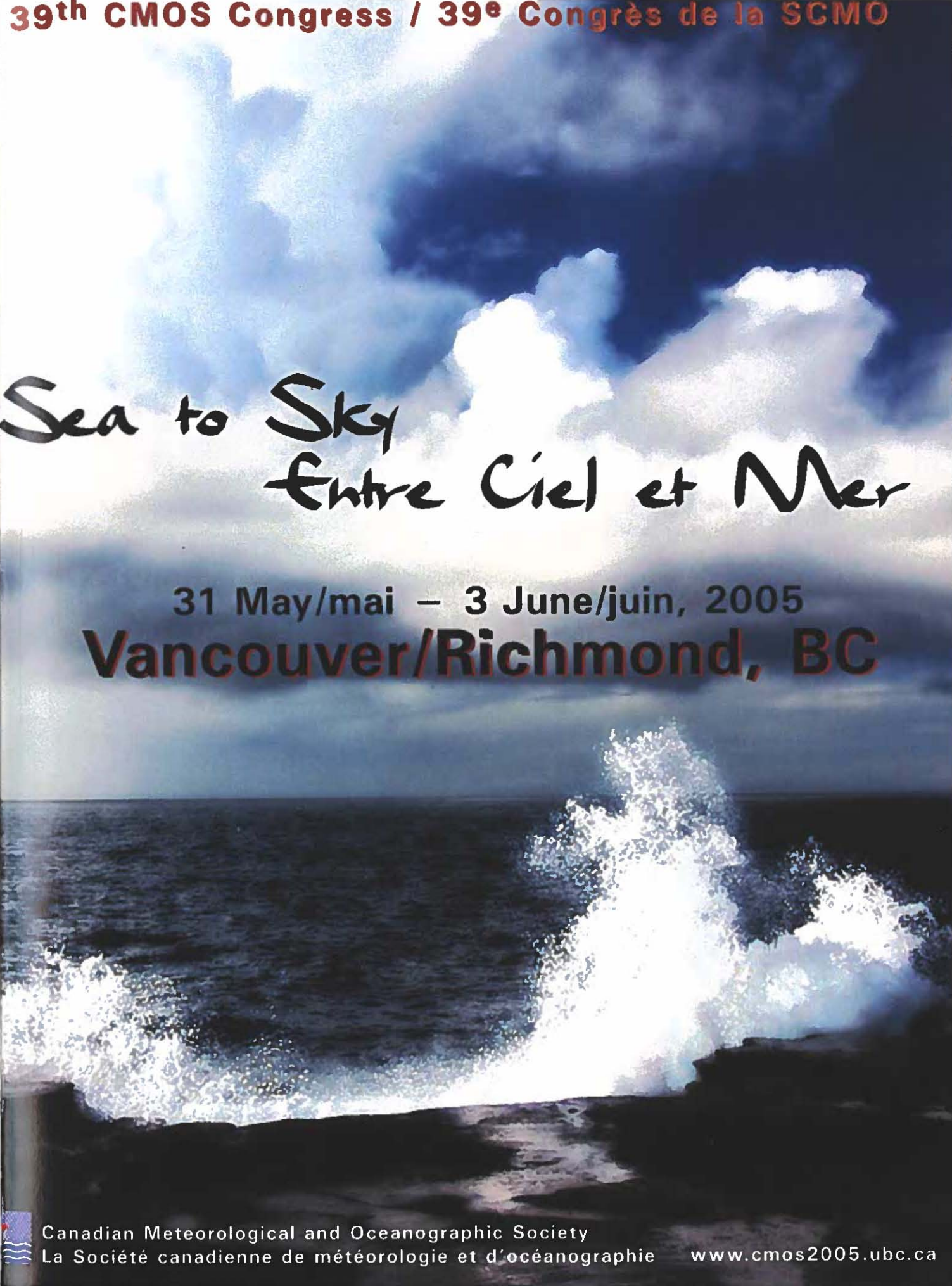
39th CMOS Congress / 39e Congrès de la SCMO

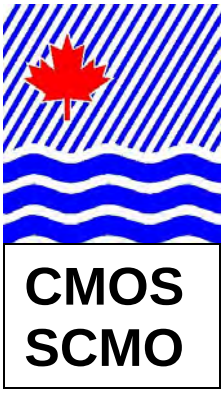


Sea to Sky
Entre Ciel et Mer

31 May/mai – 3 June/juin, 2005
Vancouver/Richmond, BC

Canadian Meteorological and Oceanographic Society
La Société canadienne de météorologie et d'océanographie

www.cmos2005.ubc.ca



Canadian Meteorological and Oceanographic Society

La Societe canadienne de météorologie et d'océanographie

39th CMOS Congress / 39ième Congrès SCMO
31 May –03 June / 31 mai—03 juin, 2005
Vancouver / Richmond, British Columbia

Sea to Sky
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Welcome / Bienvenue
A Word from our President
Un mot de notre président

On behalf of CMOS, I would like to welcome you to the 39th Annual CMOS Congress. With over 400 presentations, it promises to be a very stimulating scientific program covering our Society's broad spectrum of interests. There is also a busy schedule of associated meetings and enjoyable evening events, including our Annual General Meeting. We noticed an encouraging surge in membership applications around the abstract submission deadline, which is just one indication of the crucial role that our Congresses play in the vitality of our Society. The Congress provides us our one annual opportunity to gather to share our scientific advances, recognize our outstanding colleagues through a variety of prizes, awards, and Fellows appointments, celebrate together, conduct important business in the evolution of CMOS, renew old friendships and make new ones.

Our Society and our Congresses thrive thanks to the continuing involvement and support of many volunteers both locally and across the country. This Congress is the culmination of more than a year's planning and effort by the Scientific Program Committee led by Rich Pawlowicz and the Local Arrangements Committee led by Laurie Neil. I would like to thank Rich. Laurie, their committee members, and all the volunteers of the B.C. Lower Mainland Centre for hosting this wonderful meeting.

Best wishes to all for an exciting and productive Congress in Vancouver.

Harold Ritchie
CMOS President / Président SCMO

Au nom de la SCMO, j'aimerais vous souhaiter la bienvenue au 39e congrès annuel de la SCMO. Comptant plus de 400 présentations couvrant les intérêts multiples de la société, le programme scientifique promet d'être des plus enlevant. Un horaire chargé de rencontres et d'activités sociales, incluant l'Assemblée générale annuelle est aussi au programme. Le nombre de demande d'adhésion a augmenté près de la date limite de soumission des résumés, soulignant le rôle important que nos congrès jouent dans la vie de notre société. Le congrès nous fournit une occasion annuelle pour se rassembler pour faire part de nos progrès scientifiques, pour présenter à nos collègues exceptionnels une variété de prix, d'honneurs et de nominations, pour célébrer ensemble, pour transiger d'affaires importantes pour l'avenir de la société, pour renouer de vieilles amitiés et pour en établir de niouvelles..

Notre société et ses congrès fleurissent grâce à la participation soutenue et au support de volontaires localement et à travers le pays. Le congrès est l'aboutissement de plus d'une année de préparation et d'effort par le comité du programme scientifique présidé par Rich Pawlowicz et par le comité local d'organisation présidé par Laurie Neil. J'aimerais remercier Rich, Laurie, les membres de leurs comités, et tous les volontaires du centre Lower Mainland de la Colombie-Britannique qui ont mis sur pied cette merveilleuse conférence.

Je souhaite à tous un congrès à Vancouver qui sera productif et enlevant.

Harold Ritchie
Président SCMO

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Quelques mots à propos de la Société
A Word about the Society

La Société canadienne de météorologie a été formée en 1967, à partir d'un chapitre de la Royal Meteorological Society. Lorsque les océanographes s'y sont joints en 1977, le nom de la Société est devenu Société canadienne de météorologie et d'océanographie. La Société fut incorporée sous ce nom en 1984.

La SCMO est une organisation nationale regroupant des individus voués à la promotion au Canada de la météorologie et de l'océanographie, ainsi que des disciplines environnementales connexes, sous tous leurs aspects. La Société offre aussi la certification d'experts-conseils en météorologie et l'agrémentation des présentateurs météo. Quatorze centres locaux sont les pivots des activités locales et régionales.

Les intérêts scientifiques de la Société incluent: la météorologie opérationelle, la climatologie, l'hydrologie, la pollution de l'air, la météorologie agricole et forestière, la mésométéorologie, les glaces flottantes et l'océanographie chimique, physique et halieutique.

La Société offre des bourses de voyages à des étudiants pour assister au congrès annuel, une bourse de voyage à un enseignant pour l'atelier "Project Atmosphere" de l'AMS/NOAA, la bourse de troisième cycle "Weather Research House/SCMO/CRSNG, des bourse aux étudiants sous gradués, le Prix Campbell Scientific pour la meilleure présentation sur poster, la bourse SCMO/MétéoMédia, et depuis peu, la bourse pour publication post doctoral Roger Daley.

Les principales publications de la Société sont le CMOS Bulletin SCMO bimestriel et ATMOSPHERE-OCÉAN (A-O), une revue scientifique trimestrielle qui présente des articles, préalablement soumis à la critique, sur les résultats de recherches originales. La SCMO a aussi une page d'accueil sur son site WEB où on trouve de l'information générale sur la SCMO et ses activités, ainsi que sur la science et l'enseignement de la météorologie et de l'océanographie au Canada. Il y a une section dévouée au secteur privé où on énumère les compagnies et leurs services.

Une section du site web est réservée aux membres seulement. Les membres peuvent ainsi mettre à jour leur adresse et préférences, renouveler leur adhésion, consulter le répertoire des membres, s'inscrire aux réunions et y soumettre des résumés, ainsi que consulter le Bulletin et la Revue Annuelle, en ligne.

On trouvera plus d'information sur la SCMO à http://www.scmo.ca

CMOS
SCMO

La Société canadienne de météorologie et d'océanographie
Canadian Meteorological and Oceanographic Society

The Canadian Meteorological Society was formed in 1967 from a branch of the Royal Meteorological Society. In 1977 when the oceanographic community joined, the name of the Society was changed to the Canadian Meteorological and Oceanographic Society (CMOS). The Society was subsequently incorporated with this name in 1984.

CMOS is a national society of individuals dedicated to advancing all aspects of atmospheric sciences, oceanography, and related disciplines in Canada. The Society also offers accreditation of meteorological consultants and endorsement of media weathercasters. Fourteen Centres across Canada serve as focal points for local and regional activities.

Scientific interests of the Society include: operational meteorology, climatology, hydrology, air pollution, agriculture/forestry meteorology, mesoscale meteorology, floating ice, physical, chemical and fisheries oceanography.

The Society offers travel bursaries for students to attend Annual Congresses, a secondary school teacher travel bursary for the AMS/NOAA Workshop "Project Atmosphere", the Weather Research House/CMOS/NSERC graduate student supplementary scholarship, undergraduate scholarships, the Campbell Scientific prize for the best poster presentation at a Congress, the CMOS Weather Network Scholarship, and most recently the Roger Daley Postdoctoral Publication Award.

The main publications of CMOS are the bimonthly CMOS Bulletin SCMO and ATMOSPHERE-OCEAN (A-O), a quarterly refereed journal for the publication of results of original research. The Society also Maintains an electronic Web site with information on the Society and its activities pertaining to meteorological and oceanographic activities across Canada. There is a special section devoted to the Private Sector where companies and services are now listed.

There is a "Members Only" section on the Web site for updating of addresses and preferences, renewing membership, consulting a directory of members, registering and submitting abstracts to meetings, and viewing the Bulletin and Annual Review on line.

For additional information visit the CMOS web site at http://www.cmos.ca

CMOS
SCMO

Canadian Meteorological and Oceanographic Society
La Société canadienne de météorologie et d'océanographie

A Word from the Chair of the Science Program Committee
Un mot du president du comite scientifique

A fluid spins around in a lazy eddy and changes colour. Do we measure its physics, chemistry and biology, from ships, aircraft, satellites, towers, and microscopically tiny probes? Do we forecast it, hindcast it, assimilate it, modify it, simulate it? Do we communicate our findings through the printed word, the spoken word, the visualization of TV? CMOS members do all of these and the weight of this book illustrates both the strength of ocean and atmospheric sciences in Canada and also our dedication to important scientific and policy issues. The members of the Science Program Committee and the Special Session Convenors have worked hard to put together the program, and Laurie Neil and the Local Arrangements Committee have done their best to make sure everything goes smoothly. CMOS2005 is packed with exciting talks and interesting sessions - enjoy!

Welcome to your Congress!

Rich Pawlowicz

Un fluide tournoie dans un tourbillon lent et change de couleur. Est-ce qu'on mesure sa physique, sa chimie et sa biologie, à partir de bateaux, d'avions, de satellites, avec des tours, et avec des petites sondes microscopiques? Est-ce qu`on le prévoit, qu'on en fait des prévisions historiques, qu'on l'assimile, le modifie, le modèlise? Est-ce qu'on communique nos constatations par écrit, oralement, en utilisant la télévision? Les membres de la SCMO font tout cela et le poids de ce cahier démontre la force des sciences atmosphériques et océanographiques au Canada, et aussi notre dévouement aux problématiques scientifiques et des politiques. Les membres du comité du programme scientifique et les responsables des sessions spéciales ont travaillé fort pour établir le programme, et Laurie Neil et le comité local d'organisation ont fait de leur mieux pour que le congrès se déroule en douceur. Une foule de présentations enlevantes et de sessions intéressantes sont au programme de SCMO 2005– amusez-vous bien!

Bienvenue au congrès!

Rich Pawlowicz
Président, Comité du programme scientifique pour SCMO 2005

A Word from the Chair of the Local Arrangements Committee
Un mot du president du comite organisateur local

On behalf of the Local Arrangements Committee I would like to extend a warm west coast welcome to all participants at the 2005 CMOS Congress. We have tried to ensure that all your needs for a productive week of learning, sharing, and networking have been addressed. Feel free to contact myself or any member of the L.A.C. if you have concerns or requirements that we can help you with.

In addition to extending thanks to all the hard-working members of my committee, many thanks must also go to Dr. Rich Pawlowicz and the members of the Science Program Committee for developing an excellent, multidisciplinary congress program. In fact Rich and Dr. Phil Austin did double duty, serving on both committees. As well, Dr. Ian Rutherford and other members of the CMOS Executive and staff also provided much assistance during the months leading up to the congress. Special acknowledgement is extended to Richard Asselin for successfully implementing the new CMOS registration and abstract software, which will also ease the burden on local chapters in arranging future congresses.

It has been five years since this event was last held in British Columbia, and I hope the weather is as pleasant as it was for the Victoria Congress in 2000. We have tried to provide for some free time for you to get out and enjoy the city and west coast environment, and do hope you enjoy your week at the congress.

Laurie Neil
Chair, Vancouver Local Arrangements Committee

Au nom du comité local d'organisation, j'aimerais souhaiter la bienvenue à tous les participants au congrès SCMO 2005. Nous avons fait de notre mieux pour que tous vos besoins pour une semaine productive d'apprentissage, de partage et de réseautage soient satisfaits. N'hesitez pas à communiquer avec moi ou tout membre du comité local d'organisation si vous avez des exigences ou des préoccupations demandant notre aide.

En plus de remercier tous les membres de mon comité, j'aimerais aussi remercier Dr. Rich Pawlowicz et les membres du comité du programme scientifique qui ont crée un excellent programme multidisciplinaire pour le congrès. De fait, Rich et Dr. Phil Austin ont mis les bouchées doubles, étant membres des deux comités. De plus, Dr. Ian Rutherford et autres membres de l'exécutif de la SCMO ont aussi aidé durant les mois meant au congrès. Je remercie tout particulièrement Richard Asselin pour avoir implanté avec succès les logiciels pour l'inscription et pour les résumés de la SCMO, logiciels qui faciliteront la tâche des centres locaux qui organiseront les futurs congrès.

Il y a déjà cinq ans que ce congrès s'est tenu en Colombie-Britannique, et j'espère que le temps sera aussi plaisant qu'il a été durant le congrès de Victoria en 2000. Nous avons mis à l'horaire du temps de loisir pour vous permettre de visiter et d'apprécier la ville ainsi que l'environnement de la côte ouest. Nous espérons que votre semaine de congrès sera agréable.

Laurie Neil
Président, Comité local d'organisation de Vancouver

Registration And Social Events Desks
The registration desk and social events desks will be located adjacent to the Grand Pacific Foyer. Signs posted in the main hotel lobby will provide directions. These desks will be open during the following periods:

- Monday May 30 from 16:00 to 21:00
- Tuesday May 31 from 07:00 to 18:00
- Wednesday June 1 from 07:30 to 18:00
- Thursday June 2 from 07:30 to 18:00
- Friday June 3 from 07:30 to 13:00

General congress information will be available each day at the registration desk. Extra tickets for social events can be purchased across the aisle at the Social Events desk, where sign-up sheets for various other social activities will also be located. The CMOS Congress and Exhibits Office will be located in the hotel's Executive Boardroom, where a Local Arrangements Committee member will usually be available between the hours of 07:00 to 18:00 daily.

Congress Rooms
All meeting rooms are on the main floor except Suite 2100 (21st floor). The following rooms will be used during the congress:

- Grand Pacific Ballroom (Salons A, B, C, D) for plenary sessions, weather briefings, science sessions, Patterson and Parsons Medals Luncheon, Awards Banquet
- Grand Pacific Foyer and International Foyer for exhibits, coffee, lunch buffets
- International Ballroom (sponsored by UBC) for posters, lunchtime seating
- Delta Room for science sessions, business meetings
- Steveston Room for Workshops on Monday, then Internet Cafe rest of week
- Executive Boardroom for Local Arrangements Committee office
- Round Room for Icebreaker, AGM, science sessions, Teachers Day
- Lansdowne and Nielson rooms for science sessions, business meetings
- Suite 2100 for business meetings and social events
- Richmond Room for science sessions, business meetings

Special requests of rooms for unscheduled business meetings should be brought to the attention of a member of the Local Arrangements Committee (Executive Boardroom). These will be granted based on availability of appropriate meeting rooms.

Note: Please see final page of this book for Hotel Map

Computer Services
For internet access and other computer needs of participants, ten PC's running Microsoft Windows will be available in the Internet Cafe (Steveston Room) as follows:

- Monday May 30 from 17:00 to 21:00
- Tuesday May 31 from 07:00 to 21:00
- Wednesday June 1 from 07:00 to 21:00
- Thursday June 2 from 07:00 to 21:00
- Friday June 3 from 07:00 to 13:30

A networked, monochrome laser printer will be available for limited printing jobs. Special requests to burn a CD may be made at the Congress and Exhibits Office. However blank CD's will not be provided.

Message Board
A message board will be available near the Social Events desk, to allow congress attendees to receive messages from other attendees or their home or office.

Poster Sessions
Science posters will be on display in three groupings, one each day, in the UBC-sponsored International Ballroom. Presenters will be available to discuss their work at the following times:
Tuesday May 31 from 15:00 to 16:00
Wednesday June 1 from 15:15 to 16:15
Thursday June 2 from 16:30 to 17:30
A cash bar will be available in the posters area on Thursday.

Icebreaker
Our Icebreaker sponsor, Campbell Scientific Inc., invites all participants for food and refreshments at 18:30 Monday May 30 in the Round Room. This Icebreaker Social will be extended out to the adjacent outdoor courtyard and gardens if the weather is nice. Each participant's registration package includes an Icebreaker ticket which can be exchanged for one free drink at the bar. A cash-bar service will be provided thereafter. The Icebreaker Social is a favorite among attendees because it provides an excellent opportunity to chat with one another.

CMOS AGM Warm-Up Reception
There will be a CMOS Warm-up Reception at 18:00 Tuesday May 31 in the Round Room. A cash-bar service will be provided. Appetizers will be served at 19:00. All participants are invited for good conversations and food. You will have ample time to mingle and catch-up with one another before attending the CMOS AGM which starts at 20:30. So we encourage everyone to come and enjoy the evening!

VENUS & NEPTUNE Networking Reception
Please join us on Tuesday May 31 at 17:30 in the Richmond Room for a networking-information reception hosted by *VENUS* and *NEPTUNE Canada* and the *University of Victoria.* The *VENUS* and *NEPTUNE* projects are two cabled ocean observatories being built for installation off Canada's west coast. *VENUS* will be a coastal observatory, concentrating resources in the near-shore waters of B.C. *NEPTUNE Canada* will design and build a regional cabled observatory out into the deeper regions of the North-East Pacific. The reception will be an opportunity to meet the project teams, find out what these projects have to offer, explore scientific opportunities, establish collaborations, and help build the future of ocean sciences.

Macfarlane Reception
An informal reception will take place on Tuesday May 31 at 18:00 in Room 2100 to honour the work of Dr. Norman McFarlane. Internationally, Dr. McFarlane is recognized for his lead role in the development and application of parameterizations in climate models, and he has been instrumental in establishing Canada's high profile in climate research. A limited number of tickets will be available for this event at the Social Events desk.

Parsons And Patterson Medals Luncheon
This luncheon, which is sponsored by the BC Ministry, Water, Land and Air Protection, will be served in the Grand Pacific Ballroom on Wednesday June 1 from 12:00 to 14:00. During this time the Parsons Medal will be presented by Wendy Watson-Wright, DFO's Assistant Deputy Minister for Science, and the Patterson Medals will be presented by Michel Beland, Director General, Atmospheric and Climate Science Directorate of the MSC.

Teachers Day
Elementary and high school teachers of science, geography and related subjects throughout British Columbia have been invited to a special session on Friday June 3 from 08:15 to 17:00. Several well know special guests including experts on climate, tsunamis, hurricanes, and curriculum development will be giving presentations and leading discussions.

CSAFM
We welcome members of the Canadian Society of Agricultural and Forest Meteorology who are holding a special session on Wednesday to be followed by their Annual General Meeting.

CMOS Awards Banquet
The annual congress banquet will be held in the Grand Pacific Ballroom on Thursday June 2. Cocktails will begin at 17:30 and dinner will begin at 18:30. Various honours will be presented at the end of the dinner. The evening will finish with music by the classic rock band "Legal Limit," which includes a forecaster for the Pacific Storm Prediction Centre.

Social/Technical Tours
Four local social/technical tours are planned for Wednesday evening, June 1st. These tours are designed to whisk you into Vancouver for an evening of fun. Registration is free*. But space for these tours is limited(maximum of 47 persons per tour). We recommend that you sign up early for these tours at the Social Events Desk as these tours promise to fill quickly. Registration will be on a first come-first served basis. Don't miss out!

Coach-buses will pick you up/drop you off directly from the hotel(Vancouver Airport Conference Resort) and shuttle you to:

- **Visit the Pacific Storm Prediction Center** (time allotted for you to stroll to downtown Vancouver's Robson & Gastown Districts)

- **Rainforest Walk at Lighthouse Park** (see coastal West Vancouver and catch the sunset)

- **Explore Vancouver: "Pub Crawl**" (see Granville Island & Yaletown Districts)

*this tour will cost registrants $5.25 to cover the cost of the aquabus transportation

- **Tour TRIUMF**, national lab for particle/nuclear physics on UBC campus (time allotted for you to stroll the Kitsilano neighborhood and beaches)

COMPTOIRS D'INSCRIPTION ET DES ACTIVITES SOCIALES

Les comptoirs d'inscription et des activités sociales seront situés près du Foyer Grand Pacific. Des écriteaux dans le hall principal de l'hôtel indiqueront le chemin à suivre.
Les comptoirs seront ouverts durant les périodes suivantes :
Lundi 30 mai de 16 :00 à 21 :00
Mardi 31 mai de 07 :00 à 18 :00
Mercredi 1 juin de 07 :30 à 18 :00
Jeudi 2 juin de 07 :30 à 18 :00
Vendredi 3 juin de 07 :30 à 13 :00

Information sur le congrès sera disponible à tous les jours au comptoir d'inscription. Il sera possible d'acheter des billets additionnels pour les activités sociales au comptoir des activités sociales. Le bureau du congrès sera situé dans la salle Executive Boardroom, où un membre du comité local d'organisation sera disponible de 07 :00 à 18 :00 à tous les jours.

SALLES DE CONGRÈS

Toutes les salles sont à l'étage principal sauf la suite 2100 (21^{e} étage). Les salles suivantes seront utilisées durant le congrès :

- Grand Pacific Ballroom (Salons A, B, C, D) pour les sessions plénières, les présentations météo, les sessions scientifiques, dîner de remise des médailles Patterson et Parsons, banquet de remise des prix et honneurs
- Foyer Grand Pacific et Foyer International pour la galerie des exposants, les pauses-cafés, les buffets
- International Ballroom (commandité par UBC) pour les sessions d'affichage, pour des places assises durant l`heure des repas
- Salle Delta pour les sessions scientifiques, les rencontres d'affaires
- Salle Steveston pour les ateliers le lundi, le Café Internet pour le reste de la semaine
- Executive Boardroom pour le bureau du comité local d'organisation
- Salle Round pour le cocktail de bienvenue, AGA, les sessions scientifiques, la journée des enseignants
- Les salles Lansdowne et Nielson pour les sessions scientifiques, les rencontres d'affaires
- Suite 2100 pour rencontres d'affaires et des activités sociales
- Salle Richmond pour les sessions scientifiques, les rencontres d'affaires

Les requêtes spéciales de salles pour des rencontres d'affaires non prévues à l'horaire devront être soumises à un membre du comité local d'organisation (salle Executive Boardroom). On accédera à ces requêtes selon la disponibilité des salles réservées pour ces rencontres.
Voir la page finale de ce cahier pour un plan de l'hotel

SERVICES D'ORDINATEUR

Pour accès à l'internet et autres besoins informatiques, dix ordinateurs utilisant le système Windows de Microsoft seront disponibles au Café Internet (Salle Steveston) durant les périodes suivantes :
Lundi 30 mai de 17 :00 à 21 :00
Mardi 31 mai de 07 :00 à 21 :00
Mercredi 1 juin de 07 :00 à 21 :00
Jeudi 2 juin de 07 :00 à 21 :00
Vendredi 3 juin de 07 :00 à 13 :30

Une imprimante laser monochrome en réseau sera disponible pour faire un nombre limité de copies. Des requêtes spéciales pour graver un disque optique devront être faites au bureau du congrès. Cependant les disques optiques vierges ne seront pas fournis.

BABILLARD
Un babillard sera disponible au comptoir des activités sociales, permettant aux participants au congrès de recevoir des messages de la part d'autres participants ou venant de la maison ou du bureau.

SESSIONS D'AFFICHAGES
Les affiches seront regoupées en trois groupes. On pourra voir les affiches, à raison d'un groupe par jour, dans la salle International Ballroom commandité par UBC. Les présentateurs seront disponibles pour discuter de leur travail durant les périodes suivantes :
Mardi 31 mai de 15 :00 à 16 :00
Mercredi 1 juin de 15 :15 à 16 :15
Jeudi 2 juin de 16 :30 à 17 :30
Un bar à la carte sera disponible le jeudi.

COCKTAIL DE BIENVENUE
Campbell Scientific Inc. , qui commandite le cocktail, invite tous les participants pour des rafraîchissements et des hors d'œuvres à 18 :30 lundi 30 mai dans la salle Round. Le cocktail aura lieu dans la cour extérieur et les jardins adjacents si les conditions atmosphériques le permettent. Chaque participant aura reçu lors de l'inscription un billet pour le cocktail donnant droit à une boisson gratuite. Pour recevoir la boisson, présentez le billet au bar. Un bar à la carte sera aussi disponible.

JOURNÉE DES ENSEIGNANTS
Des professeurs de science, géographie et de sujets connexes du niveau élémentaire et secondaire de la Colombie-Britannique ont été invités à une session spéciale le vendredi 3 juin de 08 :15 à 17 :00. Plusieurs invités spéciaux bien connus incluant des experts sur le climat, les tsunamis, les ouragans, et sur l'élaboration des programmes d'enseignement feront des présentations et mèneront les débats.

SCMAF
Bienvenue aux membres de la Société canadienne de météorologie agricole et forestière qui tiendront une session spéciale le mercredi. Leur assemblée générale annuelle.aura lieu après la sessions spéciale.

RÉCEPTION AVANT AGA DE LA SCMO
Il y aura une réception avant AGA à 19 :00 mardi 30 mai dans la salle Round. Un bar à la carte sera disponible. Les hors d'œuvres seront servis à 19 :00. Tous les participants sont invités. L' AGA de la SCMO débutera à 20 :30.

