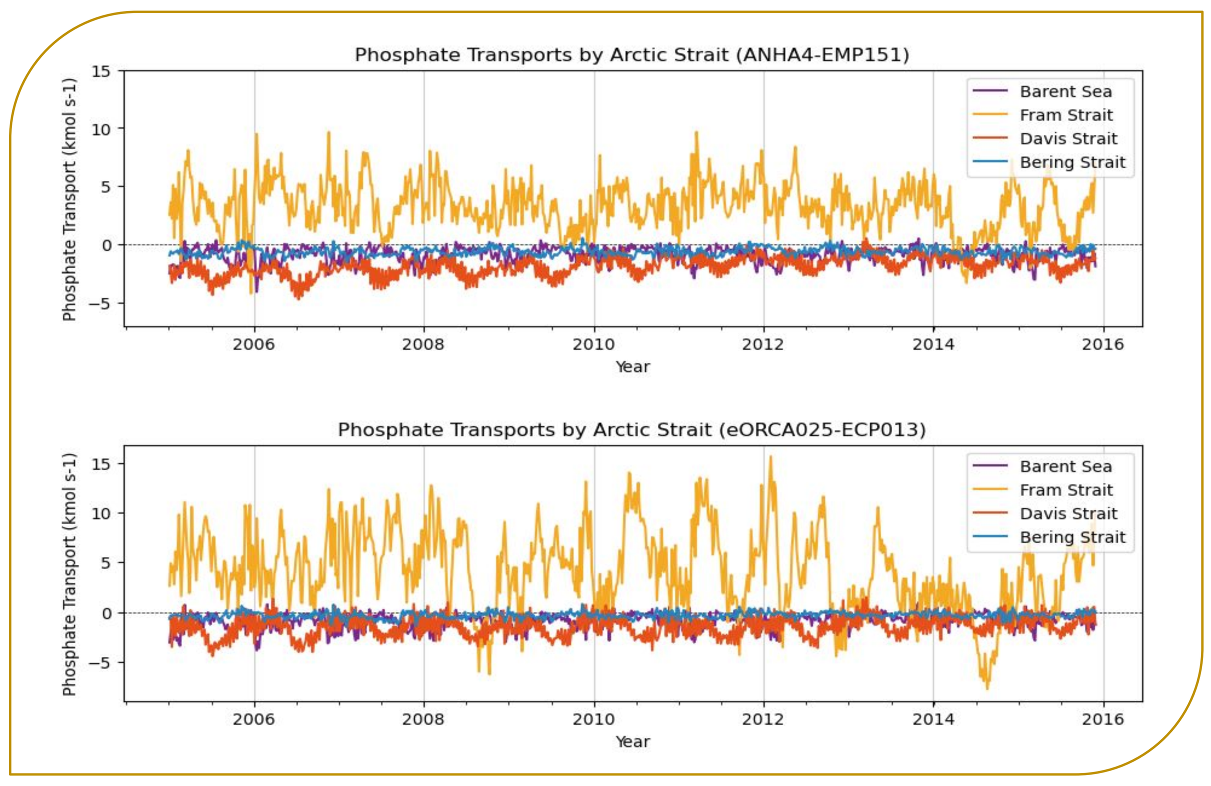


Figure 5. *Phosphate transports calculated for ANHA4 run (top panel) and eORCA025 run (bottom panel), over the full model timeframe, with the four main Arctic gateway straits in the same colours as the map.*

	Davis Strait		*Fram Strait*		*Barents Sea*		*Bering Strait*		*Total*	
	ANHA4	*eORCA*	*ANHA4*	*eORCA*	*ANHA4*	*eORCA*	*ANHA4*	*eORCA*	*ANHA4*	*eORCA*
Phosphate	-1.834	-1.441	3.306	4.203	-0.889	-0.921	-0.619	-0.326	-0.036	1.515
Oxygen	-554.555	-381.493	1034.562	950.725	-578.159	-534.869	-362.047	-169.112	-461.99	-134.749
Iron	-0.001	-0.0006	0.016	0.002	-0.001	-0.001	-0.002	-0.0008	0.012	-0.0004
Chl-a	-199.321	-278.034	10.825	111.816	-537.672	-595.422	-1649.295	-444.266	-2375.463	-1205.906

Table 2. *Average of biogeochemical transports in kmol s^{-1} for each gateway strait, and for regional (2002-2022) and global (2005-2016) configurations, calculated over the entire model run time.*

6 Seasonality

- Fram Strait, Davis Strait and Bering Strait have outflow of phosphate in the summer months and inflow of phosphate in the winter months. Barents Sea Opening shows inflow of phosphate during the winter and summer, with large outflows in the spring and early winter (*Fig. 6*).