RÉCEPTION DE RÉSEAUTAGE VENUS ET NEPTUNE
VENUS et NEPTUNE Canada et l'université de Victoria tiendront une réception de réseautage
le mardi 31 mai à 17 :30 dans la salle Richmond. Les projets VENUS et NEPTUNE sont deux observatoires océaniques par cable qui sont en construction et qui seront placés au large de la côte ouest du Canada. VENUS sera un observatoire côtier se concentrant sur les ressources des eaux littorales de la Colombie-Britannique. NEPTUNE Canada concevra et construira un observatoire régional par cable

dans les eaux profondes du Pacifique Nord-Est, au-delà du rebord du talus continental au sud-ouest de l'île de Vancouver. La bande passante large et la haute puissance des observatoires permettront aux scientistes océanographes de déployer des réseaux d'instruments élaborés et, en utilisant un navigateur internet, de pouvoir donner des commandes et manipuler, et d'obtenir des données de transmission en continu afin d'observer l'océan comme il n'a jamais été possible. La réception sera une occasion de rencontrer les équipes participant aux projets, de découvrir ce que ces projets ont à offrir, de voir les designs préliminaires, d'explorer les opportunités scientifiques, d'établir des collaborations, et d'aider à construire l'avenir des sciences océaniques.

RÉCEPTION McFARLANE
Une réception informelle aura lieu le mardi 31 mai à 18 :00 dans la suite 2100 pour honorer le travail de Dr. Norman McFarlane. Internationellement, Dr. McFarlane est reconnu comme une figure de proue dans l'élaboration et l'application de paramétrisations dans les modèles de climat, et a joué un rôle clef dans la mise en valeur du Canada en recherche climatique. Un nombre limité de billets seront disponibles au comptoir des activités sociales.

DÎNER DE REMISE DES MÉDAILLES PARSONS ET PATTERSON
Le dîner aura lieu dans la salle Grand Pacific Ballroom le mercredi 1 juin de 12 :00 à 14 :00. Durant le dîner, la médaille Parsons sera présentée par Wendy Watson-Wright, sous- ministre adjointe des sciences pour MPO, et la médaille Patterson sera présentée par Michel Béland, directeur général de la direction générale des sciences atmosphériques et climatiques du Service météorologique du Canada.

BANQUET DE REMISE DES PRIX ET HONNEURS DE LA SCMO
Le banquet du congrès annuel aura lieu dans la salle Grand Pacific Ballroom le jeudi 2 juin. Le service de boisson débutera à 17 :30 et le service des repas commencera à 18 :30. Plusieurs prix et honneurs seront présentés à la fin du repas. La soirée se terminera avec la musique de « Legal Limit » un groupe de musique rock classique, dont un des membres est prévisionniste au Centre de prévsision des tempêtes du Pacifique.

EXCURSIONS
Quatre excursions sont prévues pour la soirée du mercredi 1 juin. L'inscription est gratuite[*]. Cependant les places sont limitées (maximum de 47 personnes par excursion). Inscrivez vous tôt pour les excursions au comptoir des activités sociales car les places s'envoleront rapidement. Les inscriptions seront acceptées selon l'ordre d'arrivée.

Des autobus vous transporteront de l'hôtel (Vancouver Airport Conference Resort) à :

(1) Visite du Centre de prévision des tempêtes du Pacifique (Du temps sera réservé pour visiter la rue Robson et le quartier Gastown situé au centre-ville de Vancouver)
(2) Marche en forêt au parc Lighthouse (voyez la région côtière de West Vancouver et le coucher du soleil)
(3) Explorer Vancouver : « Tournée des grands ducs » (visitez Granville Island et le quartier Yaletown)
[*] Des frais de $5.25 seront exigés pour défrayer le coût du transport par aquabus
(4) Visite de TRIUMF, laboratoire national de physique nucléaire et des particules situé sur Le campus de UBC (Du temps sera réservé pour visiter le quartier de Kitsilano et ses plages)

The Organizers
Les organisateurs

Scientific Program Committee

Rich Pawlowicz (Chair)	*UBC, Earth and Ocean Sciences*
Susan Allen	*UBC, Earth and Ocean Sciences*
Phil Austin	*UBC, Earth and Ocean Sciences/Geography*
John Fyfe	*Canadian Centre for Climate Modelling and Analysis, MSC*
Grant Ingram	*UBC, Earth and Ocean Sciences*
Robert Nissen	*Meteorological Service of Canada*
Tim Oke	*UBC, Geography*
Knut von Salzen	*Canadian Centre for Climate Modelling and Analysis, MSC*

Local Arrangements Committee

Laurie Neil	*Environment Canada/MSC*	*Chair*
Phil Austin	*UBC, Earth & Ocean Sciences/Geog*	*Website*
Reg Dunkley	Environment Canada (retired)	*Publications*
William Hsieh	*UBC, Earth and Ocean Sciences*	*Treasurer*
David Jones	Environment Canada/MSC	*Media Relations*
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Kenneth Kwok	*Environment Canada/MSC*	*Registration*
Matt Loney	*Environment Canada/MSC*	*Social Committee*
Mark Madryga	*Environment Canada/MSC*	*Media Relations*
Neil McLennan	*Environment Canada/MSC*	*Facilities and Technical Convenor*
Gerard Neault	*Environment Canada/MSC*	*Translation*
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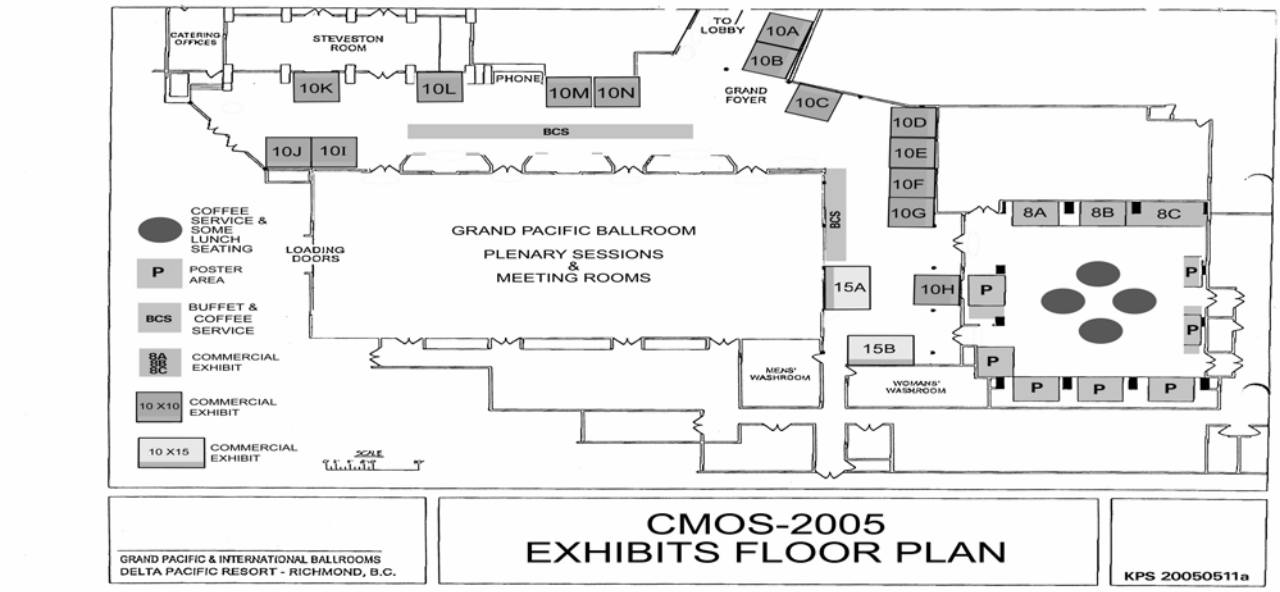
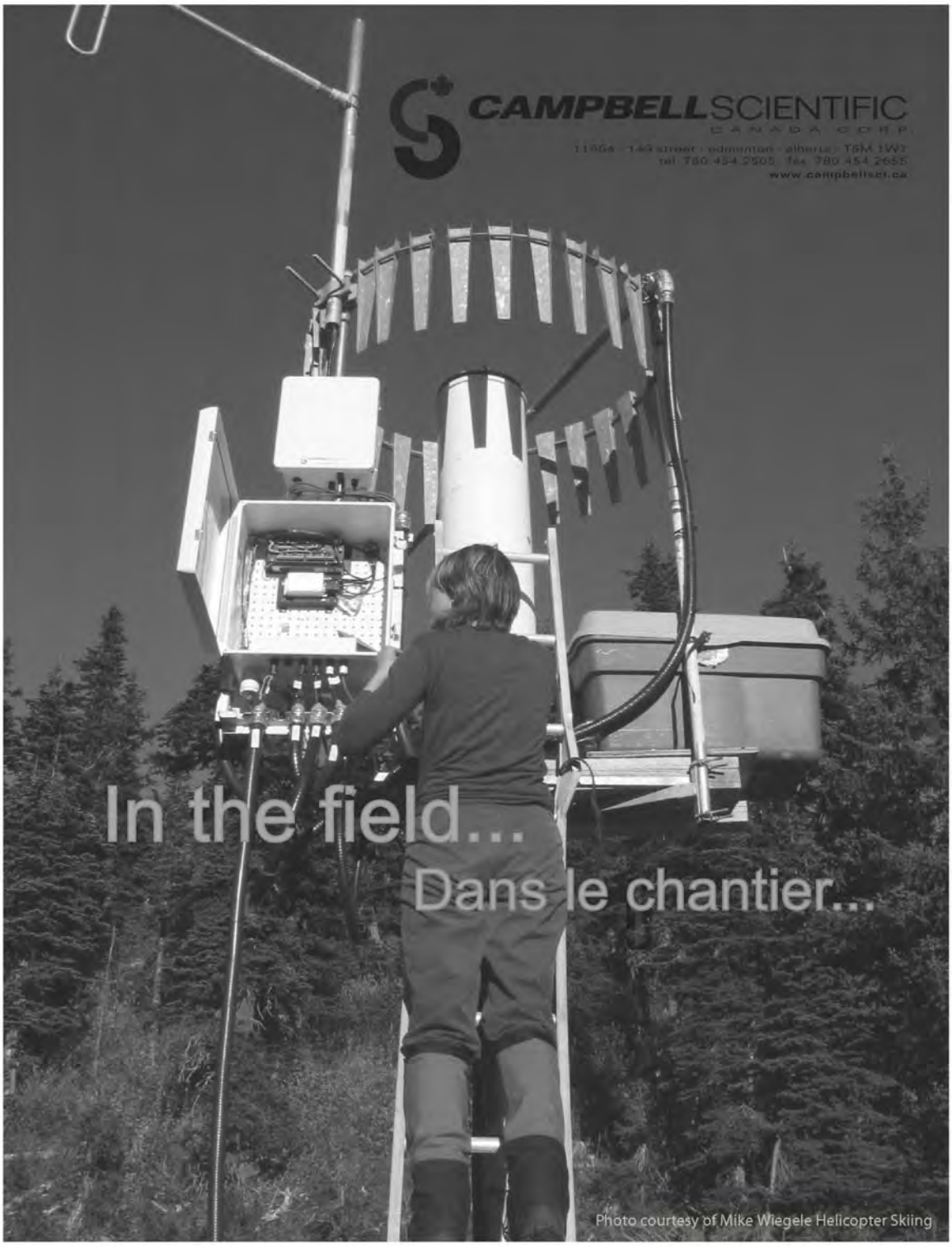
Ian Rutherford	*CMOS Executive Director*	*Wise Advice*
Peter Scholefield	Environment Canada (retired)	*Sponsorships*
Brad Snyder	*Environment Canada/ECB*	*Social Committee*
Kelsey Spring	*Environment Canada/MSC*	*Commercial exhibitors*
Pat Wong	*Environment Canada/MSC*	*Social Committee, Teachers Day, Recording Secretary*

Booth	Exhibitors	Sponsors
8A	Recherche en Prevision Numerique	★ Vancouver Airport Conference Resort
8B	Senes Consulting LTD.	★ Campbell Scientific (Canada) Corp.
8C	York University	★ BC Ministry of Water, Land and Air Protection
10A	CMOS	Meteorological Service of Canada - Pacific and Yukon Region
10B	CFCAS	Fisheries and Oceans Canada - Pacific Region
10C	OEA Technologies Inc.	MDA
10D	Global Imaging	Vincor International
10E	Info-Electronics Systems Inc.	University of British Columbia
10F	Weather Decision Technologies	BC Hydro
10G	Degreane/Radiometrics	Mustang Survival
10H	AXYS Environmental Systems	
10I	Technel Engineering Inc	
10J	Lightning Detection Network	
10K	The Weather Network	
10L	Campbell Scientific	**Exhibit Booth Hours**
10M	Meteorological Service of Canada	Tuesday, May 31 09:30---------- 16:00
10N	Meteorological Service of Canada	Wednesday, June 01 09:30----------16:00
15A	Hoskin Scientific Limited	Thursday, June 02 09:30 ----------16:00
15B	CBC News: Weather Centre	Friday, June 03 09:30 ----------12:00

★ Indentifies A Gold Star Sponsor (Contribution > $5000)

CMOS Exhibitor Booths





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40th CMOS Congress / 40e Congrès de SCMO
Toronto Ontario
30 May/mai
– 2 June/juin, 2006
Weather, Oceans & Climate
Météo, océans et climat
Explorer les liens
Exploring the Connections
Canadian Meteorological and Oceanographic Society CMOS2006@eg.gc.ca
La Société canadienne de météorologie et d'océanographie
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Bursary Recipients, Student Travel
Récipiendaires des bourses, voyage d'étudiants

The CMOS Student Travel Bursary awards an amount of about $5000, funded from Congress Revenues, to assist and encourage presentations by students, especially first-time presenters, and to equalize geographical cost factors. 37 Applications were received this year and of those 13 were chosen for awards after ranking based on a) CMOS membership status, b) acceptance of previous awards, c) status in Congress program (presenters, first authors, etc.), d) geographical distance, e) other factors.

Name	**School**	**Supervisor**
Amount: $500		
Sarah Jane Eaton	Memorial University of Newfoundland	Mark Wilson
Reza Ghoddousi-Fard	University of New Brunswick	Peter Dare
Moritz Lehmann	Dalhousie University	John Cullen
Clark Richards	Memorial University of Newfoundland	Brad de Young
Amount: $375		
Teresa Fisico	University of Manitoba	John Hanesiak
Steve Gibson	McGill University	Ronald Stewart
Alexandra Jahn	McGill University	Lawrence Mysak
Erika Klyszejko	University of Waterloo	Nicholas Kouwen
Martine Lizotte	Université Laval	Maurice Levasseur
Dorina Surcel	Université du Québec à Montréal	René Laprise
Amount: $250		
Sébastien Chouinard	McGill University	John Gyakum
Julien Pommier	Université du Québec à Rimouski	Michel Gosselin
Barbara Winter	McGill University	Charles Lin

Session Descriptions (Session Convenors cited)

SA1 Chemical Composition of the Troposphere
Randall Martin rvmartin@fizz.phys.dal.ca
Tropospheric composition has been changing dramatically over the last century with substantial implications for climate and air quality. We particularly encourage papers that address these issues by improving scientific understanding of tropospheric ozone, aerosol processes, emission inventories, atmosphere-biosphere interactions, and long-range transport

SA2 GPS Atmospheric Moisture Retrieval and Applications
Susan Skone sskone@geomatics.ucalgary.ca
Models and estimation strategies for atmospheric moisture recovery using GPS, ground-based zenith and slant path measurements, GPS tropospheric tomography, regional models and potential for severe weather monitoring, derivation of meteorological parameters and assimilation strategies for weather prediction, derivation of climate databases and applications, validation techniques, real-time methods, current national and international projects, (space-borne) radio occultation methods and global models

SA3 Atmospheric Community Modelling
Sylvie Gravel sylvie.gravel@ec.gc.ca
In support of atmospheric research, the Meteorological Research Branch of MSC provides the scientific community with a state-of-the-art atmospheric model. The goal of this Community modelling session is to bring together the many users of the Canadian community model, communicate results, exchange ideas, and facilitate new collaborations.

SA4 Mackenzie GEWEX Study (MAGS): Contribution to Atmospheric Science
Peter di Cenzo gewex.mags@ec.gc.ca
The year 2005 will mark the successful closure of the Mackenzie GEWEX Study (MAGS). This session invites contributions on atmospheric and hydrometeorological research in the Mackenzie region which have significant applications to other areas with a cold climate. In addition to invited presentations from the MAGS community, papers are solicited to present results on process, case studies, and model development and application.

SA5 Micrometeorology of surface covers (CSAFM/CMOS Joint Session)
Ian Strachan ian.strachan@mcgill.ca
All aspects of micrometeorology from a variety of surface cover types. This session is sponsored by the Canadian Society of Agricultural and Forest Meteorologists (CSAFM). .

SC1 Statistics in Oceanography and Meteorology
Michael Dowd mdowd@mathstat.dal.ca
The development and/or novel application of statistical methods for oceanography and atmospheric science.

SC2 Ocean/Cyclone Interactions
William Perrie PerrieW@mar.dfo-mpo.gc.ca
Papers are solicited on all aspects of interactions of cyclones with the ocean, including their global characteristics and properties, tropical and extratropical coupled interactions, including air-sea

interaction, intra-seasonal variability, climate and prediction. Examples are 'named' hurricanes and their impacts on the ocean, and concomitant feedbacks to the atmosphere. Surface winds, waves and surface currents are of special interest

SC3 Ocean-Atmosphere Interactions and their Influence on Ocean Biogeochemistry
Maurice Levasseur maurice.levasseur@bio.ulaval.ca Co-conveners: Richard Leaitch and Richard Rivkin
Cycles of elements and energy within the Earth System are closely coupled. Climate feedbacks are regulated by a variety of processes including exchanges between the ocean and atmosphere of solar energy and momentum, gases and particles. Understanding which processes are important and constraining their magnitudes are essential for diagnostic and prognostic models of contemporary and future climate. This type of information is being collected during several IGBP core projects including the Surface Ocean - Lower Atmosphere Study (SOLAS) program. This special session invites papers on the physical, chemical and biological processes underlying these ocean-atmosphere climate-relevant interactions and feedbacks.

SF1 Air Quality Forecasting
Dave Henderson Dave.Henderson@ec.gc.ca
Papers are invited on: experiences with operational air quality forecasting including validations, performance measurement, etc., scientific progress on support tools for air quality forecasting such as numerical models, data assimilation, emissions inventories, etc., applications such as forest fire modelling, security, and health issues, and associated communications and outreach initiatives

SF2 Decision Support Systems for Forecasting
Bjarne Hansen bjarne.hansen@ec.gc.ca
Forecast techniques, statistical systems, ensemble prediction systems, probabilistic forecasts, post-processing, AI, expert systems, alerting systems, teaching systems, visualization systems, graphical user interfaces, Internet applications, risk assessment systems, quality control, performance measurement, and verification systems. (more information at http://chebucto.ns.ca/Science/AIMET/dss/cmos/)

SF3 Broadcast Meteorology
Claire Martin cmartin@globaltv.ca
In recent years the role of the broadcast meteorologist has greatly evolved. The job has professionally matured into a widely accepted avenue of work for Canadian meteorologists. As such papers are invited on the topic of all aspects of weather dissemination through the broadcast medium. Examples of both good and bad weather-broadcasting are requested, as well as case studies that highlight the difficulties of delivering severe weather watches and warnings. Examples of reliability of interpretation, regional biases, educational efforts would also be welcome.

SO1 Ocean Observatories
Richard Dewey rdewey@uvic.ca
Cabled observing systems are either in place or being deployed in several locations. This session is devoted to talks on technical aspects and scientific results from such observatories

SO2 Canadian Arctic Shelf Exchange Study (CASES) and Related Research
John Hanesiak john_hanesiak@umanitoba.ca
Papers are invited on all aspects of physical, biogeochemical and ecological consequences of sea ice variability and change in the Arctic Submit abstracts through the Congress Web Site as well as John Hanesiak .

SO3 Physical Impacts on Ocean Ecosystems
Susan Allen sallen@eos.ubc.ca
Papers are sought that examine how living marine resources are effected by variability of their physical environment. Marine ecosystems are influenced by horizontal and vertical and temporal structure of the ocean's physical properties. Papers are sought that examine how living marine resources are effected by variability of their physical environment. In particular, this session will include research that investigates the mechanisms of coupling between the physical and biological and attempts to quantify that interaction. The emphasis will be at lower trophic levels. Both modelling and observational studies are welcome.

SO4 The 2007 International Polar Year and the Future of Polar Science
Robie Macdonald macdonaldrob@pac.dfo-mpo.gc.ca
In the past century much has been learned about the polar oceans, but many problems remain. This session is devoted to discussing ideas about the future - what problems should we be addressing, what kind of approaches (especially inter- and cross-disciplinary work) are needed? What kind of data should we be gathering?

SO5 Ocean Observations and Assimilation using Argo
Howard Freeland FreelandHj@pac.dfo-mpo.gc.ca and Hal Ritchie Hal.Ritchie@ec.gc.ca
The global Argo array is now well past 50% of implementation and offers the ability to map ocean properties in real time in any ocean basin. As the array continues to increase in size and duration, demand for ocean state assessments and prediction is expected to increase. This session is devoted to 1) invited reports on the current state of Argo, 2) a panel discussion during which users may propose improvements in the way the Canadian component of Argo operates and 3) contributed papers on data assimilation or other use of Argo data .

SP1 Advances and Applications in Road Weather Technologies
Susan Woodbury psc@cmos.ca
Papers are invited on: road weather forecasting in the private sector, the Road Weather Information System for Canada, the benefits of using RWIS stations and pro-active road treatment strategies, RWIS and Intelligent Transportation Systems, technology transfer of the METRo heat balance model, links to the US Clarus initiatives and more .

SG1 Health Issues in Weather and Climate
Denis Bourque denis.bourque@ec.gc.ca
Climate/Climate Change and health issues; Weather and Health issues; Operational Weather-based Health Products & Programs; and papers/research which address the policy and economic aspects of weather and climate on health issues

SG2 The Role of Terrestrial and Oceanic Biogeochemical Cycles in the Climate System
Jim Christian and Vivek Arora jim.christian@ec.gc.ca, vivek.arora@ec.gc.ca
This session will examine exchanges of carbon dioxide and other radiatively active compounds at the earth's surface, including both terrestrial and ocean systems as well as interdisciplinary approaches combining ocean, land and atmosphere. Papers are sought that examine mechanisms that determine the fluxes of greenhouse gases or other radiatively active compounds at the land-atmosphere and ocean-atmosphere interfaces, mechanisms of carbon 'burial' in the deep ocean or in soils, and interactions of the carbon cycle with other elemental cycles (e.g., N). Papers that address the effects of climate variability and change on sources and sinks are particularly encouraged

SG3 Lawrence Mysak Session on Ocean and Climate Dynamics
William Hsieh whsieh@eos.ubc.ca
Professor Lawrence Mysak's early work was in dynamical oceanography, especially on low-frequency wave dynamics and continental shelf processes. Later, he broadened his interests to climate dynamics and modelling of the ocean-ice-atmosphere system, from present day climate variability to paleoclimate. Abstracts are solicited on ocean and climate dynamics, and on all aspects of Mysak's work . The session will be followed by a dinner at a local Chinese restaurant on Wed. June 1 to celebrate with Prof. Mysak and friends (dinner tickets available at registration).

SG4 Norman McFarlane Session on Physical and Numerical Aspects of Climate Modelling
Knut von Salzen knut.vonsalzen@ec.gc.ca
Climate research makes use of a wide range of numerical models of varying complexity. In the last few decades a substantial effort has been directed toward parameterizing the impact of unresolved dynamical and physical processes on the large-scale climate. Internationally, Dr. McFarlane is recognized for his lead role in the development and Application of such parameterizations and he has been instrumental in establishing Canada's high profile in the area of climate research. In honour of Dr. McFarlane's achievements, contributions are invited to address past, present, and future aspects of modelling the physics of the climate system (invited talks/contributed posters). The session will be followed by a reception for Dr. McFarlane.

SG5 Cloud/Climate Interactions
Philip Austin paustin@eos.ubc.ca
Papers are invited on the coupling of clouds and climate, including the impact of clouds on the radiation budget, cloud/climate feedback and aerosol/cloud interactions. Example topics include satellite and in-situ cloud observations, modeling of clouds across a range of temporal and spatial scales, and the representation of clouds in climate and forecast models .

Plenary Speakers

Presentations Delivered In Grand Ballroom

Day & Time	Speaker	Title
Tuesday, May 31 8:45 AM	Michel Jean Service Météorologique du Canada Contact: michel.jean@ec.gc.ca	Current and future Issues in Forecasting : From Traditional Meteorology to Environmental Predictions
Tuesday, May 31 9:30 AM	Jim Abraham Meteorological Service of Canada Contact:jim.abraham@ec.gc.ca	Regional Science Partnerships: a network of national labs
Wednesday, June 1 8:15 AM	Brian Stocks Canadian Forest Service Contact:bstocks@nrcan.gc.ca	Boreal Forest Fire Smoke: Current and Future Issues
Wednesday, June 1 9:00 AM	Verena Tunnicliffe University of Victoria Contact:verenat@uvic.ca	Fast Living in the Deepsea
Thursday, June 2 8:15AM	Douw Steyn, Bruce Ainslie, Ian McKendry University of British Columbia Contact:douw.steyn@ubc.ca	Air pollution in the Lower Fraser Valley, B.C.: Evolution, Measurement, Modelling, and Management.
Thursday, June 2 9:00AM	Richard Thomson Institute of Ocean Sciences Contact:thomsonr@dfo-mpo.gc.ca	The tsunami of 26 December 2004 and its message to Canada
Friday, June 3 8:15 AM	Frédéric Fabry McGill University Contact:frederic.fabry@mcgill.ca	Peeping through the keyhole at the mesoscale variability of atmospheric humidity, or examples and applications of radar refractivity mapping
Friday, June 3 9:00 AM	Harrison, Paul Hong Kong University of Science and Technology Contact:harrison@ust.hk	Is There a Link Between Dust and Fish?: Examining Factors That Control Production in the North Pacific

Abstract Coding Explanation
Explication des codes de résumés

Each paper has been given a uniue 4-part code that serves to identify it within Congress sessions.

- Digit (1-4) denotes the day (Tuesday – Friday).
- Letter (A-E) denotes the part of the day (plenary, morning, early afternoon, late afternoon).
- Letter (D) denotes a 'poster" presentation.
- Digit (1-10) denotes which parallel session it is being presented in.
- Digit (.1-n) denotes the consecutive number of the paper's time slot within a session.

Chaque pré sentation a reçu un code unique, compose de 4 parties pour identifier Durant les session de Congrès'

- Chiffre (1-4) repr"esente le jou dela semaine (mardi – vendredi).
- Lettre (A-E) représente la partied u jour (plénière, matin après la pause, début d'après-midi, fin d'après-midi).
- Lettre (D) représente ne presentation 'affiche'.
- Chiffre (-10) représente la session parallèle dans laquelle se situe la pr'sentation.
- Chiffre (.1-n) représentant le rand consecutive d la presentation durant un une session.

Example: 1B2.3

This paper is being presented on in the first day (1=Tuesday), in the second time slot (B= morning, after break), and is the third paper (.3) being presented in the second session (2) for that time slot.

Cette presentation est la troisième (.3), donnée le premier jour (1=mardi), Durant le matin après le pause (B), dans la deuxième (2) session.

Early Bird Meetings and Events

Day 0 / jour 0		**Monday, May 30 / lundi 30 mai**
Room /salle	**Time / heures**	**Session Name / nom de la séance**
Steveston	09:00-12:00	**Workshop**: Risk Based Systems Using Probabilistic Forecasts
Richmond	09:00-12:00	CMOS Publications Committee
Delta	09:00-17:00	Canadian National Committee for SCOR
Nielson	09:00-12:00	CMOS Private Sector Committee
	12:00-13:00	LUNCH / DÉJEUNER
Richmond	13:00-15:00	CMOS Scientific Committee
Nielson	13:00-14:00	CMOS Centres and Chapters
Steveston	13:00-16:00	**Workshop**: Risk Based Systems Using Probabilistic Forecasts
Nielson	14:00-15:00	CMOS University & Professional Education Committee
Richmond	15:00-16:30	Canadian Foundation for Climate and Atmospheric Sciences (CFCAS) Annual Meeting
Nielson	15:00-16:00	CMOS School & Public Education Committee
Richmond	16:30-18:00	CMOS Council

Additional Meetings and Events Through the Week

Date	**Time**	**Room**	**Event**
Wednesday June 1	16:15-17:30	Grand C	NSERC Presentation
Wednesday June 1	17:30-19:30	Room 2100	Canadian Society of Agricultural and Forest Meteorology (CSAFM) AGM
Wednesday June 1	20:30-22:30	Round Room	CMOS AGM
Friday June 3	10:30-12:00	Landsdowne	Human Resources Study of the Meteorological Sector
Friday June 3	8:15 – 17:00	Round Room	Teachers Day

Associated Information

NSERC

Paul Potvin an NSERC representative will provide an update regarding news at NSERC, statistics from the 2005 Competition, and a review of the future of the Canadian earth and environmental sciences community. At this interactive session, participants are encouraged to ask questions and give their point of view regarding where they see their discipline evolving.

Human Resources Study of the Meteorological Sector

Grant Trump will make a presentation on the 2004-2005 Human Resource Study for the Meteorological Sector which quantified the number of meteorological practitioners in Canada and determined the current and future scope of the activities in which meteorological practitioners are engaging. The study is facilitating the development of a strong human resource strategy that directly investigates workplace skills and addresses the main human resource issues in the private sector. Outputs of the study included:

- Providing the private Canadian meteorological sector with a greater understanding of their current and forecasted labour market requirements.
- Providing meteorological educators and trainers with a greater understanding of the industry's skills requirements and a competency foundation for program and course development and refinement.
- Determining the next steps for the building the capacity of the meteorological sector.

Teachers Day Friday 8:15 to 17:00 Round Room

8:15	Introductions
8:30	**CCGE/CMOS Oceans theme lesson plans** Vince Warry, BC Geography teacher.
9:30	**Atmospheric Science Educational programs from Environment Canada** **And key factors to identify when forecasting the weather in Western Canada** David Jones, senior meteorologist with Environment Canada,
10 am	Health break – viewing of exhibitor booths
10:30	**Making Weather Literacy Part of Every Child's Education** David Phillips. Senior Climatologist, Environment Canada and author of the Canadian Weather Trivia Calendar
11:15	**Online sources of meteorological Materials and how to integrate them into the classroom setting** Dwight Owens, instructional designer and developer with COMET/UCAR in Boulder CO
12-12:30	**Lunch & weather Q&A.** **Ply meteorologist, Mark Madryga with all your weather questions!**
12:30	**The Global Reach of the Sumatra Tsunami of 26 December 2004** Richard Thomson, Tsunami expert from DFO Institute of Ocean Sciences
1:15	**Hurricane Andrew - A Simulation Exercise:** Dale Gregory, retired BC Geography teacher
2:15	**Tying the TV Forecast Into the Curriculum** **Natasha Ramsahai,** Chief Meteorologist with the CBC Weather Centre in Toronto,
3:00	Health break
3:30-5	**The Temperature is Rising** GVRD Climate Change Educational presentation

Week at a Glance/Aperçu de semaine

	Day 1 / jour 1		Tuesday, May 31 / mardi 31 mai	Day 2 / jour 2		Wednesday, June 1 / mercredi 1 juin
	Room / salle	Time /heures	Session Name/ Nom de la session	Room / salle	Time /heures	Session Name/ Nom de la session
Session Block A	Grand Pacific	08:10-08:45	**Opening Ceremony/Cérémonie d'ouverture**	Grand Pacific	08:10	P-2 Plenary day 2/ Plénière jour 2
	Grand Pacific		P-1 Plenary day 1/ Plénière jour 1		08:15	Brian Stocks: Boreal Forest Fire Smoke
		08:45	Michel Jean: Issues in Forecasting		09:00	V Tunnicliffe: Fast Living in the Deepsea
		09:30	Jim Abraham: Regional Science Partnerships			
		09:50	**Daily Weather Briefing**		09:45	**Daily Weather Briefing**
	Foyer	**10:00-10:30**	COFFEE BREAK / PAUSE CAFÉ	**Foyer**	**10:00-10:30**	COFFEE BREAK / PAUSE CAFÉ
Session Block B	Grand A	10:30-12:00	SC1-1 Statistics in Oceanography and Meteorology-1	**Foyer**	**10:00**	**Commercial Exhibitors Gallery Open**
	Grand B	10:30-12:00	SC2-1 Ocean-Cyclone Interactions-1	Richmond	10:30-12:00	SG5-2 Cloud/Climate Interactions-2
	Grand C	10:30-12:00	SG4-1 Norman McFarlane Session-1	Delta	10:30-12:00	SF2-1 Forecasting Decision Support-1
	Grand D	10:30-12:00	SA1-1 Troposphere Chemistry-1	Round Room	10:30-12:00	SG3-1 Lawrence Mysak Session-1
	Richmond	10:30-12:15	SO4-1 2007 International Polar Year-1	Lansdowne	10:30-12:00	SA5-1 Micrometeorology (CMOS/CSAFM)-1
	Delta	10:30-12:00	T1D-1 Precipitation Processes and Patterns-1	Nielson	10:30-12:00	T1F Orographic Flows
	Round Room	10:30-12:00	SA3-1 Atmospheric Community Modelling-1			
	Foyer	12:00-13:30	**LUNCH / DÉJEUNER**	Grand Pacific	12:00-14:00	**Parsons/Patterson Luncheon**
Session Block C	Grand A	13:30-15:00	SC1-2 Statistics in Oceanography and Meteorology-2	Richmond	14:00-15:15	SG5-3 Cloud/Climate Interactions-3
	Grand B	13:30-15:00	SO3-1 Physical Impacts on Ocean Ecosystems-1	Delta	14:00-15:15	SF2-2 Forecasting Decision Support-2
	Grand C	13:30-15:00	SG4-2 Norman McFarlane Session-2	Round Room	14:00-15:15	SG3-2 Lawrence Mysak Session-2
	Grand D	13:30-15:00	SA1-2 Troposphere Chemistry-2	Nielson	14:00-15:15	SA5-2 Micrometeorology (CMOS/CSAFM)-2
	Richmond	13:30-15:00	SO2-1 Canadian Arctic Shelf Exchanges-1	Nielson	14:00-15:15	T1B-1 Forecast Systems-1
	Delta	13:30-17:00	T8A-1 Policy/Education-1			
	Round Room	13:30-15:00	SA3-2 Atmospheric Community Modelling-2			
	Foyer	15:00-16:00	**COFFEE BREAK / PAUSE CAFÉ**	Foyer	15:15-16:15	**COFFEE BREAK / PAUSE CAFÉ**
Block D	UBC Room	15:00-16:00	**POSTERS 1**	UBC Room	15:15-16:15	**POSTERS 2**
Session Block E	Grand A	16:00-17:30	SC1-3 Statistics in Oceanography and Meteorology-3	Grand A	16:15-17:30	T1C Measurement Systems
	Grand B	16:00-17:30	SO3-2 Physical Impacts on Ocean Ecosystems-2	Grand B	16:15-17:30	SG1-1 Health Issues in Weather and Climate-1
	Grand C	16:00-17:30	SG5-1 Cloud/Climate Interactions-1	Richmond	16:15-17:30	SF3 Broadcast Meteorology
	Grand D	16:00-17:30	SA1-3 Troposphere Chemistry-3	Delta	16:15-17:30	SF2-3 Forecasting Decision Support-3
	Richmond	16:00-17:30	SO1-1 Ocean Observatories-1	Round Room	16:15-17:30	SG3-3 Lawrence Mysak Session-3
	Delta	16:00-17:30	T1D-2 Precipitation Processes and Patterns-2	Lansdowne	16:15-17:30	SA5-3 Micrometeorology (CMOS/CSAFM)-3
	Round Room	16:00-17:30	SA2-1 GPS Atmospheric Moisture Retrieval-1	Nielson	16:15-17:30	T1B-2 Forecast Systems-2
	Richmond	18:00	VENUS / NEPTUNE Reception	Grand C	16:15-17:30	**NSERC Presentation**
	Rm 2100	18:00	MacFarlane Reception		17:00-24:00	**Social / Technical Tours**
	Round Room	18:00	**CMOS Warm-Up Reception**	Rm 2100	17:30-19:30	**CSAFM AGM**
	Round Room	20:30	**CMOS AGM**		18:00-22:00	Mysak Dinner

	Day 3 / jour 3		Thursday, June 2 / jeudi 2 juin	Day 4 / jour 4		Friday, June 3 / vendredi 3 juin
	Room / salle	Time /heures	Session Name/ Nom de la session	Room / salle	Time /heures	Session Name/ Nom de la session
Session Block A	Grand Pacific	08:10-	P-3 Plenary day 3/ Plénière jour 3	Grand Pacific	08:10-10:00	P-4 Plenary day 4/ Plénière jour 4
		08:15	Douw Steyn Air pollution Lower Fraser Vly		08:15	Frédéric Fabry: Radar Refractivity Mapping
		09:00	Rick Thomson Tsunami of Dec. 26 2004		09:00	Paul Harrison: Link Between Dust and Fish?:
		09:45	**Daily Weather Briefing**		09:45	**Daily Weather Briefing**
				Round Rm	08:15-	**Teachers Day** (ends at 17:00)
	Foyer	**10:00-10:30**	COFFEE BREAK / PAUSE CAFÉ	**Foyer**	**10:00-10:30**	COFFEE BREAK / PAUSE CAFÉ
Session Block B	Grand A	**10:30-12:00**	SG2-1 Terrestrial and Oceanic Biogeochemical Cycle-1	Grand A	10:30-12:00	T1A-1 Data Assimilation-1
	Grand B	**10:30-12:00**	T6A-1 Climate-1	Grand B	10:30-12:00	T6A-4 Climate-4
	Grand C	**10:30-12:00**	T2C Ocean Data and Observations	Grand C	10:30-12:00	TAA-1 Remote Sensing-1
	Grand D	**10:30-12:00**	SG3-4 Lawrence Mysak Session-4	Grand D	10:30-12:00	SF1-3 Air Quality Forecasting-3
	Richmond	**10:30-12:00**	T1E-1 Severe Weather-1	Richmond	10:30-12:00	SC3-1 Atmosphere/Ocean Biogeochemistry-1
	Delta	**10:30-12:00**	SA4-1 Mackenzie GEWEX Study (MAGS)-1	Delta	10:30-12:00	SO5-1 Argo-1
	Lansdowne	**10:30-12:00**	SF2-4 Forecasting Decision Support-4	Lansdowne	10:30-12:00	Study on Human Resources in Meteorological Sector
	Foyer	12:00-13:30	**LUNCH / DÉJEUNER**	Foyer	12:00-13:30	**LUNCH / DÉJEUNER**
Session Block C	Grand A	13:30-15:00	SG2-2 Terrestrial and Oceanic Biogeochemical Cycle-2	Foyer	13:00	**Commercial Exhibitors Gallery closes**
	Grand B	13:30-15:00	T6A-2 Climate-2	Grand A	13:30-15:00	T1A-2 Data Assimilation-2
	Grand C	13:30-15:00	T2B Ocean Models	Grand B	13:30-15:00	T6A-5 Climate-5
	Grand D	13:30-15:00	SF1-1 Air Quality Forecasting-1	Grand C	13:30-15:00	TAA-2 Remote Sensing-2
	Richmond	13:30-15:00	T1E-2 Severe Weather-2	Grand D	13:30-15:00	SF1-4 Air Quality Forecasting-4
	Delta	13:30-15:00	SA4-2 Mackenzie GEWEX Study (MAGS)-2	Richmond	13:30-15:00	SC3-2 Atmosphere/Ocean Biogeochemistry-2
	Lansdowne	13:30-15:00	SP1-1 Advances and Applications in Road Weather-1	Delta	13:30-15:00	SO5-2 Argo-2
	Nielson	13:30-15:00	Decision Support Systems Discussion			
	Foyer	15:00-15:30	**COFFEE BREAK / PAUSE CAFÉ**	Foyer	15:00-15:30	**COFFEE BREAK / PAUSE CAFÉ**
Session Block E	Grand A	15:30-17:00	SG2-3 Terrestrial and Oceanic Biogeochemical Cycle-3	Richmond	15:30-17:00	SC3-3 Atmosphere/Ocean Biogeochemistry-3
	Grand B	15:30-16:30	T6A-3 Climate-3			
	Grand C	15:30-16:30	T2A Ocean Tides and Tsunamis			
	Grand D	15:30-16:30	SF1-2 Air Quality Forecasting-2			
	Delta	15:30-16:30	T1G-1 Martian Atmosphere-1			
	Lansdowne	15:30-16:30	SP1-2 Advances and Applications in Road Weather-2			
Block D	UBC Room	16:30-17:30	**POSTERS 3**			
	Foyer	17.30-18.30	**Pre Banquet Cocktails (Bar Service)**		17:00	**CMOS Congress 2005 Closes**
	Grand Pacific	18:30	**CMOS Annual Awards Banquet**	**Toronto**	May 30 2006	**See You At CMOS Congress 2006 In Toronto!**

08:10-08:45	**Opening Ceremonies** Room/salle **Grand Ballroom**		
08:45	**P-1 Plenary Day 1** (Al Wallace) Room/salle **Grand Ballroom**		
08:45-09:15	1A0.1: Current and future Issues in Forecasting : From Traditional Meteorology to Environmental Predictions (**Michel Jean**) Inv		
09:30-09:50	1A0.2: Regional Science Partnerships: a network of national labs (**Jim Abraham**)		
09:50-10:00	**Daily Weather Briefing**		**Note: "Inv"** following the author name indicates an **Invited Presentation**
10:00-10:30	**Coffee Break**	**Foyer**	**Pause Café**
	Session Block **1B1** Room/salle **Grand A**	Session Block **1B2** Room/salle **Grand B**	Session Block **1B3** Room/salle **Grand C**
Session Title	SC1-1 Statistics in Oceanography and Meteorology-1 (Michael Dowd)	SC2-1 Ocean-Cyclone Interactions-1 (Jinyu Shen)	SG4-1 Norman McFarlane Session-1 (Knut von Salzen)
10:30	1B1.1: Quantifying the predictability of noisy nonlinear biogeochemical systems (Barbara Bailey) Inv		1B3.1: A new approach to representing cloud processes in climate models (David Randall) Inv
10:45		1B2.1: Study of interannual variability of coupled Atmosphere-Sea Ice-Ocean conditions in Hudson Bay, Foxe Basin and Hudson Straits (Minwei Qian)	
11:00	1B1.2: Recent developments in data assimilation in ocean biogeochemistry (James Christian) Inv	1B2.2: Assessing the Performance of a High-Resolution Coastal Circulation Model Using Observations Made in Lunenburg Bay of Nova Scotia During Hurricane Juan (Jinyu Sheng)	1B3.2: Parameterization and Resolved-Scale Resolution (James Hack) Inv
11:15	1B1.3: An Overview of State Space Models and Particle Filters for Data Assimilation (Michael Dowd)	1B2.3: Dynamical Structures and Precipitation Distribution of Transitioning Tropical Cyclones in Eastern Canada, 1979-2004 (Shawn Milrad)	
11:30	1B1.4: Skewness of Sea Level Variability of the World Ocean (K.R. Thompson) Inv	1B2.4: On the impact of a cold SST anomaly on a strong western North Pacific cyclone (Rick Danielson)	1B3.3: Radiation, Climate, and Climate Modelling (Howard Barker) Inv
11:45	1B1.5: Accounting for serial correlation in multiple linear regression with a random phase periodogram-preserving method (Denis Gilbert)	1B2.5: Giving surface wind model outputs a hurricane attitude: Towards and operational approach (Serge Desjardins)	
12:00			
12:00-13:30	**Lunch**	**Foyer**	**Déjeuner**

	Coffee Break	**Foyer**	**Pause Café**	10:00-10:30
Session Block **1B4** Room/salle **Grand D**	Session Block **1B5** Room/salle **Richmond**	Session Block **1B6** Room/salle **Delta**	**Session Block 1B7 Round Room**	
SA1-1 Troposphere Chemistry-1 (Randall Martin)	SO4-1 2007 International Polar Year1 (Robie W. MacDonald)	T1D-1 Precipitation Processes & Patterns1 (Derrick Kania)	SA3-1 Atmospheric Community Modelling-1 (Sylvie Gravel)	**Session Title**
1B4.1: Deliquescence and Crystallization of Ammonium Sulfate Particles Internally Mixed with Water-Soluble Compounds (Matthew T. Parsons)	1B5.1: Climate Variability and Physical Forcing on Panarctic Shelves: An IPY Perspective (Eddy Carmack) Inv	1B6.1: Progress on the Canadian Precipitation Analysis (CaPA) project (Jean-Francois Mahfouf)	1B7.1: The Canadian weather forecast model is forcasting weather on Mars (Youssef Moudden)	10:30
1B4.2: Gas-Aerosol Chemistry in the Global Troposphere: New Laboratory Measurements (Jon Abbatt) Inv	1B5.2: An International Polar Year project: Thorpex Arctic Weather and Environmental Prediction Initiative (TAWEPI) (Gilbert Brunet)	1B6.2: Characteristics of ice pellets during a winter storm (Steve Gibson)	1B7.2: Evaluation of Precipitation from Weather Prediction Models, Radars and Satellites (Slavko Vasic)	10:45
	1B5.3: The International Polar Year: One year in the life of a variable ocean. (R. Allyn Clarke)	1B6.3: A new way to simulate freezing rain on complex structures (Wladyslaw Rudzinski)	1B7.3: How well does the MC2 model forecast Montreal's record-breaking 8-9 November 1996 precipitation event? (Dorothy Durnford)	11:00
1B4.3: Ice Formation On and In Atmospheric Aerosol Particles (Allan Bertram)	1B5.4: The Polar Environment Atmospheric Research Laboratory (PEARL) at Eureka (80N, 86W) (James R. Drummond)	1B6.4: Reducing Precipitation Forecasting Errors Associated With Ice Phase Particle Classification in Bulk Microphysics Schemes (Jason Milbrandt)	1B7.4: Atmospheric-hydrological modelling of severe precipitation and floods in the Huaihe River Basin, China (Lei Wen)	11:15
1B4.4: The optical and chemical properties of marine aerosol measured off the coast of Nova Scotia (Julia Marshall)	1B5.5: Development of a GEOTRACES program within IPY (Roger Francois)	1B6.5: Parameterization of mass-weighted terminal velocity and precipitation rate of ice particles in terms of ice water content using in-situ aircraft measurements (Faisal Boudala)	1B7.5: The role of anomalously warm sea surface temperatures on the intensity of Hurricane Juan (2003) during its approach to Nova Scotia (Chris Fogarty)	11:30
1B4.5: Multi-year chemistry of particles and selected trace gases at a high elevation Pacific site (Anne Marie Macdonald)	1B5.6: The emerging framework for IPY 2007-2008 (Michel Beland) Inv	1B6.6: Numerical Studies on Winter Precipitation Type Formation (Julie Theriault)	1B7.6: Verifications of parallel runs of MC2 at high resolution (Yan Shen)	11:45
	1B5.7: There's something polar about mercury but is it the atmosphere or the ocean? (Robie W. MacDonald)			12:00
	Lunch	**Foyer**	**Déjeuner**	12:00-13:30

Day 1, Tuesday, May 31 – Session Schedule *Afternoon/après-midi*
1er jour, mardi 31 mai – Horaire des presentations

	Session Block **1C1** Room/salle **Grand A**	Session Block **1C2** Room/salle **Grand B**	Session Block **1C3** Room/salle **Grand C**
Session Title	SC1-2 Statistics in Oceanography and Meteorology-2 (Michael Dowd)	SO3-1 Physical Impacts on Ocean Ecosystems-1 (Susan E. Allen)	SG4-2 Norman McFarlane Session-2 (John Scinocca)
13:30	1C1.1: Nonlinear complex principal component analysis and its applications (W. Hsieh) Inv	1C2.1: Three years of Physics and Biology in the Strait of Georgia (Rich Pawlowicz)	1C3.1: Cirrus, cloud microphysics and aerosols: What can we learn from detailed parcel models for use in global climate models (Ulrike Lohmann) Inv
13:45	1C1.2: Neural Network forecasts of the tropical Pacific sea surface temperatures (Aiming Wu)	1C2.2: Interannual & seasonal variability in the composition, production & trophic status of Strait of Georgia copepod community during STRATOGEM (Akash Sastri)	
14:00	1C1.3: Analysis of past, present and future extreme wave climate (Sofia Caires)	1C2.3: A remotely-sensed survey of the biological response to tropical hurricanes passage in the North West Atlantic in 2003 (César Fuentes-Yaco)	1C3.2: Some issues in middle atmosphere climate modelling (T.G. Shepherd) Inv
14:15	1C1.4: Marine Wind Retrieval and Error Estimation using Synthetic Aperture Radar (Rick Danielson)	1C2.4: Fisheries applications of finite element models in the Bay of Fundy and Gulf of Maine. (D.A. Greenberg)	
14:30	1C1.5: Warm Season Lightning Probability Prediction for Canada and the Northern United States (William Burrows)	1C2.5: Validating a model of plankton-DOM dynamics across different regions in the North Atlantic (Markus Pahlow)	1C3.3: The role of small-scale GWs in the general circulation of the middle atmosphere (Charles McLandress) Inv
14:45		1C2.6: Stochastic methods to quantify the effect of environmental variability on plankton ecosystems (Moritz Lehmann)	
15:00-16:00	**Coffee Break Foyer**	**POSTER Session 1 UBC Room (Int'l Ballroom)**	**Pause Café Foyer**
	Session Block **1E1** Room/salle **Grand A**	Session Block **1E2** Room/salle **Grand B**	Session Block **1E3** Room/salle **Grand C**
Session Title	SC1-3 Statistics in Oceanography and Meteorology-3 (Lawrence Wilson)	SO3-2 Physical Impacts on Ocean Ecosystems-2 (John F. Dower)	SG5-1 Cloud/Climate Interactions-1 (Philip Austin)
16:00	1E1.1 : Climate change signal and uncertainty in projections of ocean wave heights (Xiaolan Wang)	1E2.1: Thermodynamic characterization of the partitioning of iron between soluble and colloidal species in the Atlantic Ocean (Jay Cullen)	1E3.1: Evidence for an Indirect Effect of the Organic Aerosol (Richard Leaitch)
16:15	1E1.2: Correction of Ensemble Temperature Forecasts with Bayesian Model Averaging (Lawrence Wilson)	1E2.2: The Distribution of Dissolved Iron in Coastal Shelf and Slope Waters South of the Queen Charlotte Islands (Marina Chong)	1E3.2: Atmospheric Kinetic Energy Spectrum Simulated by the AFES Global Atmospheric Model (Kevin Hamilton)
16:30	1E1.3: CMC Numerical Weather Prediction Model performance (Thomas E. Robinson)	1E2.3: STRATOGEM 2002-2005: Transports and Biochemical Tracer Fluxes Derived with a Three-Box Inverse Model of the Strait of Georgia (Olivier Riche)	1E3.3: Radiative forcing and response of a GCM to maximum-random overlap of homogeneous clouds (Howard Barker)
16:45	1E1.4: Performance of Precipitation Forecasts for Various Forecast Providers (Patrick McCarthy)	1E2.4: High resolution ferry-based observations of three consecutive spring blooms in the Strait of Georgia (Mark Halverson)	1E3.4: Assessing the response of several GCMs to the McICA radiative transfer methodology (Howard Barker)
17:00	1E1.5: UMOS Marine Wind Forecasting (Lawrence Wilson)		1E3.5: The role of shallow convection in the water and energy cycles of the atmosphere (Knut von Salzen)
17:15			1E3.6: A single scheme for representing cloud amount and condensate: Coupling a statistical cloud scheme with moist turbulence, convection and microphysics. (Colin Jones)
18:00	CMOS Warm-up Reception Round Room AGM @ 20:30	Venus-Neptune Reception Richmond Room	MacFarlane Reception Room 2100

Session Block **1C4** Room/salle **Grand D**	Session Block **1C5** Room/salle **Richmond**	Session Block **1C6** Room/salle **Delta**	Session Block **1C7** Room/salle **Round Room**	
SA1-2 Troposphere Chemistry-2 (Randall Martin)	SO2-1 Canadian Arctic Shelf Exchanges-1 (John M. Hanesiak)	T8A-1 Policy/Education-1 (Patrick McCarthy)	SA3-2 Atmospheric Community Modelling-2 (Sylvie Gravel)	**Session Title**
1C4.1: Bioaerosols: Impacts on Chemistry and Physics of the Lower Atmosphere (Parisa Ariya)	1C5.1: Meteorology and Adverse Weather During CASES (Teresa Fisico)	1C6.1: Defining the Impact of Weather: Solving the HIW Definition Dilemma (Patrick McCarthy)	1C7.1: Back Trajectory Analysis Based on MC2 Sensitivity Study (Xin Qiu)	13:30
1C4.2: Mineral Dust Transport in the CCCma Atmospheric GCM (Mary Catherine Reader)	1C5.2: Blowing Snow Studies in CASES (Canadian Arctic Shelf Exchange Study)03-04 (P.A. Taylor)	1C6.2: The Third MSC Forecasters Forum: Overview and Recommendations (Dov Richard Bensimon)	1C7.2: Surface data assimilation over mountainous British Columbia: Results from near real-time operational runs (Xingxiu Deng)	13:45
1C4.3: Black carbon ageing in the Canadian Centre for Climate modelling & analysis atmospheric general circulation model (Betty [illegible])	1C5.3: Blowing snow (BS)model for prediction of BS events on the Canadian Prairies and Arctic: Preliminary analysis (Jim Butler)	1C6.3: Probabilistic Forecasts and the future of meteorology: Who are the clients? (Kent Johnson)	1C7.3: An Atlantic meso-scale modelling system for the Lunenburg Bay Project (Augustus Fanning)	14:00
1C4.4: Simulation of tropospheric chemistry in the Canadian Middle Atmosphere Model (David Plummer)	1C5.4: The cloud vertical structure in winter Arctic (Xin Jin)	1C6.4: Does Canada need a school of operational meteorology? (Kent Johnson)	1C7.4: Computational Modeling of 3D Turbulent Flows with MC2 (Claude Pelletier)	14:15
1C4.5: GEM-AQ: a multiscale 3D model for chemical weather (John C. McConnell) Inv	1C5.5: Multi-seasonal ocean hindcasting of the Canadian Arctic Archipelago (Frederic Dupont)	1C6.5: An Integrated and Interoperable Risk Assessment and Prediction System for Disaster Monitoring and Management (Harinder Ahluwalia)	1C7.5: Instantaneous Precipitation-Rate Errors Associated With the Microphysics Scheme Used in the 2.5 km GEM-LAM (Jason Milbrandt)	14:30
	1C5.6: Sedimentation of organic matter in northern Baffin Bay phytoplankton & fecal pellets contribution to carbon flux (Gitane Caron)		1C7.6: The Europeo-Canadian unified coupler OASIS3-GOSSIP2 and first coupled applications using the GEM (Sophie Valcke)	14:45
	Coffee Break Foyer	**POSTER Session 1 UBC Room**	**Pause Café foyer**	15:00-16:00
Session Block 1E4 Room/salle Grand D	Session Block 1E5 Room/salle Richmond	Session Block 1E6 Room/salle Delta	Session Block 1E7 Room/salle Round Room	
SA1-3 Troposphere Chemistry-3 (James Sloan)	SO1-1 Ocean Observatories-1 (Richard K. Dewey)	T1D-2 Precip Processes &Patterns-2 (Robert Nissen)	SA2-1 GPS Atmospheric Moisture Retrieval-1 (Susan Skone)	
1E4.1: Latest Measurements from the Measurements Of Pollution in the Troposphere (MOPITT) Instrument (James R. Drummond)	1E5.1: The NEPTUNE Project: installation planning and challenges for Stage 1 (Christopher R. Barnes) Inv	1E6.1: A Preliminary Climatology of Cold Lows over Alberta (Chris Wielki)	1E7.1: Assessing the bias in GPS derived atmospheric moisture in Southern Alberta during the A-GAME project (Craig Smith)	16:00
1E4.2: Space-based constraints on emission inventories of nitrogen oxides (Randall Martin)		1E6.2: Edmonton Extreme Precipitation Event July 11, 2004 (Derrick Kania)	1E7.2: Comparison and Validation of Different Tropospheric Tomography Models in a Regional GPS Network (Natalya Nicholson)	16:15
1E4.3: The Atmospheric Chemistry Experiment (ACE): Mission Overview (John C. McConnell)	1E5.2: SCOOP: Towards an Interoperable Network for Ocean Observing Data (William Allan Perrie)	1E6.3: Large-scale circulation precursors to mesovortices in Alberta (Sébastien Chouinard)	1E7.3: Capping Lid/Dryline Interactions during A-GAME (G.S. Strong)	16:30
1E4.4: The effect of parametrised convection on the vertical distrib of trace gases. (Carlo Buontempo)	1E5.3: WaMoS ll wave radar determining ocean waves and surface currents using x-band marine radar.(Simon Skey)	1E6.4: Pineapple Punch on Ice: Impacts and Implications for British Columbia (Mindy Brugman)	1E7.4: Monitoring of Ground-Based GPS Observations in Preparation for Assimilation in the CMC Analysis and Fcst System (Stephen Macpherson)	16:45
1E4.5: Ground-Level Ozone Trends in Canada 1994-2003 (Amy Hou)	1E5.4: VENUS - The Victoria Experimental Network Under the Sea (Richard K. Dewey)		1E7.5: The performance of regional GEM zenith delay products in the Canadian Arctic (Reza Ghoddousi-Fard)	17:00
1E4.6: High Spring Time Ozone in Northern Latitudes (Dennis Fudge)			1E7.6: FTIR Spectroradiometer Retrievals of Temp and Moisture During 2004 Srn Manitoba Convective Season (John M. Hanesiak)	17:15
				18:00