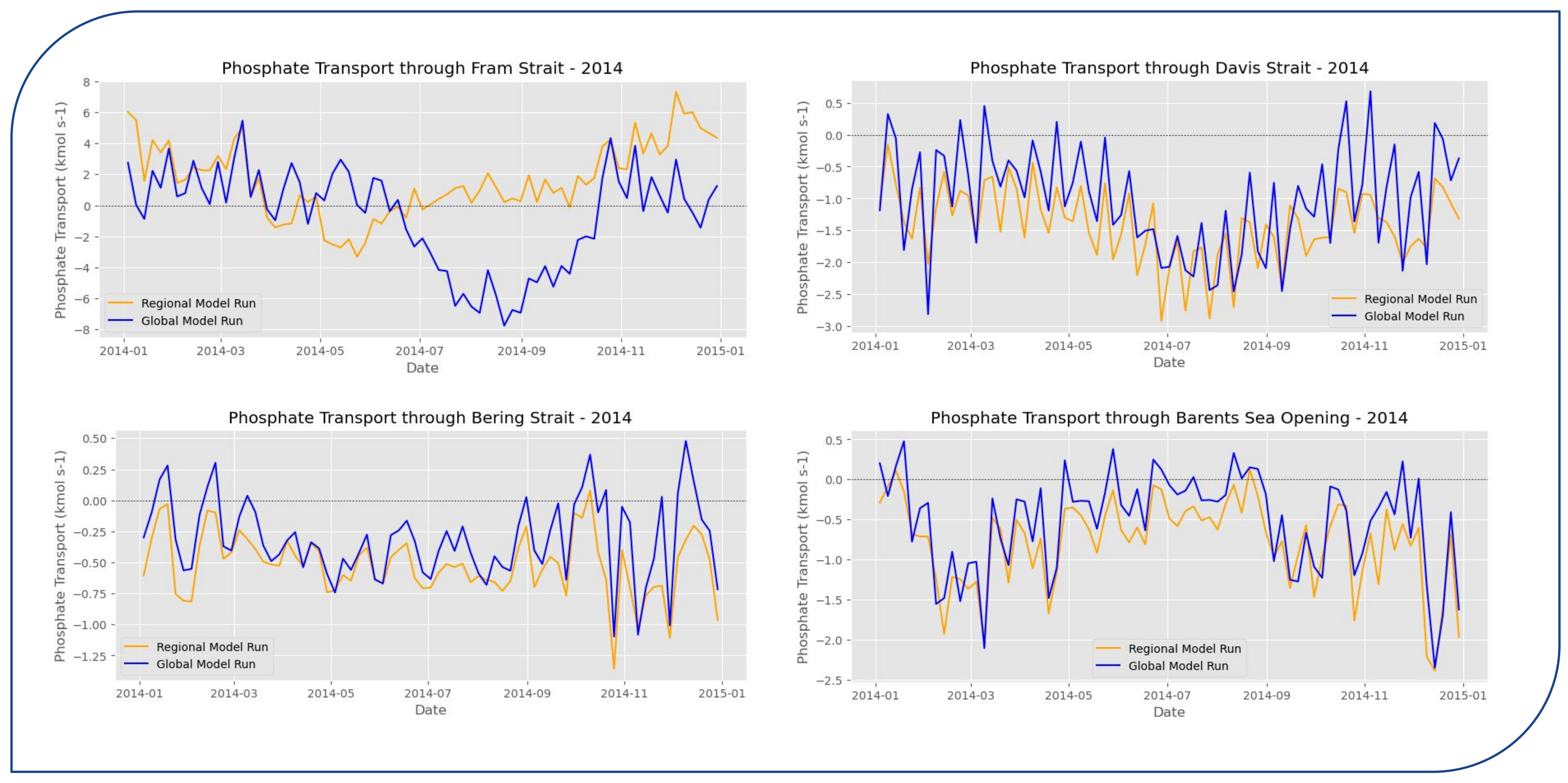


Figure 6. *Phosphate transports through Bering Strait, Davis Strait, Fram Strait, and Barents Sea Opening for 2014, showing the regional ANHA4 model (orange) and the global eORCA025 model (blue).*

- These preliminary results indicate there is variability in the transports throughout the year, and on long-term time frame, providing incentives for further research. We aim to understand the temporal and spatial variability, as well as the underlying causes of these changing transports.

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