08:10	**Daily Announcements** Room/salle **Grand Ballroom**	
08:15	**P-2 Plenary day 2** (Rich Pawlowicz) Room/salle **Grand Ballroom**	
08:15-09:00	2A0.1: Boreal Forest Fire Smoke: Current and Future Issues (**Brian Stocks**) Inv	
09:00-09:45	2A0.2: Fast Living in the Deepsea (**Verena Tunnicliffe**) Inv	
09:45-10:00	**Daily Weather Briefing**	**Note: "Inv"** following the author name indicates an **Invited Presentation**

10:00-10:30	**Coffee Break**	**Foyer**	**Pause Café**
	Session Block **2B5** Room/salle **Richmond**	Session Block **2B6** Room/salle **Delta**	Session Block **2B7** Room/salle **Round Room**
Session Title	**SG5-2 Cloud/ClimateInteractions-2 (Philip Austin)**	**SF2-1 Forecasting Decision Support-1 (Bjarne Hansen)**	**SG3-1 Lawrence MysakSession-1 (W. Hsieh)**
10:30	2B5.1: Cloud retrievals from measurements by the SciSat-1 satellite (James Sloan)	2B6.1: The Warning Decision Support System -- Integrated Information (WDSS-II): A DSS for severe weather analysis and forecasting (Valliappa Lakshmanan)	2B7.1: Modeling Landfast Ice (David M. Holland)
10:45	2B5.2: Interactions between gravity waves and convection in shallow cumulus clouds (Terry Clark)	2B6.2: The NCAR Auto-Nowcast System and forecaster role (James Wilson)	2B7.2: Arctic Dipole Anomaly (DA) and Arctic sea ice (Jia Wang)
11:00	2B5.3: Extended time large-eddy simulations of equilibrium marine boundary layer cloud anomalies (Quanzhen Geng)	2B6.3: The Nowcast Decision Support System: A Complete Approach to Decision Making (John Conway)	2B7.3: Neural networks: windows to nonlinearity? (W. Hsieh)
11:15	2B5.4: Dynamics and Predictability of Shallow Cumulus Clouds (J. Kyle Spyksma)	2B6.4: Target identification with a dual polarized C-band radar (David R. Hudak)	2B7.4: The nonlinear association between the Arctic Oscillation and North American winter climate (Aiming Wu)
11:30	2B5.1: Cloud retrievals from measurements by the SciSat-1 satellite (James Sloan)	2B6.5: The Mixed phase precipitation storm of 23 December 2004 in southern Ontario. Part 1: Meteorological Aspects (Patrick King)	2B7.5: On the Genesis of Prolonged Droughts in Canada (Amir Shabbar)
11:45		2B6.6: The Mixed phase precipitation storm of 23 December 2004 in southern Ontario. Part 2: Analysis using polarimetric data (Patrick King)	2B7.6: On the reliability of ENSO dynamical predictions (Youmin Tang)
12:00-14:00	**Parsons / Patterson**	**Luncheon**	GRAND Pacific Ballroom

	Coffee Break	Foyer	Pause Café	
Session Block **2B8** Room/salle **Lansdowne**	Session Block **2B9** Room/salle **Nielson**			
SA5-1 Micrometeorology (CMOS/CSAFM) -1 (T.R. Oke)	T1F Orographic Flows (John Scinocca)			**Session Title**
2B8.1: Recent progress in urban meteorology in Canada (James Voogt)	2B9.1: Climatology of mountain waves over Eastern Canada (Ivan Dubé)			10:30
2B8.2: Overview of the 2005 MontrÃ©al Urban Snow Experiment (MUSE-2005) (Mario Benjamin)	2B9.2: Current and future challenges in diagnosing/forecasting mountain waves over Eastern Canada (Ivan Dubé)			10:45
2B8.3: Methodology of urban cover classification for atmospheric modeling (Aude Lemonsu)	2B9.3: Low-Level Jets and Vertical Wind Shear in Mountainous Regions of the Eastern Canadian Arctic (Nikolaj Nawri)			11:00
2B8.4: Parameterization of Urban Covers for Mesoscale Models (Aude Lemonsu)	2B9.4: Water Tank Modelling of Air Pollution Trapping in Daytime Upslope Flows (Christian Reuten)			11:15
2B8.5: Numerical Simulations of the Urban Boundary Layer Observed During Joint Urban 2003 (Claude Pelletier)	2B9.5: An Evaluation of Several Turbulence Closure Schemes for Modelling Slope Flows (Xiurong Sun)			11:30
2B8.6: Development of a micro-scale 3-D urban energy balance model & application to the study of intra-facet temp distributions Scott Krayenhoff)	2B9.6: Improvements of the MSFD model for Wind Energy Applications (Wensong Weng)			11:45
				12:00-14:00

Day 2, Wednesday, June 1 – Session Schedule *Afternoon/après-midi*
2ième jour, mercredi 1 juin – Horaire des presentations

	Session Block **2C5** Room/salle **Richmond**	Session Block **2C6** Room/salle **Delta**	Session Block **2C7** Room/salle **Round Room**
Session Title	SG5-3 Cloud / Climate Interactions-3 (Philip Austin)	SF2-2 Forecasting Decision Support-2 (Bjarne Hansen)	SG3-2 Lawrence Mysak Session-2 (David M. Holland)
14:00	2C5.1: Development in MOC2 of a Cloud Resolving Model embedded into the Canadian Regional Climate Model (Jean-Pierre Blanchet)	2C6.1: Using Enhanced Graphic Production for Decision Support (Brian T. Greaves)	2C7.1: Simulations of water mass formation and circulation during the early-mid Holocene in a regional eddy-permitting ocean model of the sub-polar North Atlantic (Duo Yang)
14:15	2C5.2: Drizzle category predicted with 3D-CRM (Cristina Stefanof)	2C6.2: Nowcasting Airport Winter Weather: AVISA and Beyond (G.A. Isaac)	2C7.2: Quantifying the Effect of Vegetation Dynamics on the Climate of the Last Glacial Maximum (Alexandra Jahn)
14:30	2C5.3: Effect of Inertia on Turbulent Cloud Droplet Collision Rates (Charmaine Franklin)	2C6.3: The integrated system for production, monitoring and diagnostics at the Norwegian Meteorological Insitute. (Helen Korsmo)	2C7.3: Arctic sea ice modelling: introducing the UVic-granular sea ice coupled model (Jean-Francois Lemieux)
14:45	2C5.4: Cloud Absorption of Solar NIR (Wayne Evans)	2C6.4: Scribe Nowcasting - A Decision Support System (Claude Landry)	2C7.4: Glacial abrupt climate changes and Dansgaard-Oeschger oscillations in a coupled climate model (Zhaomin Wang)
15:00		2C6.5: CMC colour image production and the Vizaweb interface (Lewis Poulin)	
15:15-16:15	**Coffee Break Foyer**	**POSTER Session 2 UBC Room (Int'l Ballroom)**	**Pause Café Foyer**
	Session Block **2E1** Room/salle **Grand A**	Session Block **2E2** Room/salle **Grand B**	Session Block **2E5** Room/salle **Richmond**
Session Title	T1C Measurement Systems (Claude Labine)	SG1-1 Health Issues in Weather and Climate-1 (Denis A. Bourque)	SF3 Broadcast Meteorology (Claire Martin)
16:15	2E1.1: Assessing the Importance of Instrument Testing and Calibration in the Production of a Reliable Temperature Dataset (Gary Beaney)	2E2.1: Impacts of seasonal variability and temperature on foodborne disease (Manon Fleury)	2E5.1: Confessions of A Weather Weenie (D.W. Phillips) Inv
16:30	2E1.2: Measuring Longwave Radiative Flux Divergence (Andres Soux)	2E2.2: The BC Avian Influenza Outbreak: atmospheric transport as a possible propagation mechanism (Real D'Amours)	
16:45	2E1.3: Validation of NO2 and Ozone Retrievals from the MAESTRO Instrument on SCISAT-1 (James R. Drummond)	2E2.3: A possible role of high impact weather events in waterborne disease outbreaks in Canada, 1975-2001 (M. Kate Thomas)	2E5.2: Benefits Of An Operational Relationship Between A TV News Organization & Portland, OR, National Weather Service Office (Matthew Zaffino)
17:00	2E1.4: Rainfall Analysis by Calibrating Weather Radar Images (Xin Qiu)	2E2.4: Weather and air pollution as triggers for heart disease (Denis A. Bourque)	2E5.3: Hurricane Juan vs. the Tropical Punch ; Perfect Forecasts, Imperfect Perceptions (David Jones)
17:15	2E1.5: Development of the Canadian Aircraft Meteorological Data Relay (AMDAR) Program and Plans for the Future (Gilles Fournier)	2E2.5: An Automated Synoptic Typing Procedure to Predict Heat-Related Mortality Occurrence in South Central Canada (Chad Shouguan Cheng)	2E5.4: Open discussion: defining a broadcast meteorologist, and the role of CMOS in endorsing such an individual. (Claire Martin) Inv
17:00-24:00	Social/Technical Tours	CSAFM AGM 17:30 Room 2100	Mysak Dinner 18:00

Session Block **2C8** Room/salle **Lansdowne**	Session Block **2C9** Room/salle **Nielson**		
SA5-2Micrometeorology (CMOS/CSAFM) -2 (Jon S. Warland)	T1B-1 Forecast Systems-1 (Roland B. Stull)		**Session Title**
2C8.1: Tools for the quantification of N2O emissions from Agroecosystems (Elizabeth Pattey)	2C9.1: Dynamics of forecast error in an NWP system (Huw Davies)		14:00
2C8.2: In situ dynamics of water soluble carbon & mineralization of liquid and solid dairy cattle manure in agricultural soils of contrasting textures. (Philippe Rochette)	2C9.: 2 A High-Resolution Global Modeling System for Medium-Range Weather Forecasting at Environment Canada (Stéphane Bélair)		14:15
2C8.3: Artificial Neural Networks (ANNs) Application for Prediction of the Date of Wheat Phenological Stages Occurrence Using Climatic Data (Babak Safa)	2C9.3: On the use of ensembles in the forecasting process (Lawrence Wilson)		14:30
2C8.4: Crop Phytomass Monitoring using Eddy CO2 Flux and Hyperspectral Reflectance (Elizabeth Pattey)	2C9.4: Performance of the CMC multi-model seasonal forecasting system (Normand Gagnon)		14:45
	2C9.5: Current status and future improvements in the CMC's operational forecasting suite (Richard Hogue)		15:00
Coffee Break Foyer	**POSTER Session 2 UBC Room**	**Pause Café Foyer**	15:15-16:15

Session Block **2E6** Room/salle **Delta**	Session Block **2E7** **Round Room**	Session Block **2E8** Room/salle **Lansdowne**	Session Block **2E9** Room/salle **Nielson**	
SF2-3 Forecasting Decision Support-3 (Bjarne Hansen)	SG3-3 Lawrence MysakSession-3 (G.E. Swaters)	SA5-3 Micrometeorology (CMOS/CSAFM) -3 (Ian Strachan)	T1B-2 Forecast Systems-2 (Laurie K. Neil)	**Session Title**
2E6.1: The Research Support Desk at the Ontario Storm Prediction Centre (David M.L. Sills)	2E7.1: Sea-Ice and Ocean Variability in Response to Different Wind Forcing Fields, with Application to the Little Ice Age	2E8.1: Water Balance of Forest, Clearcut and Regenerating Stands (D. Spittlehouse)	2E9.1: Future role of humans in the forecast process. (Kent Johnson)	16:15
2E6.2: The Edmonton Hailstorm of 2004: Integrating Hail, Convective Precipitation and Lightning Forecasts (Julian Charl Brimelow)	2E7.2: Response of the ocean, climate and terrestrial carbon cycle to the receding Laurentide Ice Sheet (Yi Wang)	2E8.2: Investigation of Water Balance using CLASS on Goose Creek near Churchill, Manitoba, Canada (Sung Joon Kim)	2E9.2: State-of-the-Science Weather Forecasting in the Private Sector - The Butterfly Effect (James Young)	16:30
2E6.3: Satellite use for fog nowcasting and cloud phase detection (Ismail Gultepe)	2E7.3: The Scotian Slope Water and the Gulf Stream (Frederic Dupont)	2E8.3: Atmospheric Modelling of Mountain Pine Beetle Dispersal (Peter L. Jackson)		16:45
2E6.4: A fuzzy logic based analog forecasting system for ceiling and visibility (Bjarne Hansen)	2E7.4: Paleotides in the Bay of Fundy and Gulf of Maine (D.A. Greenberg)	2E8.4: Development of high spatial resolution climate data for British Columbia (D. Spittlehouse)		17:00
				17:15
			NSERC Presentation Paul Potvin Grand C	**16:15 - 17:30**

08:10	**Daily Announcements** Room/salle **Grand Ballroom**	
08:15	**P-3 Plenary day 3** (Rich Pawlowicz) Room/salle **Grand Ballroom**	
08:15-09:00	3A0.1: Air pollution in the Lower Fraser Valley, B.C.: Evolution, Measurement, Modelling, and Management. (Douw Steyn/ B. Ainslie/ Ian McKendry) Inv	
09:00-09:45	3A0.2: The tsunami of 26 December 2004 and its message to Canada (R.E. Thomson) Inv	
09:45-10:00	**Daily Weather Briefing**	**Note: "Inv"** following the author name indicates an **Invited Presentation**

10:00-10:30	**Coffee Break**	**Foyer**	**Pause Café**
	Session Block **3B1** Room/salle **Grand A**	Session Block **3B2** Room/salle **Grand B**	Session Block **3B3** Room/salle **Grand C**
Session Title	SG2-1 Terrestrial and Oceanic Biogeochemical Cycle-1 (Jim Christian and Vivek Arora)	T6A-1 Climate-1 (Steven Lambert)	T2C Ocean Data and Observations (Keith Thompson)
10:30	3B1.1: The Canadian Global Coupled Carbon Climate Model (CGC3M) (Ken L. Denman) Inv	3B2.1: Simulating the atmospheric energy cycle in AMIP models (G.J. Boer)	3B3.1: Subtidal Current in the Narrows of St. John's Harbor (Ming Guo)
10:45		3B2.2: Sensitivity of the CRCM predicted climate change over North America (Hélène Côté)	3B3.2: Understanding Observed Seasonal Temperature Changes in the Labrador Sea (Youyu Lu)
11:00	3B1.2: The Canadian Model Of Ocean Carbon and its equilibrium carbon climate (Konstantin Zahariev)	3B2.3: On the Fingerprint of the Dehydration-Greenhouse Feedback (Jean-Pierre Blanchet)	3B3.3: The Formation and Circulation of the Cold Intermediate Layer in the Gulf of St. Lawrence (Gregory Smith)
11:15	3B1.3: Modelling the soil consumption of atmospheric methane (Charles Curry)	3B2.4: A Comparison of Two Downscaling Methods to Determine Site-Specific GCM-Simulated Temperature Changes in the NWT (Heather Antoniuk)	3B3.4: A Circulation Model for the Broughton Archipelago (Michael Foreman)
11:30	3B1.4: An overview of the Canadian Terrestrial Ecosystem Model (CTEM) (Vivek Arora)	3B2.5: Internal variability in regional climate downscaling (Adelina Alexandru)	3B3.5: Mean Sea Surface Topography of the North Atlantic Calculated Using an Ocean Circulation Model and Gravity Data from the Recent CHAMP and GRACE Satellite Missions (K.R. Thompson)
11:45	3B1.5: Holocene climate and carbon cycle dynamics: Experiments with the ""green"" McGill Paleoclimate Model (Yi Wang)	3B2.6: Climate variability from the instrumental record in northern British Columbia (Vanessa Egginton)	3B3.6: The scale and occurrence of surface wave-breaking (Johannes Gemmrich)
12:00-13:30	**Lunch**	**Foyer**	**Déjeuner**

	Coffee Break	**Foyer**	**Pause Café**	10:00-10:30
Session Block **3B4** Room/salle **Grand D**	Session Block **3B5** Room/salle **Richmond**	Session Block **3B6** Room/salle **Delta**	Session Block **3B8** Room/salle **Lansdowne**	
SG3-4 Lawrence MysakSession-4 (Patrick Cummins)	T1E-1 Severe Weather-1 (Pierre Gauthier)	SA4-1 Mackenzie GEWEX Study (MAGS) -1 (Peter Di Cenzo)	SF2-4 Forecasting Decision Support-4 (Bjarne Hansen)	**Session Title**
3B4.1: Stability characteristics of dynamically coupled overflows and internal gravity waves (Gordon Swaters)	3B5.1: Forecasting Tornadic Thunderstorms in Alberta using Environmental Sounding Data Part I: Wind Shear and Buoyancy (Max Dupilka)	3B6.1: Atmospheric processes and the Mackenzie basin climate system (K.K. Szeto) Inv	3B8.1: Consensus Probabilistic Forecasting of Sensible Weather (William Myers)	10:30
3B4.2: Upstream Internal Hydraulic Jumps (Patrick Cummins)	3B5.2: Forecasting Tornadic Thunderstorms in Alberta using Environmental Sounding Data. Part II: Precipitable Water, Storm Convergence and Helicity (G.W. Reuter)		3B8.2: A Comparison of methods for combining probabilistic forecasts (Matthew Pocernich)	10:45
3B4.3: Wave Source Term Parameterizations and Energy-Flux Balances (William Allan Perrie)	3B5.3: Severe Weather Linkages to Soil Moisture on the Canadian Prairies (An Tat)	3B6.2: The Impact of Climate Change and Western Pacific Extratropical Transition on the Mackenzie River Basin (Eyad Atallah)	3B8.3: The Winter Maintenance Decision Support System (MDSS): Project Status and Summary Results (William Mahoney)	11:00
3B4.4: Finite amplitude development of time-varying abyssal currents (Seung Ji Ha)	3B5.4: Canadian Lightning Detection Network: Performance Measurement, Flash Densities and Notable Statistics (Kelsey Spring)	3B6.3: Comparison of the Shortwave and Longwave Radiative Budgets of the Mackenzie River Basin from a Regional Climate Model and Satellite observations (Song Guo)	3B8.4: Using Methods of Experimental Economics to Assess the Communication of Forecast Uncertainty (Mark Roulston)	11:15
3B4.5: Observations of the Effect of Shear on Internal Wave Propagation (Caixia Wang)	3B5.5: Relationships between Lightning and Convective Rainfall in Canada (Bob Kochtubajda)	3B6.4: Moisture flux convergence into the Mackenzie River Basin using NCEP reanalysis data (Mark Schuster)	3B8.5: A Probability of Event Occurrence Approach to Performance Estimate (Phil Chadwick)	11:30
3B4.6: Submarine Canyons: Does length matter? (Amy Waterhouse)		3B6.5: Integrated Hydrologic Modelling In MAGS (Frank Seglenieks)	3B8.6: Atlantic Ensemble Marine Forecast Validation against Regional 00HR GEM Forecasts (Serge Desjardins)	11:45
	Lunch	**Foyer**	**Déjeuner**	12:00-13:30

Day 3, Thursday, June 2 – Session Schedule *Afternoon/après-midi*
3ième jour, jeudi 2 juin – Horaire des presentations

	Session Block **3C1** Room/salle **Grand A**	Session Block **3C2** Room/salle **Grand B**	Session Block **3C3** Room/salle **Grand C**
Session Title	SG2-2 Terrestrial and Oceanic Biogeochemical Cycle-2 (Jim Christian and Vivek Arora)	T6A-2 Climate-2 (G.J. Boer)	T2B Ocean Models (Zhaomin Wang)
13:30	3C1.1: Sensitivity of the marine anthropogenic CO2 sink to ocean circulation (Andrew Ridgwell) Inv	3C2.1: Winter warm spells in the Alps: Heat waves in a cold season? (Martin Beniston)	3C3.1: Circulation off Newfoundland and Labrador: Annual mean and seasonal variability (Guoqi Han)
13:45		3C2.2: Honey, I shrunk the Ocean! (John Fyfe)	3C3.2: A Lagrangian model for sea ice dynamics (Daniel Deacu)
14:00	3C1.2: Interannual variability of carbon export and DOM in the Labrador Sea (Markus Pahlow)	3C2.3: North-American Climate as downscaled by an ensemble of CRCM simulations (Ramon de Elia)	3C3.3: Simulation of the Northeast Pacific with spectral nudging (Jennifer Shore)
14:15	3C1.3: A biogeochemical patch model of the NE Pacific SERIES in situ manipulation experiment (Debby Ianson)	3C2.4: Adverse Weather Trends in the Canadian Arctic (John M. Hanesiak)	3C3.4: Constructing a Numerical Ocean Model with Local Domain but Global Boundaries (LDGB) and its Initial Applications to Tsunamis and Storm Surges (Zhigang Xu)
14:30	3C1.4: The Response of Diatoms to a Mesoscale Iron Enrichment During the SERIES Experiment in the NE subarctic Pacific (Adrian Marchetti)	3C2.5: Results of present climate simulations performed with the GEM forecast model at RPN (Bernard Dugas)	3C3.5: A Shared Atmosphere-Ocean Dynamical Core: First Validation (Francois Roy)
14:45		3C2.6: The life cycle of the AO and the NAO: An observational study (XIAOJING JIA)	3C3.6: Spectral nudging in the tracer and momentum equations (D.G. Wright)
15:00-15:30	**Coffee Break**	**Foyer**	**Pause Café**
	Session Block **3E1** Room/salle **Grand A**	Session Block **3E2** Room/salle **Grand B**	Session Block **3E3** Room/salle **Grand C**
Session Title	SG2-3 Terrestrial and Oceanic Biogeochemical Cycle-3 (Jim Christian and Vivek Arora)	T6A-3 Climate-3 (John Fyfe)	T2A Ocean Tides and Tsunamis (Michael Foreman)
15:30	3E1.1: Tree migration after a breakdown of the North Atlantic thermohaline circulation (Jennifer Brauch)	3E2.1: The Effect of Enhanced Greenhouse Warming on Freezing Rain in North America (Steven Lambert)	3E3.1: Tidal and Sub-Tidal Current Dynamics in Bonne Bay, Newfoundland (Clark Richards)
15:45	3E1.2: Seven years of CO2 and water vapour exchange measurements above a West Coast Douglas-fir forest (Kai Morgenstern)	3E2.2: The Impact of Climate Change on Northwest Atlantic Extratropical Hurricanes (Jing Jiang)	3E3.2: Tsunami generation by submarine landslides: Models and application. (Roy Walters)
16:00	3E1.3: Large-eddy simulation of CO2 transport through forest canopies in complex terrain (Haizhen Sun)	3E2.3: An investigation of the summer precipitation simulated by the Canadian Regional Climate Model (Yanjun Jiao)	3E3.3: Tides and Sea-Surface Variability in the SW Pacific from TOPEX/Poseidon (Robert Bell)
16:15	3E1.4: Biogeochemical cycling of carbon monoxide in the Canadian Beaufort sea (Huixiang Xie)	3E2.4: Correction of GCM seasonal forecasts using the leading forced SVD patterns (Hai Lin)	3E3.4: Tsunami run-up and damage on the Andaman Coast,Thailand from the Boxing Day seismic event. (Robert Bell)
16:30	**Poster Session 3** **UBC Room**		
17:30-18:30	Pre-Banquet Cocktails	FOYER (Bar Service)	
18:30	39th Annual CMOS	Awards Banquet	Grand Pacific Ballroom

Session Block **3C4** Room/salle **Grand D**	Session Block **3C5** Room/salle **Richmond**	Session Block **3C6** Room/salle **Delta**	Session Block **3C8** Room/salle **Lansdowne**	
SF1-1 Air Quality Forecasting-1 (Michael C. Howe)	T1E-2 Severe Weather-2 (G.W. Reuter)	SA4-2 Mackenzie GEWEX Study (MAGS) -2 (Peter Di Cenzo)	SP1-1 Advances and Applications in Road Wx-1 (Claude Labine)	**Session Title**
3C4.1: Ensemble Air-Quality Forecasts over the Lower Fraser Valley, British Columbia (Luca Delle Monache)	3C5.1: The Extratropical Transition of Hurricane Karen: Data and Modelling Studies (Steve Miller)	3C6.1: Convection, Lightning and Fire in the Mackenzie Basin (Bob Kochtubajda)	3C8.1: Development of Winter Severity Index for Winter Road Operations (Chris Marshall)	13:30
3C4.2: Air Quality Forecasting in Ontario: A Review of Past and Current Activities, and Future Needs (Douglas Simpson)	3C5.2: Hurricane Juan: a diagnostic and compositing study (Eyad Atallah)	3C6.2: Atmospheric Circulation Patterns of Extreme Lightning Events in the Mackenzie River Basin (Andrew Way)	3C8.2: RWIS System Deployment and Operation - The Alberta Approach. (Bruno Peters)	13:45
3C4.3: Trans-Boundary Transport of Air Pollution over Nova Scotia with Implications on AQ Fcstg: Case Study: (David Waugh)	3C5.3: Warm season precipitation events in the St. Lawrence River Valley (Eyad Atallah)	3C6.3: Wildfire Aerosol Forcing on the Radiation Budgets over the Makenzie River Basin (Song Guo)	3C8.3: How Can We Achieve Greater Value from RWIS in Winter Operations? (Dale Keep)	14:00
3C4.4: Real-Time Weather and Air Quality Forecast Products in Support of ICARTT 2004 and Prairies 2005. (Sylvain Menard)	3C5.4: Vortex Rossby Waves in Hurricanes: their importance for numerical weather prediction (Yosvany Martinez)	3C6.4: Blowing Snow Sublimation in the Northern Mackenzie River Basin (Mark Gordon)	3C8.4: The Weather Network-Commercial Services: The Complete RWIS Solution (Bruce Caven)	14:15
3C4.5: Integration of Real Time PM2.5 Emission Rates from Forest Fires with a Dynamic Model in order to Simulate Wildfires in CHRONOS to Improve the AQ Forecast (Jacques Rousseau)	3C5.5: Observing systems and predictability on forecasting extreme weather events: a component of the THORPEX programme (Pierre Gauthier)	3C6.5: Northern Lake Impacts on Climate (William Allan Perrie)	3C8.5: Panel Discussion on Road Weather Technologies-1 (Claude Labine)	14:30
3C4.6: Ozone Forecasting in Central B.C. Using Maximum Wind Speed and Hours of Bright Sunshine (Dennis Fudge)		3C6.6: The Influe nce of Great Bear Lake on Atmospheric Boundary Layer Structure (Andrew Way)		14:45
	Coffee Break	**Foyer**	**Pause Café**	15:00-15:30
Session Block **3E4** Room/salle **Grand D**	Session Block **3E6** Room/salle **Delta**	Session Block **3E8** Room/salle**Lansdowne**		
SF1-2 Air Quality Forecasting-2 (Dave Henderson)	T1G-1 Martian Atmosphere-1 (John C. McConnell)	SP1-2 Advances and Applications in Road Wx-2 (Claude Labine)		**Session Title**
3E4.1: Example of Real-Time Emergency Response: The S03 Release in Valleyfield QC. (Real D'Amours)	3E6.1: Phoenix MET: Canadian contributions to a NASA/CSA mission to Mars (P.A. Taylor)	3E8.1: A Road Weather Information System for Canada Update (Paul J. Delannoy)		15:30
3E4.2: The Sea-to-Sky Highway Corridor Improvement Project. Predicting Future Air Quality.	3E6.2: Large-Eddy Simulation of the Atmospheric Boundary Layer of Mars (Babak Tavakoli)	3E8.2: METRO 2, a new version of the road condition prediction model for general use. (Miguel Tremblay)		15:45
3E4.3: Revisiting Canadian Air Quality Indices: A Health Risk Based Approach (Dave Henderson)	3E6.3: Atmospheric Chemistry on Mars using the Global Mars Multiscale Model (GM3) (John C. McConnell)	3E8.3: EnSim-WE: a fully Canadian meso/microscale low-level wind mapping software for the private sector (Robert Benoit)		16:00
	3E6.4: Sublimation of Ice particles on urface of Mars laboratory simulations related to Phoenix. (P.A. Taylor)	3E8.4: Panel Discussion on Road Weather Technologies - 2 (Claude Labine)		16:15
				17:30-18:30
				18:30

08:15-17:00	**Teachers Day** **Round Room**	
08:15	**P-4 Plenary day 4** (Dr. C. Harold Ritchie) Room/salle **Grand Ballroom**	**Note: "Inv"** following the author name indicates an **Invited Presentation**
08:15-09:00	4A0.1: 1 Peeping through the keyhole at the mesoscale variability of atmospheric humidity, or examples and applications of radar refractivity mapping **(Frédéric Fabry) Inv**	
09:00-09:45	4A0.2: Is There a Link Between Dust and Fish?: Examining Factors That Control Production in the North Pacific **(Paul Harrison) Inv**	
09:45-10:00	**Daily Weather Briefing**	

10:00-10:30	**Coffee Break**	**Foyer**	**Pause Café**
	Session Block **4B1** Room/salle **Grand A**	Session Block **4B2** Room/salle **Grand B**	Session Block **4B3** Room/salle **Grand C**
Session Title	T1A-1 Data Assimilation-1 (Pierre Gauthier)	T6A-4 Climate-4 (Viatcheslav Kharin)	TAA-1 Remote Sensing-1 (Roland B. Stull)
10:30	4B1.1: Assimilation of radar data in mesoscale numerical prediction models (Xingbao Wang)	4B2.1: An Assessment of the PRECIS Regional Climate Modelling System over North America (Pascale Martineu)	4B3.1: The assimilation of SSM/I brightness temperatures in clear skies at MSC (David Anselmo)
10:45	4B1.2: Evaluation of the operational 4D-Var data assimilation cycle at the Meteorological Service of Canada (Jose Morneau)	4B2.2: Singular vector analysis for a fully coupled Atmosphere-Ocean-Land System (Youmin Tang)	4B3.2: Assimilation of passive microwave brightness temperatures in tropical rainy areas over oceans (Godelieve Deblonde)
11:00	4B1.3: Monitoring 4D-Var data assimilation using observation sensitivity calculation (Simon Pellerin)	4B2.3: Climatology and changes of extra-tropical storm tracks and cyclone activity: Comparison of ERA-40 with NCEP/NCAR Reanalysis for 1958-2001 (Xiaolan Wang)	4B3.3: Information projection as a way to gauge the value of added channels in satellite-sounding retrievals (Roland B. Stull)
11:15	4B1.4: Impact of a flow-dependent background error covariance model based on sensitivity functions in a 3D-VAR (Cristina Lupu)	4B2.4: January Thaw and other Singularities in a Warming Climate (G.S. Strong)	4B3.4: Statistical derivation of ground-based microwave radiometric retrieval coefficients of precipitable water vapour and liquid water path and mean radiating temperature from Maniwaki sounding data (Zlatko Vukovic)
11:30	4B1.5: Characteristics of Key Analysis Errors: Application to Data Assimilation (Peter Zwack)	4B2.5: Climate change impacts on the hydrology of six North-American basins simulated by the Canadian Regional Climate Model (Laxmi Sushama)	4B3.5: GRACE Satellite Observations of Terrestrial Moisture Changes and Drought Measurement in Western Canada (Ken Snelgrove)
11:45		4B2.6: The influence of climate regime shift on ENSO (Zhengqing Ye)	4B3.6: Canada's Participation to the Hydros Soil Moisture and Freeze/Thaw Mission (Stephane Belair)
12:00-13:30	**Lunch**	**Foyer**	**Déjeuner**

	Coffee Break	**Foyer**	**Pause Café**	10:00-10:30
Session Block **4B4** Room/salle **Grand D**	Session Block **4B5** Room/salle **Richmond**	Session Block **4B6** Room/salle **Delta**	Room/sale **Lansdowne**	
SF1-3 Air Quality Forecasting-3 (Paul Makar)	SC3-1 Atmosphere/Ocean Biogeochem-1 (Maurice Levasseur)	SO5-1 Argo-1 (Howard J. Freeland)	Extra Session	**Session Title**
4B4.1: Development work done at CMC to improve CHRONOS, the operational Canadian numerical Air Quality Model (Richard Moffet)	4B5.1: Climatology of Asian Dust Aerosol and its Trans-Pacific Transport - Interannual Variability and Climate Connections (Sunling Gong)	4B6.1: A Report on the Status of Argo in general and its status in the N. E. Pacific. (Howard J. Freeland)	Study on Human Resources to Meteorological Sector (Grant Trump) 1.5 hours	10:30
4B4.2: Real-time PM2.5 forecasts over Eastern North America during the summer of 2004: An assessment of several models and their ensemble (Stuart McKeen)	4B5.2: Canadian SOLAS Experiments Simulated in a 1-D Coupled Atmosphere-Ocean-Biogeochemical Model (Nadja Steiner)	4B6.2: Canadian Argo program in the North Atlantic (R. Allyn Clarke) Inv		10:45
4B4.3: Objective Analysis and Assimilation of Surface Ozone into Air Quality Models (Alain Robichaud)	4B5.3: Determination of the relative importance of physical and biological processes on surface ocean DMS pool during SERIES (Yvonnick Le Clainche)	4B6.3: Oxygen measurements on Argo floats (Denis Gilbert) Inv		11:00
4B4.4: Bias Corrected Ensemble Predictions of Surface Ozone (James Wilczak)	4B5.4: Comparative analysis of NARCM simulations and measurements taken during CSOLAS-SERIES field campaign (Jean-Pierre Blanchet)	4B6.4: Canada's contributions to Argo in observing the ocean in real-time (Anh Tran) Inv		11:15
4B4.5: Processing the Canadian National Emissions Inventory 2000 with SMOKE (Mourad Sassi)	4B5.5: Modelling the Ecosystem Response to Iron Fertilization during SERIES (Angelica Pena)	4B6.5: Panel discussion on Argo implementation (Howard J. Freeland)		11:30
4B4.6: Real-time Air Quality Forecasting - A State-of-the-Art Approach (James Young)	4B5.6: Identification of water masses in the North West Atlantic during Canada-SOLAS research cruises in 2003 using MODIS data (Emmanuel Devred)			11:45
	Lunch	**Foyer**	**Déjeuner**	12:00-13:30

Day 4, Friday, June 3 – Session Schedule *Afternoon/après-midi*
4ième jour, vendredi 3 juin – Horaire des presentations

	Session Block **4C1** Room/salle **Grand A**	Session Block **4C2** Room/salle **Grand B**	Session Block **4C3** Room/salle **Grand C**
Session Title	T1A-2 Data Assimilation-2 (Peter Zwack)	T6A-5 Climate-5 (Hai Lin)	TAA-2 Remote Sensing-2 (Stéphane Bélair)
13:30	4C1.1: Innovation based estimation of background and obseravtion error statistics in variational data assimilation (Zhuo Liu)	4C2.1: Simulating Heterogeneous stratospheric Ozone loss in a GCM:Continuing studies using CMAM. (John C. McConnell)	4C3.1: Improved measurements of wind profilers (Philipp Currier)
13:45	4C1.2: SST data assimilation (Youmin Tang)	4C2.2: Real-Time Collection and Distribution of MSC T&P Climate Data (John MacPhee)	4C3.2: Radar Meteorology at VHF band (Edwin F. Campos)
14:00	4C1.3: Description of a Canadian Land Data Assimilation System (CaLDAS) (Jean-Francois Mahfouf)	4C2.3: Numerical Wind Energy Atlas for Canada (Wei Yu)	4C3.3: Identification of microphysical processes with polarimetric radar (Dimka Dafinova)
14:15		4C2.4: Rehabilitating the Referecne climate Station Network (Yves Durocher)	4C3.4: Effect of the spatial variability of precipitation on the differential phase shift (Julie Deshaies)
14:30		4C2.5: The Role of Soil Moisture in Climate Predictability (Barbara Winter)	4C3.5: Hydrological Model Validation of Surface precipitation from Volumetric Doppler Radar Data (Erika Klyszejko)
14:45		4C2.6: Changes in temperature and precipitation extremes as simulated in the IPCC multi-model ensemble of global coupled climate model simulations (Viatcheslav Kharin)	
15:00-15:30	**Coffee Break**	**Foyer**	**Pause Café**

	Session Block **4E5** Room/salle **Richmond**
Session Title	SC3-3 Atmosphere/Ocean Biogeochemistry-3 (Richard Leaitch)
15:30	4E5.1: Development of coupling strategy NODEM-NARCM through GOTM (Jean-Pierre Blanchet)
15:45	4E5.2: Algal Production of Dimethylsulphoxide (DMSO) in Seawater (Louise Darroch)
16:00	4E5.3: Spatial and temporal patterns of microbial dynamics in the Northwest Atlantic: Potential role in cycling of climate active gases (Richard Rivkin)
16:15	4E5.4: Seasonal and spatial variability of ocean-atmosphere fluxes of methyl halides in the N. Atlantic: what do they reveal of the sources? (Robert M. Moore)
16:30	4E5.5: High concentrations of DMSP and DMS during a Northwest Atlantic seasonal cycle (Michael Scarratt)
16:45	4E5.6: Seasonal Variations in Atmospheric Dimethylsulphide Over the North Atlantic during SABINA (Ann-Lise Norman)
17:00	39th Annual CMOS Congress Adjourns

Session Block **4C4** Room/salle **Grand D**	Session Block **4C5** Room/salle **Richmond**	Session Block **4C6** Room/salle **Delta**	
SF1-4 Air Quality Forecasting-4 (Richard Moffet)	SC3-2 Atmosphere/Ocean Biogeochemistry-2 (Richard Rivkin)	SO5-2 Argo-2 (C. Harold Ritchie)	**Session Title**
4C4.1: Simulations of Anthropogenic Heat: Meteorological and Air Quality Implications (Paul Makar)	4C5.1: Phytoplankton Production and Export during the Decline of a Northwest Atlantic Spring Bloom (Julien Pommier)	4C6.1: Towards Operational Assimilation of ARGO Data (C. Harold Ritchie)	13:30
4C4.2: Fuzzy Logic Modeling of Surface Ozone Concentrations (Rachel Mintz)	4C5.2: Uptake of CO2 in the Northwest Atlantic Ocean (Zhi-Ping Mei)	4C6.2: Estimation of the circulation in an ocean basin using Argo. (Howard J. Freeland)	13:45
4C4.3: A simulation of aerosol dispersion and wet deposition using a Lagrangian stochastic dispersion model and precipitation fields from	4C5.3: Seasonal and Spatial Patterns of Bacterial Community Structure in the Northwest Atlantic (Kimberley Keats)	4C6.3: Recent Ocean Temperature Anomalies in the Gulf of Alaska (W.R. Crawford)	14:00
4C4.4: A new numerical scheme for sub-grid scale convective transport of chemical tracers (Daniel Figueras-Nieto)	4C5.4: Springtime DMS production during a Lagrangian study of the North Atlantic diatom bloom (Martine Lizotte)	4C6.4: Can seal based observations complement Argo observations for ocean forecasting in eastern Canadian Waters? (Fraser Davidson)	14:15
4C4.5: The CMC Trajectory Model (Jacinthe Racine)	4C5.5: Dynamics of DMSP consumption and DMS production by attached and free bacteria during the declining phase of a diatom spring bloom (Anissa Merzouk)		14:30
	4C5.6: Source Apportionment of Sulphate Aerosols & Gaseous Sulphur Dioxide over NW Atlantic using Stable Sulphur Isotopes. (Sarah Jane Eaton)		14:45
Coffee Break	**Foyer**	**Pause Café**	15:00-15:30

Tuesday/mardi, 31 May/mai
Session 1A0
Plenary day 1
Grand Ballroom, Chair/Président: ***Al Wallace***

(INVITED/INVITÉ) 8:45 AM

1A0.1
Current and future Issues in Forecasting : From Traditional Meteorology to Environmental Predictions
Michel Jean
Service Météorologique du Canada
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Predicting the weather accurately, in the traditional sense, has been one of the factors associated with the development of safe transportation systems, of increased agricultural and silvicultural productivity and of warning systems to alert and protect citizens from extreme weather events. This infrastructure opens new and exciting opportunities and numerical modelling has been increasingly used to better understand and predict the state of our environment. The use of numerical modeling and the associated interactions with judgement and expertise of human beings for short or long term decision making is not unique to meteorology and is being experienced increasingly in the financial system, in various areas of risk management to name a few.

We will first discuss current issues in forecasting, making the point that we are certainly not alone having to face those issues. We will introduce some of the current factors of change through the presentation of a few examples dealing with extreme health and safety issues (volcanic ash and aviation safety), policy development and assessment (air quality prediction systems), national security issues (CBRN terrorism) and the role of Canada on the international scene (modelling used as a forensic tool to identify and possibly geolocate illegal nuclear explosions or proliferation activities). We will then discuss the added value, and the fundamental necessity, of having insight from current research in scientific fields outside of meteorology such as cognitive psychology (Doswell, J. Weather and Forecasting, vol 19, December 2004), decision-making in complex non-linear environment, man-machine interactions through synthetic environment and others in order to improve the role of human in meteorological and environmental prediction.

Nowadays, we have an unprecedent capability to monitor the state of our environment, the GEOSS initiative opens the door to orders of magnitude increase in the volume of data and, thanks to supercomputing technologies, an unprecedent capability to predict its future condition. The broad range of applications of meteorological modelling tools is paving the way toward exciting synergies with other scientific disciplines. Forecasting will change and forecasters will play a critical role, different but critical.

Meteorological modelling will be demystified by explaining that numerical weather prediction attempts to forecast future states of the atmosphere by concentrating on the factors that make it change. The scope of application is quite broad, but includes nuclear accidents or volcanic eruptions that could have serious and dangerous impacts on our environment and on the health and safety of Canadians at home or abroad.

We will also explore how meteorological banned under the Comprehensive Nuclear Test Ban Treaty, which was ratified by Canada in 1998. The treaty is a landmark international agreement prohibiting all types of nuclear explosions for the purpose of weapons testing and requiring the state parties to prevent all such explosions at locations under their jurisdiction.

Meteorological modelling tools benefit all Canadians by maintaining state-of-the-art technical expertise in Canada, providing daily predictions of the state of the canadien environment and ensuring a state of operational readiness for emergencies. Other benefits include easier monitoring of forest fires and potential increases in agricultural production by predicting the arrival of airborne pests .

9:30 AM

1A0.2
Regional Science Partnerships: a network of national labs
Jim Abraham
Meteorological Service of Canada
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The Meteorological Service of Canada (MSC) has been undergoing a transition in order to ensure forecasts and warnings of hazardous weather are improved. This thrust involves an emphasis on research and development, as well as changes in production and delivery of services...partly through internal reinvestment as well as through enhanced partnering.

Universities are the most important partner in research and development. The Canadian Weather Research Program (CWRP) was initiated in 1999 to provide a focused and complementary research and development program on hazardous weather. The CWRP essentially links university and government scientists with the operational weather forecast community in order for the R&D to result in improved warnings and forecasts. Subsequently, the Canadian Foundation for Climate and Atmospheric Science (CFCAS) was announced in the 2000 federal budget, with approximately $10 million available per year... one of the major thrusts being extreme and hazardous weather. CFCAS presented itself as a very good opportunity to strengthen the university research in severe weather within CWRP.

The Meteorological Service of Canada recognizes the relevance of research is through effective transfer of tools and knowledge for the benefit of the production and services program. The MSC is therefore establishing a network of laboratories in regional forecast centres to facilitate this technology transfer. As well, new training and science transfer positions have been staffed in each weather centre. This presentation will provide an overview of the labs, and some examples of activities that have been or will be conducted within this partnership.

(INVITED/INVITÉ) 10:30 AM

1B1.1
Quantifying the predictability of noisy nonlinear biogeochemical systems

Barbara Bailey
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Statistical modeling of dynamical systems makes the estimation and construction of confidence intervals for interesting quantities from data possible. When noise is an integral part of the system's dynamics, a nonlinear time series approach can be used to quantify the dynamics and predictability of the system. This involves fitting nonlinear models and estimating dynamical systems quantities of interest such as global and local Lyapunov exponents, along with measures of uncertainty for these estimates. This approach will be used quantify the predictability of the effects of different types of noise on a simple biogeochemical model of plankton dynamics. The models consist of nonlinear systems of first-order differential equations for the flows or intercompartmental exchanges among nutrients, phytoplankton, zooplankton and detritus.

(INVITED/INVITÉ) 11:00 AM

1B1.2
Recent developments in data assimilation in ocean biogeochemistry

James Christian [1] , *Marjorie Friedrichs* [2]
[1] Fisheries and Oceans Canada, University of Victoria
[2] Old Dominion University
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The application of data assimilation techniques in ocean biogeochemistry has progressed rapidly over the past decade. This paper presents an overview of some recent developments, including estimation of the information value of ocean colour data, model intercomparison experiments using JGOFS data, and sensitivity analysis of the "microbial loop". Most data assimilation experiments have been conducted in a one-dimensional context, and computational and data issues related to generalization to three-dimensional ocean models will be discussed. Extracting information that can facilitate accurate simulation of interannual to interdecadal variability will likely depend strongly on whether the same biological processes control the ecosystem response to physical forcing as in the more data-rich annual cycle, and on the accuracy of the underlying ocean circulation models.

11:15 AM

1B1.3
An Overview of State Space Models and Particle Filters for Data Assimilation

Michael Dowd
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Particle filters are sequential Monte Carlo methods designed for online estimation and prediction. They offer sampling based solutions for the general nonlinear and nonGaussian state space model, which provides a useful statistical framework for oceanographic and atmospheric data assimilation. This talk overviews the use of particle filters for addressing the filtering (nowcasting) and prediction (forecasting) problems widely encountered in ocean and atmospheric data assimilation. The general approach mimics the data assimilation cycle, being comprised of an ensemble forecast followed by an analysis step which combines the forecast with available observations using Bayesian principles. Various particle filtering techniques are reviewed for carrying out this analysis step including sequential importance sampling/resampling and Markov Chain Monte Carlo methods (and popular approximations such as the ensemble Kalman filter). An application involving a simple marine ecosystem model is used for illustration. Practical challenges for implementing these approaches in oceanography and meteorology are discussed.

(INVITED/INVITÉ) 11:30 AM

1B1.4
Skewness of Sea Level Variability of the World Ocean

K.R. Thompson [1] , *E. Emirov* [2]
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Skewness of sea-level variability for the world's oceans is estimated from gridded sea-level fields observed by space-borne altimeters over the period 1993-2001. Most of the significant features in the global skewness map can be identified with well known oceanic features such as the Gulf Stream, Kuroshio Extension, Alaskan Stream, Brazil-Malvinas Current Confluence and Agulhas Retroflection. It is shown, through an idealized example and results from a quasigeostrophic model, that sea-level skewness can be used to identify the mean path of coastal currents and unstable mid-ocean jets, and also regions dominated by eddies with a particular sense of rotation. These ideas are illustrated with a more detailed analysis of the skewness fields for the Northwest Atlantic and Agulhas Retroflection region. Finally is argued that sea level skewness, like variance, is a potentially powerful diagnostic for use in testing the realism of high-resolution ocean circulation models.

11:45 AM

1B1.5
Accounting for serial correlation in multiple linear regression with a random phase periodogram-preserving method

Denis Gilbert [1] , *Doug Swain* [2]
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Critical F-values from standard statistical tables cannot be used to test the significance of a multiple linear regression fit when the assumptions of normality and independence of successive observations of the response variable are not met. Acknowledging that serial correlation is a fundamental property of time series in meteorology, oceanography, fisheries, economics and several other disciplines, we present a method that preserves the autocorrelation function of the response variable by generating thousands of synthetic time series with the same periodogram as the original response variable but with random phases at each frequency. We use this pseudo-population of synthetic response variable time series to compute empirical cumulative distribution functions (CDF) for the F-statistic, the intercept and the slopes associated with each of the predictor variables. Each test statistic (F, intercept and slopes) calculated from the original data sample is then compared with the computer-generated CDF of the corresponding test statistic in order to determine its statistical significance level.

10:45 AM

1B2.1

Study of interannual variability of coupled Atmosphere-Sea Ice-Ocean conditions in Hudson Bay, Foxe Basin and Hudson Straits

Minwei Qian [1] , *François Saucier* [4] , *Daniel Caya* [3] , *Rene Laprise* [2]
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Using the Canadian Regional Climate Model (CRCM) coupled with Regional Ocean Model (ROM) in Hudson Bay, Foxe Bay and Hudson Strait, a four years' simulation has been performed using boundary forcing from the NCEP reanalyses. The simulation shows that air-sea-ice circulation in Hudson Bay is highly variable due to the presence of the dynamic sea ice that covers the bay about 9 months of the year. The model is able to reproduce the observed sea ice distribution, and its variability has important effects on the regional climate around the bay. Furthermore, the model confirms the observed geostrophic circulation during summertime, and reveals complex patterns under sea ice during wintertime.

11:00 AM

1B2.2

Assessing the Performance of a High-Resolution Coastal Circulation Model Using Observations Made in Lunenburg Bay of Nova Scotia During Hurricane Juan

Jinyu Sheng , *Liang Wang* , *Li Zhai*
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A high-resolution coastal circulation model was developed for Lunenburg Bay of Nova Scotia, as part of an interdisciplinary research project of marine environmental prediction in the Atlantic Canada. The model is used to simulate the barotropic circulation in the bay during Hurricane Juan in September 2004 and driven by tides and shelf waves specified at the model open boundaries and wind stress applied at the sea surface. The tidal forcing at the model open boundaries is inferred from the tidal sea level prediction at Lunenburg Harbour. The wind stress was calculated from the observed wind speeds at three locations in the bay. The model results demonstrate strong interactions between the local wind stress, tidal forcing, and remotely generated shelf waves during this period. We compared the model results with the observed surface elevation and currents in the Bay and found that the model results reproduce reasonably well the barotropic circulation in the region. The coastal circulation model is currently used in a process study of the baroclinic circulation forced by tides and wind in Lunenburg Bay.

11:15 AM

1B2.3

Dynamical Structures and Precipitation Distribution of Transitioning Tropical Cyclones in Eastern Canada, 1979-2004

Shawn Milrad [1] , *Eyad Atallah* [2] , *John Gyakum* [2]
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[2] Dept of Atmospheric and Oceanic Sciences, McGill
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From 1979-2004, 33 storms originally tropical in nature (as classified by the National Hurricane Center) have affected Eastern Canada to various degrees during or after extratropical transition. This study examines the dynamical structure of these 33 cases from a QG perspective using the Trenberth approximation to the QG omega equation (advection of mid-tropospheric vorticity by the thermal wind), primarily utilizing the NCEP North American Regional Reanalysis (NARR) dataset. Via the Trenberth approximation method described above, we were able to partition the storms into two groups, "intensifying" and "decaying", based upon the quasigeostrophic forcing for ascent. In addition, we analyze the precipitation distribution of the cases in the study using the 3-hour accumulated precipitation field in the NARR. Composites of both partitioned groups have been completed for several mass fields and will be presented. Furthermore, both the 'good' and the 'bad' of the NARR will be shown, including Canadian precipitation assimilation problems,

precipitation over the oceans, comparisons with the NCEP global reanalysis, etc. Hurricane Juan (2003) will be highlighted as a particular failure for the NARR.

11:30 AM

1B2.4
On the impact of a cold SST anomaly on a strong western North Pacific cyclone
Rick Danielson
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The classical interpretation of how warm SST anomalies impact the cold-season environment of a midlatitude cyclone is that they warm and moisten the environment and make it easier for a cyclone to develop. This implies that cold SST anomalies should have a negative impact on cyclones, but is this true all year round? Preliminary indications from SST anomalies found beneath strong cyclones are that cold SST anomalies may in fact be cyclogenetic if the atmosphere is already relatively warm and moist. To test this, an extended predictability experiment is performed using the environment of a cyclone that appears to benefit from the presence of a cold SST anomaly. A series of control simulations are initiated from 10 to 15 days before this cyclone forms. These are compared to simulations that are perturbed by removing the cold SST anomaly. The impact of this anomaly is then interpreted by the net difference in intensity of the simulated cyclones.

11:45 AM

1B2.5
Giving surface wind model outputs a hurricane attitude: Towards and operational approach
Serge Desjardins [1] *, Roop Lalbeharry* [3] *, Hal Ritchie* [2] *, Allan MacAfee* [2]
[1] Service Météorologique du Canada région Atlantique
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[3] Service météorologique du Canada
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Progress has been made in the last year to blend a parametric hurricane surface field into the CMC forecast surface wind field. Briefly the purpose of such an insertion is to insure at least a realistic representation of the hurricane wind and pressure fields when the operational model fails either in the positioning and/or the intensity of the vortex. Moreover, despite the improvement of numerical models and mainly because of the highly unpredictable nature of hurricane tracks, it is likely that human intervention will always be needed to correct the given numerical wind field used as input for wind-driven models such as those used for waves or storm surges. The insertion and the blending are done with the help of SWIM (Surface Wind Interpolator and Modifier), a one way coupled system including a feeder program, an interpolator/insertor/blender program and a wind-driven model. While a proof of concept was presented last year, work is in progress to get more realistic insertion and blending processes like those used in 3D vortex insertion. Results from this work will be shown for various hurricanes from the 5 most recent hurricane seasons.

(INVITED/INVITÉ) 10:30 AM

1B3.1
A new approach to representing cloud processes in climate models
David Randall
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Traditionally, the effects of clouds in GCMs have been represented by semi-empirical parameterizations. Recently, we embedded a two-dimensional cloud-resolving model (CRM) into each grid column of a realistic GCM, the NCAR Community Atmosphere Model (CAM), to serve as a superparameterization (SP) of clouds. Results will be presented from several versions of the model, including one that makes use of a small-domain three-dimensional SP, with and without explicit large-scale momentum transport by convection. Sensitivity to CRM resolution will also be discussed.

(INVITED/INVITÉ) 11:00 AM

1B3.2
Parameterization and Resolved-Scale Resolution
James Hack
National Center for Atmospheric Research
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To place any confidence in numerical investigations of climate, the horizontal and vertical resolution must be fine enough to properly represent the phenomenological scales of motion of most importance to the climate system. Motion scales below the truncation limit required to represent these large-scale fluid properties must be treated in some other way, and generally enter the solution in the form of a forcing term,almost always evaluated using some type of parameterization.
Parameterization techniques can be highly nonlinear and generally depend on the explicitly resolved atmospheric state variables.This talk will focus on whether there exists an optimal break between resolved and parameterized motion scales. We will illustrate how the statistical characteristics of resolved-scale motions exhibit large changes as a function of resolution at truncations typical of global climate models.

(INVITED/INVITÉ) 11:30 AM

1B3.3
Radiation, Climate, and Climate Modelling
Howard Barker
Meteorological Service of Canada (ARMP)
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This talk will provide a brief overview of the role of radiation in the climate system and how radiative transfer and radiative processes have been represented in Global Climate Models (GCMs). Emphasis will be on atmospheric radiation but radiative characteristics of other media will be mentioned too (e.g., snow and ice, and vegetation). Topics to be discussed span from early ideas of radiation and Earth's energy budget, to 3D radiative transfer calculations for datasets produced by global arrays of cloud system-resolving models.

10:30 AM

1B4.1

Deliquescence and Crystallization of Ammonium Sulfate Particles Internally Mixed with Water-Soluble Compounds

Matthew T. Parsons [1] , *A. Pant* [2] , *D. A. Knopf* [2] , *A. K. Bertram* [2]
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Deliquescence and crystallization relative humidities of particles containing ammonium sulfate internally mixed with water-soluble organic material have been measured. The organic material included malonic acid, glycerol, levoglucosan, and Suwannee River fulvic acid. Results for deliquescence of systems with malonic and fulvic acids are in agreement with existing literature values. The glycerol system undergoes deliquescence at slightly lower relative humidity than previous measurements. The levoglucosan results are the first of this kind. Deliquescence relative humidities for the different systems are the same within the uncertainty of the measurements when the organic mole fraction is less than 0.35. The maximum deviation of deliquescence relative humidities across the systems is approximately 10 % relative humidity at an organic mole fraction of 0.6. The crystallization relative humidity (CRH) of ammonium sulfate with malonic acid, glycerol, or levoglucosan, decreases significantly from the CRH of pure ammonium sulfate when the organic mole fraction is greater than 0.25. This is in contrast to our previous study with glutaric acid where the CRH remained close to the CRH of pure ammonium sulfate up to a glutaric acid mole fraction of 0.4. In terms of atmospheric implications, we estimate that organics, on average, are only a minor perturbation on the deliquescence relative humidity of the pure inorganic particles; however, the organics, on average, may decrease the CRH of pure inorganic particles significantly and this effect depends on the type of organic material.

(INVITED/INVITÉ) 10:45 AM

1B4.2

Gas-Aerosol Chemistry in the Global Troposphere: New Laboratory Measurements

Jon Abbatt [1] , *Rachel Chang* [1] , *John Roscoe* [4] , *Ryan Sullivan* [3] , *Joel Thornton* [2]
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There remain considerable uncertainties in assessing the global importance of gas-aerosol heterogeneous chemistry, in part because our understanding of the underlying chemistry is not sufficiently well defined for the wide range of aerosol types known to be present. In this talk, the major issues facing the laboratory heterogeneous chemistry community will be presented, along with a detailed presentation on some new laboratory results that may impact model predictions of the oxidizing capacity of the troposphere. Specific chemical systems to be discussed include the uptake of N2O5, HO2 and O3 on different model aerosol surfaces, including water soluble organics, aqueous sulfates and mineral dust. The atmospheric implications of these studies will be presented, along with directions for future study.

11:15 AM

1B4.3

Ice Formation On and In Atmospheric Aerosol Particles

Allan Bertram , *Ben Murray* , *Daniel Knopf* , *Magda Dymarska*

University of British Columbia

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An important mechanism for ice cloud formation in the Earth's atmosphere is homogeneous nucleation of ice in aqueous droplets, and this process is generally assumed to produce hexagonal ice. However, there are some reports that the metastable crystalline phase of ice, cubic ice, may form in the Earth's atmosphere. Here we present laboratory experiments demonstrating that cubic ice forms when micrometer-sized droplets of pure water and aqueous solutions freeze homogeneously at cooling rates approaching those found in the atmosphere. Our results suggest that cubic ice will form in the Earth's atmosphere. These measurements will be presented and the atmospheric implications will be discussed. In addition, heterogeneous nucleation of ice on atmospheric aerosols will also be briefly discussed.

11:30 AM

1B4.4
The optical and chemical properties of marine aerosol measured off the coast of Nova Scotia
Julia Marshall [1] *, W. R. Leaitch* [3] *, U. Lohmann* [4] *, D. Toom-Sauntry* [3] *, K. Hayden* [3] *, J. W. Strapp* [3] *, P. Lehr* [2]
[1] Dalhousie University
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As part of the Canadian Surface Ocean Lower Atmosphere Study, a series of six research flights were conducted from October 13 to 17, 2003, in and around stratocumulus clouds over the waters surrounding Nova Scotia. A variety of instruments were used to measure aerosol size distributions over a wide range of sizes. The time-resolved chemical composition of the aerosols was determined through the use of an Aerodyne Aerosol Mass Spectrometer and a Particle In Liquid Sampler. The latter is able to measure the concentrations of dissolved sea salt ions, though not the size distribution of the chemical constituents. Scattering and backscattering coefficients at three visible wavelengths were measured with an integrating nephelometer. A mass closure study and an optical closure study are carried out for the flights, taking into account the limitations of the nephelometer in measuring light scattered from supermicron particles. The flight data provide vertical profiles of the aerosol particles below and above marine stratocumulus decks, and give an indication of the optical properties of the aerosols as a function of altitude above sea level. In general, the source of the air mass has a dominant effect; within the flight data examples of near-pristine marine air can be compared with examples illustrating a strong continental influence. In all cases, the air above the stratocumulus clouds is considerably cleaner than that below. One of the flights also illustrates the ability of coarse sea salt particles to influence the optical properties of the air at altitudes above 1 km.

11:45 AM

1B4.5
Multi-year chemistry of particles and selected trace gases at a high elevation Pacific site
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Meteorological Service of Canada
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In spring 2002, Environment Canada established a high-elevation measurement site at Whistler Mountain, British Columbia. In the first phase of this project, a three year pilot study has been undertaken with the primary objectives of providing a climatology of background chemistry in the lower free troposphere as well as information on incursions of pollution transported across the Pacific and into North America.

Measurements at Whistler Peak (elevation 2182 m-asl) include the trace gases carbon monoxide and ozone. Aerosol particles (< 2.5 μm) have been analyzed for a suite of inorganic compounds (Cl^-, NO_3^-, $SO_4^=$, Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}) by ion chromatography. Particle size distributions over the size range of 10 nm to 20 μm have been made with a differential mobility analyzer and an optical particle counter. Standard meteorological parameters are also available at the site. An overview of the measurement site and first results from the pilot study will be presented. Results will include seasonal cycles in CO and ozone and the interannual variability of their mixing ratios; the soluble inorganic composition of the aerosol particles and its relation to total particle mass; and the size distributions of the background aerosol. Chemical distributions will be presented within the context of supporting meteorological data, and various transport scenarios will be discussed.

(INVITED/INVITÉ) 10:30 AM

1B5.1

Climate Variability and Physical Forcing on Panarctic Shelves: An IPY Perspective

Eddy Carmack
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Brief overviews of the Arctic's atmosphere, ice cover, circulation, primary production and sediment regime are given to provide a conceptual framework of panarctic shelves under scenarios of climate variability. Environmental functions that are critically poised and/or near transition and thereby sensitive to climate change are noted. Panarctic shelf regions are described and distinguished among three types: inflow, interior and outflow shelves. Emphasis is on projected climate changes that will likely have the greatest impact on shelf-basin exchange, productivity and sediment processes including (a) changes in wind fields (e.g. currents, ice drift, upwelling/downwelling); (b) changes in sea ice distribution (e.g. radiation and wind regimes, enhanced upwelling and mixing, ice transport and scour resuspension, primary production); and (c) changes in hydrology (e.g. sediment and organic carbon delivery, nutrient supplies). A fundamental conclusion is that the changes associated with the shelf-break will be greatest, and that this forms a natural focus for a coordinated international effort. Recognizing that the real value of climate research is to prepare society for possible futures, and that such research must be based both on an understanding of the past (e.g. the palaeo-record) as well as an ability to reliably predict future scenarios (e.g. validated models), two IPY themes emerge: firstly, a survey of circumpolar shelf-break and slope sediments to provide long-term records of shelf-basin exchange and production at the shelf edge; secondly, a synoptic panarctic survey to provide the data required to properly model key forcing processes.

10:45 AM

1B5.2

An International Polar Year project: Thorpex Arctic Weather and Environmental Prediction Initiative (TAWEPI)

Gilbert Brunet [1] *, G. Burke* [3] *, W. Burrows* [3] *, S. Cober* [3] *, G. Flato* [3] *, P. Gauthier* [3] *, J. Hanesiak* [5] *, K. Moore* [4] *, A. Pietroniro* [3] *, S. Polavarapu* [3] *, R. Stewart* [2]
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Weather and Environmental Prediction is one of the most important technological and societal successes of the last century. The positive impact of WEP on health, wealth and economy competitiveness is recognized worldwide. The science of WEP, including its operational applications, has attained a degree of maturity that is unprecedented in the environmental sciences. The benefit of WEP applications in polar regions has somewhat been delayed historically due the high priority of the more dense populated southern regions. It is now time to bring to the Arctic's communities the advantage of WEP in collaboration with the scientific international community.

An important component of TAWEPI is to develop a regional Numerical Weather Prediction (NWP) system (10-15km horizontal resolution) over the Arctic in support of the IPY projects, like THORPEX and field measurement campaigns. The proposed model will be a twin of the actual worldwide recognized operational Environment Canada regional GEM model (used for 1-2 day forecasts) but displaced and extended over the Arctic and surrounding regions. The new model is called Polar-GEM. (Contact: Dr. G. Brunet)

One inevitable R&D thrust of TAWEPI will be to validate and improve Polar-GEM parameterizations/treatments of unique high latitude processes such as sea ice or flow over glaciers/ice-caps or high latitude clouds. This will demand that Polar-GEM drives finer horizontal scale (1-3km) limited-area model (GEM-LAM) over specific Northern regions in combination with field measurement campaigns and process studies. As an example, the Hydro-meteorological and Arctic Laboratory in Canada (Contact: G. Burke) will configure and operate a high resolution (2.5 km) NWP window that would cover southern Baffin Island, Hudson Strait and northern Quebec in support to the IPY Canadian and international research community.

Follows a list of field campaign measurements, modelling, data assimilation and process studies that will help to enhance Polar-GEM weather and environmental forecasting capabilities, and improve our understanding of Arctic climate and influence on world weather:

1) In Baffin Island region, we will use of the EC research aircraft and ground observing systems (X-band radar, radiometer, POSS, etc.) to study Arctic storms. It is a project with a large compliment of surface based observing systems in the summer of 2005 and will be fully operational by 2007. Two other field campaigns are the NOAA SEARCH and PEARL (Toronto U.) projects that will begin to deploy instruments to Eureka observing station, Ellesmere Island, in 2005 and will be fully operational by 2006. This is an U.S. ARM site for making long term Arctic observations. MSC want to use some of these observations for validating CloudSat and other space-based observation systems. (Contact: Dr. S. Cober)

2) The Polar-GEM will be coupled to a suite of environmental prediction systems for hydrological, ice, forestry applications and in support to GEWEX (Global Energy and Water Cycle Experiment) studies. This would needs examination of different surface and hydrological model runs that could feed into or make use of some of the proposed observational networks (both atmospheric and hydrological) and help validate and calibrate aspects of the land-surface models. (Contact: Dr. A. Pietroniro)

3) The Hydro-meteorological and Arctic Laboratory in collaboration with the Canadian Forest Service proposes to couple the EC lightning prediction and a fire occurrence model over the forested region of the Arctic. (Contact: Dr. B. Burrows)

4) To improve medium-range WEP forecasts we will take care of the meteorological component of the IPY both in terms of what can influence the meteorological forecast over the polar regions and of how the meteorological conditions over those regions can impact the quality of global forecasts on time-scales of one-day to two-weeks. In conjunction with this activity, there are several types of satellite data from polar-orbiting satellites that we will assimilate and validate with field measurement campaigns. (Contact: Dr. P. Gauthier)

5) We will study severe Arctic storms, their associated hazardous conditions like blizzards, blowing snow, severe wind chill and reduced visibility.We have 3 focal points: (i) Hazardous weather-related conditions in the Iqaluit area, (ii) Regional hazardous weather-related conditions and sea ice impacts, (iii) User community interactions. (Contact: Dr. R. Stewart and Dr. J. Hanesiak)

6) We will investigate the important role of Greenland in modulating the structure and the predictability of both local and downstream weather systems. (Contact: Dr. K. Moore)

7) TAWEPI results will help develop new physics and land-surface packages for the next generation Regional Climate Model (based on GEM-LAM) developed at MSC for regional climate scenarios. (Contact: Dr. G. Flato)

11:00 AM

1B5.3
The International Polar Year: One year in the life of a variable ocean.
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The design of the ocean components of the International Polar Year needs to consider the variability of both ocean and atmosphere at these high latitudes. The strong seasonal cycle of air-sea fluxes, ice cover, stratification and biological productivity make it difficult to identify interannual changes from the scattered exploratory surveys that characterize most of our existing information. Our longest and most continuous observations related to the Arctic are the measurements of the waters as they flow from polar to the sub-polar regions. These observations show that significant variability is seen at periods as long as the observation series can begin to resolve. The IPY needs to focus on the initiation and establishment of sustained observations rather than another snapshot in time and space.

11:15 AM

1B5.4
The Polar Environment Atmospheric Research Laboratory (PEARL) at Eureka (80N, 86W)
James R. Drummond [1], *T Duck* [7], *A Manson* [6], *N O'Neill* [5], *G Shepherd* [4], *J Sloan* [3], *K Strong* [1], *W Ward* [2]
[1] University of Toronto
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The Polar Environment Atmospheric Research Laboratory (PEARL) is a "new" research laboratory that is being set up at Eureka (80N, 86W) in Canada's high Arctic. It is intended to make research measurements of the atmosphere in the altitude range 0-100km in the time frame 2005-2010 which encompasses the time frame of the International Polar Year. It will be operated as a year-round facility with intensive operations during IPY.

The laboratory will be equipped with a variety of lidar, radar, spectrometer, optical and sampling equipment sufficient to sample lower atmosphere composition, winds, clouds and aerosols; middle atmosphere composition (particularly ozone and its precursors) and dynamics; and upper atmosphere dynamics with some composition.

This talk will discuss the objectives and science program of PEARL in the context of IPY and will also outline the possibilities of collaboration through data access and through a "guest instrument" program.

11:30 AM

1B5.5
Development of a GEOTRACES program within IPY
Roger Francois [1] , *Robert Macdonald* [2]
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The mission of international GEOTRACES program is "to identify and quantify processes that control the distribution of key trace elements and isotopes (TEIs) in the ocean, and establish their sensitivity to changing environmental conditions, in order to elucidate sources of micronutrients, contaminant dispersal and tracers of past and present ocean conditions". This will be achieved by sampling detailed water column sections in all major ocean basins to establish the large scale distribution, chemical speciation, and physical form of selected TEIs. This information will be introduced into large-scale forward and inverse models to evaluate quantitatively their sources and sinks at the ocean interface with atmosphere, freshwater, ocean margins, mid-ocean ridges, and deep-sea sediments. This large scale sampling strategy will be complemented by process and time-series studies in strategically located regions to more firmly establish their internal cycling, characterize the physical processes regulating their distributions, develop geochemical proxies for reconstructing the evolution of these processes from the sediment record, and assess their sensitivity to and role in global change. This initiative builds on recent advances in clean sampling protocols, analytical techniques, data assimilation, and modeling strategies, and is prompted by the increasing recognition that TEIs are playing a crucial role as regulators and recorders of important biogeochemical and physical processes that control the structure and productivity of marine ecosystems, the dispersion of contaminants in the marine environment, the level of greenhouse gases in the atmosphere, and global climate.

Considering its sensitivity to, and potential regulatory role in, climate change, the Arctic Ocean must be included in this global program and IPY provide the opportunity to obtain synoptic TEI sections with the needed hydrological and biological context. Integration of a detailed study of the distribution and cycling of TEIs that act as micronutrients (e.g. Fe, Cu, Zn, Co etc.), contaminants (Hg, Pb, Ag, Sn etc.), tracers of sources (e.g. Ba, Al, Mn, isotopes of Nd, Hf, Fe, Mo, Cd, etc.), removal and transport processes (e.g. Th, Ra, ^{231}Pa, ^{10}Be, $^{239/240}$Pu, ^{129}I, ^{99}Tc etc.) into a multidisciplinary program aimed at investigating the rapid environmental changes occurring today in the Arctic Ocean (such as iAOOS: integrated arctic ocean observing system), will uniquely contribute to further documenting and elucidating the causes and consequences of on-going changes in sea ice cover, primary production, food web structure, carbon flux, hydrography, circulation, shelf-basin exchange and river discharge in this important oceanic region.

(INVITED/INVITÉ) 11:45 AM

1B5.6
The emerging framework for IPY 2007-2008
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The fundamental concept of the IPY 2007-2008 is of an intensive burst of internationally coordinated, interdisciplinary, scientific research and observations focused on the Earth's polar regions. The official observing period of the IPY will be from 1 March 2007 until 1 March 2009. The main geographic focus will be the Earth's high latitudes, but studies in any region relevant to the understanding of polar processes or phenomena will be encouraged. The IPY aims to exploit the intellectual resources and science assets of nations worldwide to make major advances in polar knowledge and understanding, while leaving a legacy of new or enhanced observational systems,facilities and infrastructure. Arguably the most important legacies will be a new generation of polar scientists and engineers, as well as an exceptional level of interest and participation from polar residents, schoolchildren, the general public, and decision-makers, worldwide.

A document "A Framework for the International Polar Year 2007-2008" has recently been published which outlines the scientific framework for IPY 2007-2008 and proposes a strategy for developing programme implementation. An international ICSU/WMO Joint Committee has been formed to lead the programme and an International Programme Office established. An Expression of Intent Call yielded 1000 submissions from the community illustrating the scale of enthusiasm for the programme. The progress in developing the International Polar Year will be outlined to provide a setting for subsequent presentations of emerging major research programmes underthe IPY 2007-2008 umbrella.

12:00 PM

1B5.7
There's something polar about mercury but is it the atmosphere or the ocean?
Robie W. MacDonald [1] , *Gary A. Stern* [2]
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Following a landmark paper in 1998 describing remarkable episodes of disappearance of gaseous mercury in the Arctic's atmosphere subsequent to polar sunrise, the contaminant community has focussed attention on the Arctic as receptor of global emissions of this metal. Although the process of atmospheric removal has been revealed as a sophisticated sequence of photo-mediated reactions, and although the deposited mercury has been shown to be bioavailable, there has been very little evidence produced to date that the deposited mercury actually enters ecosystems to any degree. On the other hand, trends of mercury in the Arctic's aquatic biota suggest remarkable increases at times and a very clear vulnerability of high trophic species, including humans, to mercury uptake. We examine the mercury cycle in the Arctic finding that the large gap in our understanding lies on the ocean side; recent evidence suggests that poorly understood aquatic processes likely provide the basis for observed mercury trends in high trophic species, and that change in the mercury cycle is likely a product of climate change. Accordingly, we propose that mercury would be an ideal geochemical pan-Arctic research topic for IPY.

10:30 AM

1B6.1
Progress on the Canadian Precipitation Analysis (CaPA) project
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The Canadian Precipitation Analysis (CaPA) project aims at producing an almost real-time analysis over Canada for 6-h accumulated precipitation with a 25 km resolution. This analysis uses an optimum interpolation technique, combining short-range model forecasts, raingauges and in the future radar and satellite products.First, results from a pilot project over the Quebec region will be presented. Recent efforts have been put on the evaluation of CaPA. Improved radar products have been used to assess the quality of CaPA using only precipitation reports available on the GTS and using also additional cooperative networks. Recently, the analysis has been extended to the North American continent for summer 2004 and the first results will be presented and compared with various daily precipitation analyses over US.

10:45 AM

1B6.2

Characteristics of ice pellets during a winter storm
Steve Gibson [1] , Ron Stewart [2]
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Winter storms affect all Canadians and many of their impacts are associated with precipitation. This precipitation can occur as rain, snow, freezing rain or ice pellets. Some research has been conducted on all of these types of precipitation but the least attention has been paid to ice pellets. The atmospheric environment conducive to ice pellets is known in general but the detailed nature of the actual particles is not.

To begin to address this issue, a high resolution digital camera was used to photograph ice pellets for 4 hours during a winter storm at Mirabel, Quebec in November 2003. A total of 1023 images of individual ice pellets were analyzed to determine the morphology, shapes, and size distributions of the particles. Some ice pellets were opaque, others were clear, and some had bands of varying opacity. Very few particles were spherical, most were prolate or oblate spheroids, approximately 10% were aggregates of 2-4 smaller particles, and many exhibited bulges, fractures, spicules and lobes. The ice pellets ranged up to 5 mm in diameter, and the average size was 1 mm. Such characteristics were observed to be occurring simultaneously throughout the storm. Collectively, these and other observations imply that different freezing mechanisms and rates were occurring simultaneously, and that collisions between semi-frozen ice pellets must have been occurring to produce aggregates. Such observations and results as well as their implications will be presented.

11:00 AM

1B6.3
A new way to simulate freezing rain on complex structures
Wladyslaw Rudzinski [1] , Edward P. Lozowski [3] , Masoud Farzaneh [2]
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The capability to make realistic predictions of ice accretion on large objects of complex shape is important in the design of power network equipment in cold regions. Glaze ice accretion formed during freezing precipitation is the most severe type of ice accretion, particularly for insulators, since it can affect their performance considerably. When icicles bridge shed spacings, the leakage distance of the insulator may be reduced to the point where it becomes susceptible to flashover and the resulting power loss. It is therefore essential to understand glaze ice formation on insulators in order to reduce the occurrence of flashover. In our research, we have focused on a most promising approach to insulator icing in freezing rain, namely stochastic simulation. In the present paper, we describe a novel, high-resolution, full-scale 3D discrete particle model of glaze ice accretion on a non-energized station post insulator. The model can actually be applied to 3D objects of any shape, and it can perform full-scale simulations for objects whose dimensions do not exceed about 1m. In the model, Monte Carlo methods are used to emulate the mobility of fluid particles, leading to their random walk over the ice accretion surface. The model is capable of predicting ice accretion mass and its detailed distribution over the structure under a range of glaze icing conditions. In this paper, 3D simulations of ice accretion morphology on a full-scale insulator

are examined as a function of the microscopic model parameters. In order to validate the model, a series of laboratory experiments has been undertaken at the CIGELE Precipitation Icing Simulation Laboratory at the Université du Québec à Chicoutimi. The influence of ambient conditions on the mass and dimensions of the ice accretion has been investigated. A quantitative comparison between model predictions and experiments has been made, and a relationship between the model parameters and atmospheric variables has been derived. The success of the model simulations will enable its future use to examine, in details, some consequences of ice accretion due to freezing rain.

11:15 AM

1B6.4
Reducing Precipitation Forecasting Errors Associated With Ice Phase Particle Classification in Bulk Microphysics Schemes

Jason Milbrandt [1] , *M. K. Yau* [3] , *Stephane Belaire* [2] , *Jocelyn Mailhot* [2]
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Over the past decade, there have been considerable increases in the resolution of numerical weather prediction models around the world. Consequently, bulk microphysics schemes (BMS), which compute the effects of cloud processes in models, are playing an increasingly important role. Despite advances in computer power, the need for numerical efficiency continues to limit the allowable number of predicted variables in operational models. Thus, BMSs must be restricted to a limited number of hydrometeor categories. Errors in the classification of particle types can lead to incorrect forecasts of precipitation at the surface.

During November-December 2001, the IMPROVE-2 experiment collected a comprehensive set of microphysical data over the Oregon Cascades with the objective of diagnosing and correcting problems associated with current BMSs. High-resolution simulations (1.33 km) of the 13-14 December 2001 orographic precipitation case using the MM5 model overpredicted the mass contents of snow while underpredicting the quantity of graupel (Garvet et al., 2005). Due to this misrepresentation of graupel as snow, the accumulated precipitation was overpredicted over a broad region on the lee side of the mountain range.

Our simulations of this case using the GEM-LAM model with a single-moment microphysics scheme exhibited similar errors in the snow and graupel fields aloft and precipitation at the surface. The new multi-moment BMS of Milbrandt and Yau (2005b) has been recently implemented into the RPN physics library. Results for this case using the multi-moment scheme will be presented and the implications for the BMS to be used operationally in the near future at the Canadian Meteorological Centre will be discussed.

11:30 AM

1B6.5
Parameterization of mass-weighted terminal velocity and precipitation rate of ice particles in terms of ice water content using in-situ aircraft measurements

Faisal Boudala
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Model simulation of clouds and precipitation requires a reasonable representation of the terminal velocity (V_m) of ice particles. Most models use mass-weighted terminal velocity to estimate particle sedimentation (F_m). The derivation of F_m and V_m require reliable ice particle size distributions, identification of particle habit, and atmospheric conditions. However, ice particle are highly irregular and only a limited number of mass-dimensional relations are available for such tasks. Even if the mass-dimensional relationships were available, the large-scale models would need to provide ice particle habit and size distribution in order to calculate the gravitational settling of each individual particle. Since such parameters in the current climate models are not available, the mass-weighted terminal velocity is used. Parameterization of mass-weighted terminal fall velocity and downward ice mass flux have been developed using in-situ aircraft measurements of ice particle spectra in extra tropical stratiform clouds assuming rimed and urimed aggregates of irregular ice particle. The ice particle spectra were categorized according to their mean maximum diameter and area diameter. The dependence of F_m and V_{mt} on temperature and ice water content (IWC) were also investigated. In this talk, the results of this work will be

discussed and the surface precipitation rate parameterized and measured using X–band Doppler radar that is referred to as Precipitation Occurrence Sensor System (POSS) will be compared.

11:45 AM

1B6.6
Numerical Studies on Winter Precipitation Type Formation
Julie Theriault [1] , *Ron Stewart* [2]
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Winter storms produce major problems for society and their varying types of precipitation are often the key factor responsible. The objective of this study is to better understand the formation of winter precipitation types (freezing rain, ice pellets, snow, slush, wet snow and refrozen wet snow) within the varying, and interacting, environmental conditions experienced within many winter storms. A one dimensional cloud model utilizing a double-moment microphysics scheme has been improved to address this issue by adding two categories of semi-melted particles (wet snow and slush). Temperature and moisture profiles favourable for the formation of different winter precipitation types were varied in a systematic manner in an environment in which snow is falling continuously from above a temperature inversion. The ensuing phase changes such as melting and freezing. Average soundings associated with various surface precipitation types were consequently determined, and the ranges of the temperature profile parameters across which the different precipitation types and combinations could be formed were calculated. Application of these results to accretion at the surface will also be presented.

10:30 AM

1B7.1
The Canadian weather forecast model is forcasting weather on Mars
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Not yet a reality but close enough. The Canadian weather forecast model,GEM, has undergone major changes in Physics to allow it to simulate the atmosphere of Mars. The new Global Mars Multiscale Model (GM3) is one of six global models available to the scientific community to conduct modelling studies on Mars. The construction of the new model includes the adaptation of the dynamics of GEM and the introduction of suitable physics parameterizations for radiative and subgrid processes. Preliminary evaluation has showed that the model properly simulates the large scale circulation and the outputs compare well with outputs from other models and with measurements of temperature from the Mars Global Surveyor (MGS). Used in the zoom mode to do mesoscale simulations it has been compared with meteorological data from the Viking Landers. The presentation will give an outline of the model's current state, future development work and some possible applications.

10:45 AM

1B7.2
Evaluation of Precipitation from Weather Prediction Models, Radars and Satellites
Slavko Vasic [1] , *Charles Lin* [2] , *Isztar Zawadzki* [2] , *Barry Turner* [2]
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Radar-based precipitation nowcast methods are robust and have more skill than numerical weather prediction models over time scales of several hours. This is because the models do not generally capture well the initial precipitation distribution. Over longer time scales, the models would perform better than nowcast methods as they resolve dynamically the large scale flow. We verify this conceptual picture of the relative accuracy of radar nowcasts and model forecasts using conventional skill scores. We identify the cross-over point in time where model forecasts start to have more skill than nowcast methods.

Another important issue, related to models' capabilities to predict precipitation intensity of equal magnitude as observed by radars and/or satellites, is also considered in detail. We characterize the frequency of precipitation values retrieved from models, radars and satellites. Furthermore, we studied retrieved precipitation in spectral space (using Fourier and wavelet decomposition techniques). Results clearly show that models' precipitation power spectra at small scales decay more quickly than the radar and satellite power spectra.

11:00 AM

1B7.3
How well does the MC2 model forecast Montreal's record-breaking 8-9 November 1996 precipitation event?
Dorothy Durnford , *John Gyakum* , *Eyad Atallah*
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Mesoscale Compressible Community (MC2) model 20-km forecast fields of Montreal's record-breaking (24-h precipitation total of 134.0 mm) 8-9 November 1996 precipitation event are compared to observations and to fields of the 32-km North American Regional Reanalysis (NARR) and the 2.5^{o} x 2.5^{o} (≈ 275 km latitude x 200 km longitude) National Centers for Environmental Prediction (NCEP) global reanalysis. Despite the fact that, at first glance, there are few differences between most of the MC2 and NARR fields examined (sea level pressure, 1000-500 hPa thickness, precipitable water content, 850- and 500-hPa vertical motion, dynamic tropopause fields, as well as Montreal-area soundings and surface sectionals), and that the NARR vertical moisture profiles reproduce the sounding data far more faithfully than do the MC2 profiles, the MC2 Montreal area storm-total precipitation field is considerably closer to the observed field than is the NARR's. Possible reasons for the superior MC2 precipitation fields are considered.

11:15 AM

1B7.4

Atmospheric-hydrological modelling of severe precipitation and floods in the Huaihe River Basin, China

Lei Wen [1] *, Charles Lin* [3] *, Guihua Lu* [5] *, Zhiyong Wu* [5] *, Jianyun Zhang* [4] *, Yang Yang* [4] *, Yufei Zhu* [3] *, Linying Tong* [2]
(Presented by / Présenté par ***Linying Tong***)
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Up to 70% of China's annual natural disasters are due to floods caused by heavy precipitation. An accurate and timely flood warning system can help to minimize flood damage. A numerical weather prediction (NWP) model has the potential to be part of such a system, as it could provide precipitation to the flood forecast model with a significant lead time. Precipitation from NWP models is also important for the areas where surface observations from rain gauges are sparse or even not available.

Our study focuses on the simulation of heavy precipitation and floods over the Huaihe River Basin, one of the 7 major river basins in China. The Huaihe River Basin is located between the Yellow and Yangtze Rivers, with an area of 270,000 km^2. This region has China highest population density (662 persons per km^2) and 17% of the country's cultivated land. Climatologically, it lies in the warm temperature semi-humid monsoon region, in the transition zone between North and South China. The region has suffered from flood disasters for centuries. The Huaihe River Basin is also the study site for the China GEWEX projects HUBEX (Huaihe river Basin Experiment) and MAGE (Monsoon Asian GEWEX Experiment). Data from the Intensive Observation Period of 1998 (May to August) and the great flood of 2003 (June to July) are used in this study for model verification.

Precipitation is the single most uncertain atmospheric input to a flood forecast model. Therefore, the first objective of the joint McGill-China project (Application of Coupled Hydrometeorological Modeling System for Precipitation and Flood Forecasts) is to assess the precipitation simulation from the Canadian Mesoscale Compressible Community Model (MC2). We set up MC2 at two horizontal resolutions (20 and 5km). The 20-km runs are initialized and driven laterally by CMC (Canadian Meteorological Centre) analysis without using any extra information from China. We compare MC2 precipitation with available observations from rain gauges over the Huaihe River Basin. We then apply the Chinese Xinanjiang hydrological model with both gauge measured and model precipitation to simulate hydrographs at the outlet of the Shiguanhe sub-basin. The results show a reasonable agreement of flood timing, thus demonstrating the potential of using NWP model precipitation for flood forecast.

11:30 AM

1B7.5

The role of anomalously warm sea surface temperatures on the intensity of Hurricane Juan (2003) during its approach to Nova Scotia

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On 28 September 2003 powerful Hurricane Juan struck Nova Scotia, Canada uprooting millions of trees, tearing roofs off buildings and producing a storm surge of up to two meters. Juan was only the third category-two hurricane to directly make landfall in Nova Scotia (43.5 – 46.0°N) during the past 150 years. Most hurricanes affecting this latitude have weakened to category-one status, so why did Juan maintain category-two status up until landfall?

The large-scale atmospheric flow pattern steered Juan on an almost due northward heading from its formation region southeast of Bermuda – a very unusual direction of motion for tropical cyclones at this latitude. Juan was also cocooned in a tropical airmass over Atlantic Canada, and sea surface temperatures (SSTs) south of Nova Scotia were well above normal. To what degree did the anomalously-warm SSTs affect the intensity of Juan when it struck Nova Scotia?

An ensemble of storm simulations were run using the Mesoscale Compressible Community model (MC2) with each simulation initiated with a synthetic storm vortex approximately one day prior to landfall. We discovered that the landfall intensity was a whole category weaker when using climatology SSTs with maximum sustained winds of 37.6 m s^{-1} (73 kts, category-one) versus 42.5 m s^{-1} (83 kts, category-two). With storm destructiveness being proportional to the third power of

wind speed, the simulated "climatology" storm is ~30% weaker than the "control" storm with anomalously warm SSTs. The ensemble system was also used to diagnose the roles of perturbed initial conditions (storm size, intensity, position) and model parameters (convective schemes, resolution) on storm intensity and track.

11:45 AM

1B7.6
Verifications of parallel runs of MC2 at high resolution

Yan Shen , Xingxiu Deng , Henryk Modzelewski , George Hicks , Trina Cannon , Luca Delle Monache , Roland Stull
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In addition to daily MC2v4.9.1 operational runs, the Weather Forecast Research Team at the University of British Columbia started daily MC2v4.9.8 parallel runs on 21 January 2005. The purpose of these parallel runs is to test the performance of the latest MC2 model as a future replacement for the old version. Every day, 51 nodes and 6 hours are used to run MC2v4.9.8 with horizontal grid spacings of 108, 36, 12 and 4 km. Due to the huge computational power needed for these parallel runs, this experiment will be conducted for about one and a half months.

Objective and subjective verifications of the parallel runs are done against the observed surface data for the 4 km grid spacing. Preliminary findings are that the surface winds and temperature forecasts from the parallel runs are much closer to the observed data, and the new version shows a more reasonable wind-speed distribution in the mountainous terrain of Southern BC. More details will be presented.

(INVITED/INVITÉ) 1:30 PM

1C1.1
Nonlinear complex principal component analysis and its applications
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Complex principal component analysis (CPCA) is a linear multivariate technique commonly applied to complex variables or 2-dimensional vector fields such as winds or currents. A new nonlinear CPCA (NLCPCA) method has been developed via complex-valued multi-layer perceptron neural networks. NLCPCA is applied to the tropical Pacific wind field to study the interannual variability. Compared to the CPCA mode 1, the NLCPCA mode 1 is found to explain more variance and reveal the asymmetry in the wind anomalies between warm (El Niño) and cool (La Niña) states. NLCPCA can also be used to nonlinearly generalize Hilbert PCA (where real data is complexified prior to performing CPCA). An example is provided from the nearshore bathymetry at Egmond, Netherlands, where sand bars propagate offshore, and unlike the CPCA mode 1, the NLCPCA mode 1 detects asymmetry between the bars and the troughs.

1:45 PM

1C1.2
Neural Network forecasts of the tropical Pacific sea surface temperatures
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A neural network (NN) model had been used by our group to predict the SST anomalies in the Nino3.4 region in the equatorial Pacific, where predictors were the sea level pressure (SLP) and sea surface temperature (SST) anomalies over the tropical Pacific. Our latest version of NN model has been extended to forecast the SST anomalies over the whole tropical Pacific. The major difference between the current version and the old version are: (a) the subsurface temperature anomalies in the tropical Pacific ocean are now included as predictors; and (b) the predictands are now the five leading principal components (PCs) of the tropical Pacific SST anomalies instead of a single Nino3.4 index. We built the NN models to predict each of the five leading SST PCs separately.

Relative to the linear regression (LR) models, the NN models show considerably higher forecast skills for the SST PC2 and PC3 at 6, 9, 12 and 15 months lead times, with correlation skills increased by 0.18-0.43, and slight improvement for the other PCs, indicating nonlinear relationship between the SST PC2 (and PC3) and the predictors. The predicted SST PCs were then combined with the corresponding eigenvectors (or EOFs) to yield the forecast of SST anomalies over the whole tropical Pacific. Despite the slight improvement over central-eastern equatorial Pacific (with correlation skill enhanced by 0.05-0.1), the NN models showed considerable improvement over the LR models in western Pacific, esp. 10º-20º south of the equator near the dateline, with correlation skill enhanced by 0.2-0.4.

2:00 PM

1C1.3

Analysis of past, present and future extreme wave climate
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We present estimates of trends and variability in the extremes of significant wave height from 1958 to 2001 based on the European Centre for Medium-Range Weather Forecasts reanalyses (ERA-40) of significant wave height data. Using the ERA-40 data set and the Canadian Global Circulation Model predictions under different future climate scenarios of sea level pressures up to 2100, we carry out a non-stationary extreme value analysis and present predictions of changes in future extremes of significant wave height. The non-stationary extreme value analysis is based on a non-homogeneous Poisson process, whose application in this context is new. The uncertainty in the results due to model choice is assessed by comparing the performances of the non-homogeneous Poisson process with the analogous non-stationary model based on the generalized extreme value distribution. By comparing the changes in the 1958-2001 climate of significant wave height with those estimated by us on the basis of various future global warming scenarios, we pinpoint which changes are likely to be due to global warming.

2:15 PM

1C1.4
Marine Wind Retrieval and Error Estimation using Synthetic Aperture Radar
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Synthetic aperture radar (SAR) measurements by Radarsat-1 may be well suited for incorporation into a coastal data assimilation system, but first it is necessary to demonstrate that a surface marine wind analysis improves when SAR observations are employed. The feasibility of combining SAR measurements with high-resolution simulated wind fields is examined for coastal regions of eastern and western North America. A 2D-variational approach is used to retrieve wind fields for a subset of SAR acquisitions. Observations by ships of opportunity and buoys, taken within 90 minutes of these acquisitions, are used to quantify the improvements in the retrieved wind fields. Error bias and spatial covariance are also examined. An independent set of triple collocations (SAR, model, obs) are then used to assess the generality of our error characterization.

2:30 PM

1C1.5
Warm Season Lightning Probability Prediction for Canada and the Northern United States
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Statistical models valid May to September were developed to predict the probability of lightning in three-hour intervals using observations from the North American Lightning Detection Network and predictors derived from GEM model output at the Canadian Meteorological Center. Models were built with pooled 2000-2001 data using tree-structured regression. Error reduction by most models was about .4 to .7 of initial predictand variance.
Many predictors were required to model lightning occurrence for this large area. Highest ranked overall were the Showalter index, mean sea-level pressure, and troposphere precipitable water. Three-hour changes of 500 hPa geopotential height, (500-1000) hPa thickness, and MSL pressure were highly ranked in most areas. The three-hour average of most predictors was more important than the mean or maximum (minimum where appropriate). Several predictors outranked CAPE, indicating it must appear with other predictors for successful statistical lightning prediction models.
Our results demonstrate tree structured regression is a viable method for building statistical models to forecast lightning probability. Real time forecasts in three-hour intervals to 45-48 hours were made in 2003 and 2004. 2003 verification suggests a hybrid forecast based on a mixture of maximum and mean forecast probabilities in a radius around a grid point and on monthly climatology will improve accuracy. 2004 verification shows the hybrid forecasts had positive skill with respect to a reference forecast and performed better than forecasts defined by either the mean or maximum probability at most times. This was achieved even though an increase of resolution and change of convective parameterization scheme were made to the GEM model in May 2004.

1:30 PM

1C2.1
Three years of Physics and Biology in the Strait of Georgia
Rich Pawlowicz [1], *Susan Allen* [3], *John Dower* [2], *Randall Lee* [3], *Kate Collins* [3], *Rana El-Sabaawi* [2], *Mark Halverson* [3], *Akash Sastri* [2]
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The Strait of Georgia, as well as being of intrinsic interest in its own right,has some characteristics of a mini-ocean and thus may be a good place to study the interactions between physical and biological processes in the oceans at many different time scales. STRATOGEM was a 3 year field program that monitored physical processes of renewal and mixing, the related changes in water mass properties, and biological parameters quantifying primary and secondary production. Measurements were taken through a combination of hydrographic surveys of the Southern Strait (56 spread out over the 3 years) and near-continuous monitoring using instrumention mounted on several ferries that traverse these waters 6-8 times per day. The results of this program have provided a detailed view of the evolution of this system over three very different years. Here we present some preliminary results of the analysis.

1:45 PM

1C2.2
Interannual and seasonal variability in the composition, production and trophic status of the Strait of Georgia copepod community during STRATOGEM (2002-2204)
Akash Sastri , Rana El-Sabaawi , John Dower , Kandice Parker
(Presented by / Présenté par ***John Dower***)
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As part of the Strait of Georgia Ecosystem Modeling (STRATOGEM) project we have examined monthly and interannual variability in the relative composition, biomass, production rates and trophic status of the zooplankton community since April 2002. Traditionally, the community has been dominated by the large calanoid *Neocalanus plumchrus*. Although *N. plumchrus* dominated biomass production during the spring of 2002 and 2004, the smaller calanoid *Metridia pacifica* dominated (both in terms of abundance and biomass) during 2003. Significant changes in copepod community structure of this sort may lead to interannual variability in the efficiency of energy transfer to higher trophic levels in the Strait. In order to characterize interannual changes in the copepod community we have also employed two novel approaches: 1) Developmental and growth rates of the entire copepod community were estimated through changes in the turnover rate of the molting enzyme chitobiase and; 2) variation in trophic status of the copepod community was examined through measuring variability in the stable isotope signatures (C and N) of key copepod species. These data will also be of use in the development of biophysical models of Strait of Georgia

2:00 PM

1C2.3
A remotely-sensed survey of the biological response to tropical hurricanes passage in the North West Atlantic in 2003
César Fuentes-Yaco [1], *Trevor Platt* [3], *Emmanuel Devred* [2], *Shubha Sathyendranath* [2]
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The arrival of remote sensing has improved our capacity to study the influence of hurricanes on the pelagic ocean. Their passage controls the transport of cold, nutrient-rich deep-water into the mixed-layer, which increases phytoplankton biomass (Chlorophyll-a). In 2003, the tropical cyclones season in the North Atlantic basin was very active with 16 named hurricanes. We examine the response of the fields of chlorophyll, temperature and the community structure of phytoplankton, to the passage of hurricanes: Danny, Fabián, Juan and Kate. This study was done in the North Western Atlantic (39 to 62.5º N and 42 to 71º W), using daily satellite images of sea spectral reflectance (SeaWiFS) and sea-surface

temperature (NOAA/AVHRR), on a spatial scale of approximately 1.5km. We also used satellite data to assess if diatoms are favoured by the passage of major storms, and to test whether turbulent and nutrient-rich waters prevailing after a hurricane passage are suitable for their growth. The use of an algorithm that allows distinction between diatoms from other phytoplankton populations provides the required information to discriminate these species. Composite images before and after the storms passage were used to extract data across a centered band of 700km following the storm track. The results show concurrent changes in sea-surface temperature and chlorophyll-a along the storm track. The high spatial resolution in the images revealed in great detail features on the impact of the hurricanes on the pelagic ocean. In some cases, we distinguished the stronger effect of the storms passage on the right side than on the left side of storm tracks.

2:15 PM

1C2.4
Fisheries applications of finite element models in the Bay of Fundy and Gulf of Maine.
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A three-dimensional finite-element model with the capability of simulating drying areas has been applied to the Bay of Fundy and the Gulf of Maine. We Briefly review the model and methodology. Applications that will be covered include lobster recruitment along the Maine coast, the spread of infectious salmon anemia between salmon farms, oxygen supply within a salmon farm, determining boundaries between different management areas, and particle settling from salmon cages.

2:30 PM

1C2.5
Validating a model of plankton-DOM dynamics across different regions in the North Atlantic
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The dynamics of plankton ecosystems in the surface ocean are central to understanding biogeochemical air-sea interactions (e.g. DMS, CO2). Planktonic ecosystems in the North Atlantic display strong temporal and regional variability in productivity and trophic structure, which can not be captured by simple plankton models. We have developed a 1D adaptive plankton-DOM model, which is forced by output from a physical circulation model of the North Atlantic. The model is validated individually with varying success for three regions: Station BRAVO in the Labrador Sea, the BATS site in the Sargasso Sea, and the EUMELI region off the coast of Northwest Africa. We analyse discrepancies in model predictions and parameter estimates within and among the three regions. Differences in parameter estimates can be related to differences in external forcing not included in the model. A sensitivity analysis allows us to establish relationships between individual physical and biological processes and corresponding differences between model results and observations. Information from this analysis can be used to improve the generality and predictive power of the plankton-DOM model.

2:45 PM

1C2.6
Stochastic methods to quantify the effect of environmental variability on plankton ecosystems
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The marine physical environment is often dominated by seasonal, annual or longer cycles of variability. Higher frequency events caused by local weather and mesoscale hydrodynamic processes also exist and invoke biological reactions. Physical models can resolve this high-frequency variability through time-dependent forcing, which may be derived from observations. The results from plankton models coupled to physical models that resolve high-frequency variability are specific to the exact forcing time series used. Recent application of Monte Carlo methods to marine ecosystem modeling quantify how environmental variability propagates to biological variability by fitting error statistics to simulation results. This talk presents the result of simulations of a plankton model forced with random realizations of a physical time series which contain a periodic signal and randomly generated noise. The results are presented in the form of probability

distributions that evolve over the cycle of the periodic signal. Two major findings are reported. First, the average time series from all realizations does not equal the solution of the model forced with the average of the random time series. Second, the interaction of a nonlinear (biological) system with random environmental fluctuations and periodic forcing causes emergent behavior, which can not be derived from classical model analysis.

(INVITED/INVITÉ) 1:30 PM

1C3.1
Cirrus, cloud microphysics and aerosols: What can we learn from detailed parcel models for use in global climate models

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The impact of aerosols on cirrus clouds is best represented in Lagrangian parcel models where the aerosol size distributions can be characterized in most detail. Such parcel model simulations can be used for example to derive and validate parameterizations of homogeneous and heterogeneous freezing (Kärcher and Lohmann, 2002, 2003) or to characterize the vertical velocity that is representative for cloud droplet activation (Peng et al. 2005). These parameterizations can then be applied in coarser models, such as global or regional climate models. In this talk, I will show different examples of how parcel models can be used to improve our understanding of the different processes and to derive parameterization of aerosol-cloud interactions for use in global climate models.

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(INVITED/INVITÉ) 2:00 PM

1C3.2
Some issues in middle atmosphere climate modelling

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Until recently, modelling of the middle atmosphere has been a "niche" activity. However the middle atmosphere is increasingly falling within the scope of more mainstream areas of atmospheric science. Weather forecast models now often have their upper lids at the stratopause or even higher, while climate models likewise contain increasingly improved representations of the stratosphere. In the latter case, there are two main drivers for this development. The first is to provide a more realistic upper boundary condition for tropospheric climate; this issue becomes particularly pressing once climate models include a representation of chemistry, given the important role of transport of stratospheric ozone in tropospheric chemistry. The second driver is the desire to include all sources of natural climate variability, in order to have a more credible basis for climate change simulations. The stratosphere exhibits a quasi-biennial oscillation (QBO) in tropical winds which also impacts extratropical circulation, and the principal candidate for impact of the 11-year solar cycle on climate is believed to be through stratospheric ozone. Furthermore there is recent evidence for long-term internal memory in the stratosphere which can have an impact on tropospheric climate variability. In this talk, a number of these issues will be reviewed.

(INVITED/INVITÉ) 2:30 PM

1C3.3
The role of small-scale GWs in the general circulation of the middle atmosphere

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It is well know that small-scale gravity waves play a crucial role in the general circulation of the middle atmosphere. Not only are they responsible for producing the cold summer mesopause, they are also important in controlling polar temperatures in the lower stratosphere where ozone loss occurs and in helping to drive the quasi-biennial oscillation in the tropics. Since current middle atmosphere general circulation models are too coarse to resolve these waves, their effects must be parameterized. In this presentation I will describe the basic elements of these "gravity-wave drag"

parameterizations and show results from several models, including the Canadian Middle Atmosphere Model, exemplifying their effect.

1:30 PM

1C4.1

Bioaerosols: Impacts on Chemistry and Physics of the Lower Atmosphere

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Interactions of aerosols and clouds are one of the major uncertainties of climate change studies. Aerosols can directly and indirectly impact climate by absorption and scattering of irradiation in atmosphere. The indirect effect is linked to their ability to form cloud condensation nuclei (CCN) and ice forming nuclei (IFN), and hence lead to the formation of clouds. However, a slight variation in cloud albedo significantly modifies the planetary albedo, and thus affects the global climate. Bioaerosols, a subgroup of aerosols, are a group of organic aerosols ranging from ~ 10 nm to 100 µm. In this paper, we present a combined field, laboratory and modeling studies that suggest the potential importance of bioaerosols as CCN and IFN, and at the environmental interfaces. The implication of our results to the chemistry and physics of atmosphere will be discussed

1:45 PM

1C4.2

Mineral Dust Transport in the CCCma Atmospheric GCM

Mary Catherine Reader
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Mineral dust is an excellent test case for numerical advection algorithms for several theoretical and practical reasons. In particular, it is very susceptible to the undesirable side-effects of such schemes due to its large spatial and temporal variability. It also interacts fairly weakly with other aerosols and climate, so it can be run in a passive mode and still yield realistic distributions. Validation is also aided by the fact that the sources are quite localized and there exists concentration and deposition data for widespread locations, including some far from the source regions.

Several methods of ameliorating the problems related to "holes" and Gibbs fringing in spectral transport models are investigated, separately and in combination, using mineral dust simulations with the CCCma atmospheric general circulation model. The use of a hybrid transport variable is found to be very effective in preserving gradients and reducing holes, but the concomitant lack of mass conservation may be quite problematic for this tracer. A "physics filtering" approach in which the physical tendencies are filtered to remove small-scale noise is also very promising. Various "hole-filling" procedures are also considered.

2:00 PM

1C4.3

Black carbon ageing in the Canadian Centre for Climate modelling and analysis atmospheric general circulation model

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Black carbon (BC) particles in the atmosphere have important impacts on climate. The amount of BC in the atmosphere must be carefully quantified to allow evaluation of the climate effects of this type of aerosol. In this study, we present the BC aerosol treatment in a developmental version of the Canadian Climate Centre for Modelling and Analysis (CCCma) Atmospheric General Circulation Model (AGCM). The focus of this work is on the conversion of insoluble BC to soluble/mixed BC. Five separate parameterizations of this ageing process are compared. The first simulation assumes that no ageing occurs. The remaining simulations use 1) an exponential decay with a fixed 24 hour half-life, 2) a condensation and coagulation scheme, 4) an oxidiative scheme, and 5) a linear combination of the latter two ageing treatments. Global and annual mean BC burdens were 2.15, 0.14, 0.11, 0.20, and 0.10 Tg C for these five schemes, respectively. The BC lifetimes were found to be 98.0, 6.4, 5.0, 9.1, and 4.6 days, respectively. A computationally efficient representation of the processes of condensation, coagulation and

oxidation is shown to simulate BC ageing well in the CCCma AGCM. As opposed to the globally fixed ageing time scale, this treatment of BC ageing is responsive to varying atmospheric composition.

2:15 PM

1C4.4
Simulation of tropospheric chemistry in the Canadian Middle Atmosphere Model
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The Canadian Middle Atmosphere Model (CMAM) has been developed to study the chemical and dynamical climate of the troposphere, stratosphere and mesosphere as a coupled system. The CMAM developed from the Canadian Climate Centre for Modelling and Analysis (CCCma) GCM, with chemistry calculated on-line within the GCM. Development of the model for middle atmosphere applications has included a description of stratospheric and mesospheric gas-phase chemistry, heterogeneous chemistry on background sulphate aerosols and PSC chemistry. Calculation of active gas-phase chemistry has been extended down to all model levels in the troposphere, where the stratospheric chemical mechanism reduces, in essence, to a description of background tropospheric CH_4-NO_x chemistry. Additional processes important in the troposphere, such as dry and wet deposition, emissions of CO and NO_x, hydrolysis of N_2O_5 and cloud effects on photolysis rates have been included.

The model is run at a spectral resolution of T47, approximately 3.8°x3.8°, with 71 vertical levels between the surface and approximately 95 km. A comparison of chemical fields from a model simulation for present-day conditions with observations suggests the model reproduces quite well the total column O_3 over much of the globe, though there is evidence the model is biased low for O_3 in the troposphere. The model captures the absolute amount and seasonal cycle of CO when compared with surface observations, though there is some evidence the particular biomass burning emissions used are too low. The global budget for tropospheric O_3 is well within the range of estimates produced by other global models. Average tropospheric OH concentrations also compare well with observational-based estimates.

(INVITED/INVITÉ) 2:30 PM

1C4.5
GEM-AQ: a multiscale 3D model for chemical weather
John C. McConnell , *Jacek Kaminski* [2], *Lori Neary* [2], *Alex Lupu* [2], *Jerzy Jarosz* [2], *Carlo Buontempo* [2], *Kenjiro Tyoto* [2], *Sunling Gong* [1]
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Air quality is no longer solely an urban or regional issue. Plumes of pollutants from dust storms or forest fires or urban combustion cross the Pacific and Atlantic. Pollutants from mid-latitudes end up in the Arctic. In this talk I will review the work that is being pursued as part of the Multiscale Air Quality Network using GEM-AQ as tool. GEM-AQ uses the Canadian weather forecast model GEM (Global Environmental Multiscale Model) as a host for a suite of on-line processes associated with air quality such as emissions, gas phase and heterogeneous chemistry, wet removal and dry deposition, aerosols using the Canadian Aerosol Model.

1:30 PM

1C5.1
Meteorology and Adverse Weather During CASES
Teresa Fisico [1], *John Hanesiak* [2]
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The accurate characterization of severe arctic weather is gaining importance in terms of observed climate variation and its influence on sea ice type and concentration, snow redistribution and, most importantly, human safety. There have been few studies on the simulation of arctic severe weather over sea ice. The Canadian Arctic Shelf Exchange Study (CASES 2003/2004) provided a platform for collecting a unique suite of continuous meteorological data aboard the *CCGS Amundsen* from October 22, 2003 to June 20, 2004. As a precursor to a modeling study, we present an overview of the hemispheric, synoptic and local scale meteorology observed during the CASES meteorological program. First, NCEP data were used to examine the CASES year with respect to the 1971-2000 30-year "normal". Second, surface 3-h isobaric analysis were used to track low-pressure disturbances (LPDs) affecting the CASES region during the observational period to reveal their synoptic origin and evolution. Third, a monthly (and overall) climatology of several meteorological variables (e.g. cloud type/amount/ceiling, adverse weather, wind, temperature) was produced and has been compared to surrounding standard MSC stations to characterize the differences between terrestrial and on-ice weather regimes in the CASES region. To investigate the validity of using regional model data in place of on-ice *in-situ* data, NCEP Re-analysis and GEM daily average time series data were compared to data collected at the *CCGS Amundsen* and surrounding stations. Initial results of adverse weather (with a focus on blowing snow) simulations using the Polar MM5 and GEM LAM models will also be presented.

1:45 PM

1C5.2
Blowing Snow Studies in CASES (Canadian Arctic Shelf Exchange Study)03-04
P.A. Taylor [1], *Sergiy Savelyev* [1], *Mark Gordon* [1], *John Hanesiak* [2], *Tim Papakyriakou* [2]
(Presented by / Présenté par ***Peter A. Taylor***)
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Between mid January and early May 2004 during CASES we deployed blowing snow particle counters, visibility sensors, a FlowCapt device, snow bags, an electric field meter and other instruments related to the observation of blowing and drifting snow on first year ice in Franklin Bay. CCGS Amundsen provided a most hospitable base for our operations. All instruments performed well although there are still some calibration issues outstanding to relate particle counters to number densities.

Basic results will be presented which relate particle count profiles and other data to visibility, threshold conditions for blowing snow, wind speed profiles and roughness lengths, heat and water vapour fluxes and the electric field. Relative humidity with respect to ice was generally high and sublimation rates, inferred from water vapour fluxes above blowing snow, are believed to have been low.

2:00 PM

1C5.3
Use of a blowing snow (BS)model for prediction of BS events on the Canadian Prairies and Arctic: Preliminary analysis
Jim Butler [1], *John Hanesiak* [2]
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Blowing snow in the Canadian Prairies and Arctic can be problematic for transportation and improvements in forecasting these events would be beneficial. A preliminary study focusing on using a blowing snow model (Piektuk) to better predict these events has been conducted. Historical MSC hourly weather data from 1960 to 2001 from 39 different stations in various eco-climate zones was used to force the model as well as providing validation data. The best results (critical success index (CSI) ~ 50%) occur in Arctic tundra (flatter terrain) as expected. However, optimizing wind speed thresholds

for each station improves the CSI to ~65% in tundra regions. Prairie and heavily forested areas show smaller CSIs. Results will be presented for a variety of stations from various eco-climate zones. Future analysis will attempt to include wind direction in the model forecast since all stations have preferred wind directions in which blowing snow occurs. In addition, field data collected during the Canadian Arctic Shelf Exchange Study (CASES) will also be used to improve various model parameterizations such as threshold winds and snow state.

2:15 PM

1C5.4
The cloud vertical structure in winter Arctic
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The effect of cloud microstructure on radiative transfer in the Arctic Atmosphere remains as a significant research challeng. The characteristics of Arctic cloud vertical structure (CVS), such as cloud base and top heights, the vertical distribution of temperature and humidity within the cloud layer, and the vertical airflow speed, are all important not only for the regional weather analysis but also for process studies examining ocean-sea ice-atmosphere coupling for fluxes of mass and energy.

Over two hundred upper air sounding were released during the CASES field experiment (2003.11-2004.06) to study the weather system evolution during the winter period. Vertical boundaries of CVS are identified with the ground-based laser ceilometer as well as manual observations. The in-situ MODIS CVS products by both Terra and Aqua satellites are compared. The CVS is analyzed with a consideration of the seasonal evolution and cloud type. The CVS characteristics concluded in this study can be reliable reference to parameterize the cloud physics for climatic change modeling. Still this work can be a ground validation for MODIS cloud products.

2:30 PM

1C5.5
Multi-seasonal ocean hindcasting of the Canadian Arctic Archipelago
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An ongoing effort at modelling the archipelago is under way between the Bedford institute of Oceanography and Quebec Ocean at Laval University. The model is based on FVCOM (Chen et al., 2003) which is a finite-volume unstructured mesh ocean model with a sigma vertical coordinate. The model has since been developed to include a hybrid vertical grid which enables a better conservation of the stratification and at the same time a good representation of the bottom boundary layer, critical to the representation of the tidal mixing that takes place in some of the shallow sills. The model also includes a fully prognostic ice model and is forced at the open boundaries by the AIM model of IOS (Greg Holloway). The circulation on the Arctic Ocean side is rather sensitive to the forcing and only more data will enable us to confirm some of the circulation patterns there.

2:45 PM

1C5.6
Sedimentation of organic matter in the North Water (northern Baffin Bay): phytoplankton and fecal pellets contribution to the carbon flux
Gitane Caron [1] , Christine Michel [3] , Michel Gosselin [2]
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The sedimentation of organic matter in the North Water area was assessed during June-July 1998 and August-September 1999. The material collected under the euphotic zone by free-drifting short-term particle interceptor traps was analyzed for particulate organic carbon (POC) and cells contents (diatoms and fecal pellets). The maximum sedimentation of matter was observed in June. During that month, diatom cells and fecal pellets contributed 50 and 4% of the total POC sinking flux, while they made up ca. 10 % and 30-50% during the following months. These results indicate that the dominant pathway of carbon cycling changed from export in spring to retention afterwards, which was favoured by low sinking velocities. Over

the whole sampling period, 35% of the POC phytoplankton production was exported through sinking while 65% remained in the euphotic zone. The POC produced in the euphotic zone was thus mainly transferred to pelagic grazers rather than being exported to the benthic community.

1:30 PM

1C6.1
Defining the Impact of Weather: Solving the HIW Definition Dilemma
Patrick McCarthy
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Forecasters, researchers, modelers, managers, etc. are being asked to focus their efforts on "High-impact weather." Exactly what high-impact weather is has been a topic of debate for the last few years. Without a clear understanding of the definition high-impact weather, the planning and development of weather service priorities, the allocation of resources, the defining of forecaster roles, the prioritization of research activities, the determination of data requirements, and the day-to-day production of forecasts and warnings cannot be effectively accomplished.

This document outlines a new approach to defining the impact of weather. By examining the factors that produce the weather's impact, whether it is the characteristics of the event itself, who/what is being impacted, and the capacity to mitigate the impact, this document outlines a broader range of impact types. These are:

Low-impact – minor inconvenience, small and local economic losses, etc.
Moderate-impact – minor damage, some social disruption, etc.
High-impact – damage, risks to health, broad economic impact, etc.
Extreme-impact – Catastrophic losses, deaths, injuries, major social disruption

The impact of weather is applied to economic sectors, people, the economy, and the environment to determine the characteristics of each category. This approach also suggests a tiered method of alerting Canadians to the various levels of weather impact. This is discussed briefly in the presentation.

1:45 PM

1C6.2
The Third MSC Forecasters Forum: Overview and Recommendations
Dov Richard Bensimon [1] *, David M.L. Sills* [2] *, Serge Desormeaux* [2] *, Mario Gaudette* [2] *, Louis Lefaivre* [2] *, Gilles Simard* [2] *, Jean-François Voros* [2]
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The third MSC Forecasters Forum was held 15-17 February 2005 in Montréal and had the theme "Forecasting and Services for the Future". Over 160 people attended this event with the goal of discussing future directions for MSC. Roughly half of the participants were MSC operational meteorologists. Sessions included "The Future Role of the Operational Meteorologist", "The Human-Machine Mix: The Shape of Tools to Come", and "Probabilistic Forecasts, Products and Services". For this forum, there was a greater emphasis placed on formulating recommendations to MSC senior management on a variety of issues. Recommendations were endorsed by forum participants following a number of intensive break-out sessions. An overview of the forum will be presented and the resulting recommendations will be discussed.

2:00 PM

1C6.3
Probabilistic Forecasts and the future of meteorology: Who are the clients?
Kent Johnson
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Over the next few years, probabilistic prediction systems will become widely available. Rather than a four dimensional database of weather elements, a database of probability density functions will be the output of numerical weather prediction systems. Many scientific and economic studies have demonstrated the immense potential value of probabilistic forecasts for risk-based decision-making. Clearly, there will be an expanding need for meteorological professionals to develop and interpret probabilistic forecast information.

The challenge will lie in the communication of probabilistic information to clients. Before embarking on this challenge, however, the nature of the client must be determined. Decisions must be made based on policy – who are the "clients" - and client service – what do the clients need.

2:15 PM

1C6.4
Does Canada need a school of operational meteorology?
Kent Johnson
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The advent of ensemble prediction systems and probabilistic forecasts will profoundly change applications of meteorology. The potential value of these forecast systems is likely to increase the demand for meteorological professionals. This need for trained meteorologists will stretch well beyond the Meteorological Service of Canada to provinces, private enterprise and private sector meteorology. Probabilistic forecasts can contribute to risk-based decision making in many sectors such as transportation, energy, emergency preparedness, agriculture and forestry.

Canada presently has dozens of employers of meteorologists. The Meteorological Service of Canada is perhaps the only current employer with the critical mass to establish a comprehensive training and professional development program. Although recruitment and initial training are vital, ongoing professional development is equally important. In addition, many national meteorological services are struggling with the issue of certification.

A comprehensive Canadian school of meteorology would be responsible for all training and certification of meteorologists in Canada. Such an "arms-length" organization would be started by the Government of Canada and would offer services to other organizations on a commercial basis. In addition, the school would potentially train and certify meteorologists from other nations, in English and French. Only through the establishment of a national school of meteorology will Canada be able to train sufficient professionals to truly exploit the economic benefits of future atmospheric predictions.

2:30 PM

1C6.5

An Integrated and Interoperable Risk Assessment and Prediction System for Disaster Monitoring and Management

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Weather related disasters and Seismic disasters cause extensive damage to human life and property. The Great Tsunami of December 26, 2004 affected 18 countries, 11 of which reported deaths some in tens of thousands. *The total death toll has been reported as 226,566.* However, this is an underestimate as thousands are still missing and many more may have been killed in remote islands. More than 1.5 million people were left homeless around the region. Although it will take some time to evaluate the economic impact, it is expected to be in billions in areas which can hardly afford such setbacks.

According to the brochure of the Meteorological Services of Canada, during the past 10 years, weather related disasters in Canada alone caused 8 to 11 Billion $'s worth of losses to property, *70 to 100 deaths* and 58,000 people displaced. The effect of disasters on the entire world is much more extensive.

With increasing population and pressures on resources, the world in general and developing countries in particular are finding it harder to cope with natural disasters (floods, hurricanes, earthquakes, volcanic eruptions, forest fires, etc.,) or disasters caused by human activity (oil spills, toxic leaks, etc.). Forecasting of disasters, forewarning the affected population and managing and mitigating their effects can provide extensive saving of life and property. The problem to be tackled is the forecasting and forewarning of the impending disasters in a timely manner so that effective preventive measures to minimize losses (both to life and property) could be taken. In addition the above, post-disaster assessment technologies will also be covered in this presentation.

The objective of this paper is to describe an integrated and interoperable risk assessment and prediction system for disaster monitoring and management using in-situ data and remotely sensed data. It is a system which we are planning to build. It will have three major functions as outlined below:

1. Using In-Situ collected data and remotely sensed data, the system will be able to *forecast disasters*. It will provide tools to visualize data in various forms such as text messages, tabular displays and GIS-based three-dimensional illustrations.
2. It will also interface with Public Warning Systems to generate timely warnings so that the loss of life and property could be minimized.
3. The system will also provide tools for assessing the damage caused by the disaster.

1:30 PM

1C7.1
Back Trajectory Analysis Based on MC2 Sensitivity Study
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(Presented by / Présenté par ***Mike Lepage***)
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A number of MC2 (v4.9.7) sensitivity tests were conducted in the Pacific Northwest Region of Canada and U.S. by changing geophysical parameters, cloud physics options, initial conditions (with different input data) and grid resolutions. The Canadian back trajectory model (v1.3) was applied using the MC2 sensitivity run outputs. Model runs were performed for a 21-day episode in August 2001. Back trajectories were generated twice daily for a 24-hour period, at three different heights and four locations. Trajectory outputs were mapped in a GIS to provide a visual comparison of air parcel trajectories from the different sensitivity tests.

Preliminary model results indicate that back trajectories at lower levels (50m) are more sensitive to changes in geophysical and physical parameters, whereas those above the PBL (2500m) are not sensitive to these same parameters. Increasing the number of vertical levels caused different trajectory patterns depending on the conditions during that day. Changes in horizontal grid resolution also resulted in different trajectory patterns. Significantly different trajectories were modelled at different stations at the 500m height on August 16. A air mass passed through the region on this day, suggesting that wind fields in the PBL are very sensitive to the choice of input parameters tested under these types of transitional conditions. The challenge remains to identify what might be considered the 'optimal' MC2 model settings for every situation.

1:45 PM

1C7.2
Surface data assimilation over mountainous British Columbia: Results from near real-time operational runs
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Growing computer power has led to finer resolution numerical weather prediction (NWP) models. Such resolution is important for mountainous British Columbia, because in steep mountainous terrain, the valleys contain most of the population centers, industries, and transportation routes. The University of British Columbia (UBC) has been running fine-resolution real-time forecasts with the MC2 model. A finest nest is 2-km grid spacing over southwestern BC.

The "Emergency Weather Net Canada", maintained by the Geophysical Disaster Computational Fluid Dynamics Center at UBC, exists to archive and provide timely surface weather observations for western Canada. Hourly data sets are combined in the Emergency Weather Net database from many agencies. This real-time weather information system makes it possible to get frequent and dense surface weather observations for the use in data assimilation and analysis/forecast verification as well.

Our goal is to fully utilize dense local surface weather observations to supplement the existing coarse-resolution analyses from the major operational centers, with emphasis on reducing the near-surface model prediction errors. To achieve this goal, a new anisotropic background error correlation model was developed for use in horizontally spreading surface weather observations in complex terrain. The surface data were then merged into the coarse-resolution 3D analyses. We implemented this new approach for assimilating surface observations into daily operational forecasting, and compared verification statistics with the MC2 control runs. Results obtained from two-month, near real-time operational runs will be presented.

2:00 PM

1C7.3
An Atlantic meso-scale modelling system for the Lunenburg Bay Project
Augustus Fanning [1] , Hal Ritchie [4] , Hal Ritchie [3] , Serge Desjardins [2]
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As part of a multidisciplinary research initiative centered on Lunenburg Bay, Nova Scotia, we have been developing a real time atmosphere-ocean prediction model for Atlantic Canada. The ocean model is a three-dimensional primitive equation model developed at Princeton University (the POM) model. For its atmospheric component, the Mesoscale Compressible Community (mc2) model was chosen. Wherever possible, model physics has been chosen to match the Global Environmental Multiscale (GEM) model. The GEM model supplies boundary conditions for the operational regional grid (a 10 km grid extending along the eastern seaboard of the Atlantic). This model subsequently supplies boundary conditions for an embedded research component (a 2.5 km grid centered on Nova Scotia). An overview of the mc2 model configuration, coupling strategy along with preliminary results of the coupled system will be presented.

2:15 PM

1C7.4
Computational Modeling of 3D Turbulent Flows with MC2
Claude Pelletier [1] , *Jocelyn Mailhot* [2] , *Michel Desgagne* [2]
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A three-dimensional turbulent model is developed to simulate flows ranging from meso-gamma down to micro-beta scales. The governing equations are the compressible Reynolds-averaged Navier-Stokes equations for momentum, temperature and humidity under the Boussinesq approximation coupled to the TKE budget equation. The resulting set is solved numerically on a 3D staggered grid with open lateral boundaries within the semi-implicit semi-Lagrangian MC2 model framework. Case studies comparing high-resolution 1D and 3D results are presented using data from the Oklahoma City joint urban measurement campaign of 2003.

2:30 PM

1C7.5
Instantaneous Precipitation-Rate Errors Associated With the Microphysics Scheme Used in the 2.5 km GEM-LAM
Jason Milbrandt [1] , *M. K. Yau* [3] , *Stephane Belaire* [2] , *Jocelyn Mailhot* [2] , *Amin Erfani* [2]
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Operational numerical weather prediction models have been moving to higher and higher resolutions as computer power continues to increase. At the Canadian Meteorological Centre, a 2.5-km grid configuration of the GEM-LAM forecast model is currently being tested. In this configuration, no convective parameterization scheme was used. Rather, clouds have been treated fully explicitly using the Kong-Yau microphysics scheme. During the real-time testing period of this configuration, several instances of unrealistically high instantaneous precipitation-rates from the model have been noted.

The excessive precipitation-rates appear to be related to the fact that the version of the microphysics scheme used during the testing period was a single-moment parameterization, where all quantities relating to a particular particle category, including the bulk fall velocity, are uniquely related to one predictive variable, the hydrometeor mass content. It has been shown there is a fundamental difference in the way that sedimentation is computed between schemes that predict one parameter and schemes that predict two or more.

In view of this, a new version of the Kong-Yau microphysics scheme has been developed where a predictive equation for the total number concentration of rain, in addition to the mass content, has been added, thus making the scheme double-moment for the rain category. Simulations with the GEM-LAM at 2.5 km using the original single-moment version and the double-moment-rain version of the scheme will be presented. It will be shown that for the small additional cost of adding one predictive parameter for the rain category, the problem of excessive precipitation rates is reduced and there is an overall improvement in the precipitation forecast.

2:45 PM

1C7.6

The Europeo-Canadian unified coupler OASIS3-GOSSIP2 and first coupled applications using the atmospheric model GEM

Sophie Valcke [1] , *Pierre Pellerin* [2] , *Michel Valin* [2] , *Djamel Bouhemhem* [2] , *Manon Faucher* [3] , *Serge Desjardin* [2] , *Hal Ritchie* [2]
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The new unified OASIS3-GOSSIP2 coupler is a software allowing synchronized exchanges of coupling information between numerical models of the Earth system components.

OASIS3 is a coupler widely used in the European climate modelling community, and in the USA and Australia. OASIS3 is developed in CERFACS (Toulouse) since more than 10 years and was recently upgraded within the European PRISM project. GOSSIP2 is the new version of the communication layer developed at RPN based on UNIX sockets. Particular advantages of GOSSIP2 are its simplicity, its portability and its direct support of distributed computing.

At run-time, the different constituents of OASIS3-GOSSIP2 play different roles: -the GOSSIP2 Server transfers data from a sender to a receiver (model or regridding process) ; -the regridding process transforms, on the target model grid, the 2D coupling fields expressed on the source model grid. -the PRISM System Model Interface Library (PSMILe) is used by the component models to communicate via the regridding process, and/or to perform I/O actions. Besides GOSSIP2, PSMILe can also use the Message Passing Interface (MPI) as lower communication layer.

OASIS3-GOSSIP2 is currently being used at RPN and CMC to assemble a coupled model based on the Institut Maurice Lamontagne ocean model and on the atmospheric model GEM. It is also used to externally couple GEM to the land surface schemes ISBA/CLASS, thereby giving the flexibility to easily change ISBA/CLASS resolution. First results of sensitivity studies on the effect of the land surface scheme resolution will be presented.

4:00 PM

1E1.1
Climate change signal and uncertainty in projections of ocean wave heights
Xiaolan Wang [1] *, Val R. Swail* [2]
(Presented by / Présenté par ***Xiaolan L. Wang***)
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In this study, projections of seasonal means and extremes of ocean wave heights were made using projections of sea level pressure (SLP) fields conducted with three global climate models for three forcing scenarios. For each forcing scenario, the three climate models' projections were combined to estimate the multi-model mean climate change. The relative importance of the variability in the projected wave heights that is due to the forcing prescribed in a forcing scenario was assessed on the basis of ensemble simulations conducted with the Canadian coupled climate model CGCM2. The uncertainties in the projections of wave heights that are due to differences among the three climate models and/or differences among the three forcing scenarios were characterized.

The results show that the multi-model mean climate change has patterns similar to those derived from using the CGCM2 projections alone, but the magnitudes of changes are generally smaller. The forcing-induced variability (as simulated by the CGCM2) was identified to be statistically significant in some areas in all seasons, being largest in the North Pacific (NP) in the JFM season with stronger forcing scenarios, although its statistical significance may be underestimated due to the limited ensemble size of the CGCM2 ensemble simulations. In the wave height projections, the uncertainty due to differences among the three climate models is much larger than that due to differences among the three forcing scenarios. The sum of the forcing and model uncertainties is smaller in the JFM and AMJ seasons than in the JAS and OND seasons, and it is generally small in the mid-high latitudes and large in the tropics. In particular, the areas of large projected changes were identified to have small inter-model variability. Also, the inter-scenario variability was identified to be statistically significant in most areas of the oceans, although it is small relative to the inter-model variability. This indicates that different forcing conditions do make significant differences in the wave height climate change projection.

4:15 PM

1E1.2
Correction of Ensemble Temperature Forecasts with Bayesian Model Averaging
Lawrence Wilson [1] *, Stéphane Beauregard* [2] *, Richard Verret* [2]
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Probability distributions of surface weather elements derived from ensemble forecasts are usually underdispersive and may be biased.. A statistical method called Bayesian Model Averaging (BMA) offers an intuitively appealing way of correcting forecasts of probability distributions. BMA essentially is an objective way of doing what a forecaster does in evaluating forecasts from several models that are available to him each day: Instead of selecting a single “model of the day”, BMA produces a weighted average of the forecasts from all the available models to produce a corrected forecast. While BMA can be applied to any collection of separate models, we have applied it to the 16 models of the Canadian ensemble system. Using verification results from the last X days, the bias is corrected with a simple linear regression, and the relative weights are determined from the overall performance statistics for all the models. The resulting corrected distribution is a weighted combination of (assumed) normal distributions, where the standard deviation is related to the standard error of each model. In our experiments, we found that the optimum training period is about 40 days. We also found that comparing the weights gives a wealth of information on the relative quality of the models.

In the presentation, we will show verification results for temperature forecasts produced using BMA on the output of the Canadian ensemble system, along with some specific examples of interesting forecasts from the system.

4:30 PM

1E1.3
CMC Numerical Weather Prediction Model performance
Thomas E. Robinson
(Presented by / Présenté par ***Tom Robinson***)
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Performance of the CMC NWP models over the last year or more will be presented, with emphasis on relating the verification scores to specific case studies.

CMC has had an active year in terms of changes to its NWP models, including a new 15-km version of the GEM regional model and the addition of various satellite and wind profiler data to the 3d-var assimilation system. Plans also call for the implementation of a new 4d-var assimilation system, under development for the last few years, by the spring of 2005.

These changes have led to improvements in model performance, as measured by objective verification scores for both the mass and precipitation fields, and as noted in improved day to day performance in forecasting weather systems.

Trends in objective verification scores will be presented, including those comparing CMC model performance against other major NWP centres. Specific examples will illustrate how the objective scores translate to improved numerical model outputs.

4:45 PM

1E1.4
Performance of Precipitation Forecasts for Various Forecast Providers
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Weather forecasts are not only provided by national weather services, but by many private weather forecast companies, as well. Much of this information is readily available to the general public. Is this information similar or is a person required to make sense of a wide variety of predictions? Are any of the forecasts particularly accurate?

This paper examines the precipitation forecast performance of a number of major forecast providers. Their performance is weighed against the expectations of the public as indicated in public surveys.

At the 2004 CMOS Congress, the author presented his findings on the performance of these providers with respect to day-time maximum temperature forecasts. Those findings also demonstrated that by using a simple “ensemble” of those forecasts, performance was improved for medium to long range temperature forecasts. This presentation will also examine the utility of simple ensemble forecasts for precipitation, as well as the utility of probabilistic forecasts.

5:00 PM

1E1.5
UMOS Marine Wind Forecasting
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The Updateable Model Output Statistics system has been applied to the forecasting of surface winds over Canadian waters, including both lakes and coastal areas. Prior to development of the forecast equations, a comprehensive dataset was compiled using all available buoy observations. Data was separated into “near shore” and “off shore” data for the purposes of development; the off shore data were combined into one dataset for equation development. Near shore data and lakes data were all treated separately for equation development. Experiments were also carried out to evaluate the utility of scatterometer observations for equation development, but these were found to be too infrequent to be useful. Independent sample verification results will be shown to demonstrate the quality of the forecasts, and will be compared to forecasts from the operational GEM model.

4:00 PM

1E2.1
Thermodynamic characterization of the partitioning of iron between soluble and colloidal species in the Atlantic Ocean

Jay Cullen , B.A. Bergquist Massachusetts Institute of Technology , J.W. Moffett Woods Hole Oceanographic Institution
(Presented by / Présenté par ***Jay T. Cullen***)
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Recent electrochemical measurements have shown that iron (Fe) speciation in seawater is dominated by complexation with strong organic ligands throughout the water column and have provided important thermodynamic information about these compounds. Independent work has shown that iron exists in both soluble and colloidal fractions in the Atlantic Ocean. Here we have combined these approaches in samples collected from a variety of regimes within the Atlantic Ocean. We measured the partitioning of Fe between soluble (<0.02 μm) and colloidal (0.02 μm to 0.4 μm) size classes and characterized the concentrations and conditional stability constants of Fe ligands within these size classes. Results suggest that equilibrium partitioning of Fe between soluble and colloidal ligands is partially responsible for the distribution of Fe between soluble and colloidal size classes. However, a significant fraction of the colloidal Fe was inert to ligand exchange as soluble Fe concentrations were generally lower than values predicted by a simple equilibrium partitioning model.

In surface waters, strong ligands with conditional stability constants of 10^{13} relative to total inorganic Fe appeared to dominate speciation in both the soluble and colloidal fractions. In deep waters these ligands were absent, and instead we found ligands with stability constants 100-fold smaller that were predominantly in the soluble pool. Nevertheless, significant levels of colloidal Fe were found in these samples, which we inferred must be inert to coordination exchange.

4:15 PM

1E2.2
The Distribution of Dissolved Iron in Coastal Shelf and Slope Waters South of the Queen Charlotte Islands

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Anticyclonic, mesoscale (~100 km diameter) Haida eddies that form south of the Queen Charlotte Islands are thought to be an important source of dissolved iron to the high nutrient-low chlorophyll waters of the northeast Pacific. As persistent circulation features that form during winter in Fe-replete coastal waters and move westward into oceanic waters they represent a mechanism by which chronic Fe-limiting conditions in the Gulf of Alaska basin might be partially alleviated. Here we report the results of study into the distribution of dissolved (<0.4 μm) Fe to constrain this property in Haida eddy source waters on the continental shelf and slope waters south of the Cape St. James. Dissolved Fe concentrations were found to range between 0.6±0.1 and 3.01±0.5 nmol L^{-1} roughly two to three orders of magnitude greater than typical open ocean surface waters. An analysis of metal to nutrient ratios will be presented and the importance of these shelf waters as a source of Fe to the central gyre evaluated.

4:30 PM

1E2.3
STRATOGEM 2002-2005: Transports and Biochemical Tracer Fluxes Derived with a Three-Box Inverse Model of the Strait of Georgia

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The STRATOGEM (STRAiT Of Georgia EcosysteM) program has gathered data about various physical and biochemical tracers through monthly sampling over the last four years in the central Strait of Georgia. Physical and biochemical tracer data are used in an inverse model to study transports and biochemical fluxes in the Strait of Georgia over 2002-2005. The equations of mass, heat and salt balances (driven by air-sea heat exchanges and Fraser River discharge) are used to estimate the horizontal (seaward and inward) and the vertical (upward and downward) water transports in the Strait of Georgia. Singular value decomposition is used to determine the solutions. The bootstrap approach provides a standard error for these solutions associated with the spatial and temporal variability of the input data. These errors estimates are completed by

statistical error of the biochemical tracers. Analysis of the transports and nutrient fluxes are combined with analysis of the tracer data to better understand the coupling between physics and biology.

4:45 PM

1E2.4
High resolution ferry-based observations of three consecutive spring blooms in the Strait of Georgia
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Ferry sampling is a novel approach to ocean observation, with its strength residing in its ability to resolve much of the variability inherent to coastal waters. Ferry monitoring of the Strait of Georgia has been underway for 2½ years. It has captured two spring blooms and will soon record a third. Two ferries, each equipped to measure salinity, temperature, and chlorophyll fluorescence, traverse the Strait eight times daily. The data collected by the ferries represents the most detailed information of the surface waters in this region to date. Phytoplankton growth during the spring bloom in the Strait of Georgia is determined by physical processes when zooplankton grazing pressure is low. As such, climactic conditions ought to mitigate the characteristics of the spring bloom. The first two years of ferry observations have revealed very different spring blooms. According to the ferry data, the spring 2003 bloom commenced later in the year than the 2004 bloom. As well, peak chlorophyll levels were generally lower and the bloom period was shorter. The observed yearly differences in spring bloom characteristics will be discussed in terms of nitrate exhaustion, winds, and Fraser discharge. The 2005 bloom has yet to happen as of this writing, but we anticipate noticeable effects because of the anomalously low snowpack currently observed over much of the Fraser catchment and the forecast for above normal temperatures. Such changes will alter the freshwater discharge into the Strait of Georgia and will likely affect spring bloom dynamics.

4:00 PM

1E3.1

Evidence for an Indirect Effect of the Organic Aerosol

Richard Leaitch [1], Katherine Hayden [1], Walter Strapp [1], Desiree Toom-Sauntry [1], Mohammed Wasey [1], Lohmann Ulrike [6], Lehr Pamela [5], Marshall Julia [5], Shantz Nicole [4], Garrett Timothy [3], Jayne John [2], Worsnop Douglas [2]
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The ability of organic components in atmospheric aerosol particles to influence cloud droplet nucleation remains a large source of uncertainty in estimating the indirect effect of aerosols on climate. Evidence of an indirect effect of the aerosol is present in a comparison of aerosol particle, cloud droplet and radiation measurements made above, in and below stratocumulus on two flights on sequential days over the Atlantic Ocean. Higher number concentrations of aerosol particles >100 nm (N_a) during the second flight are the result of an increase in the organic content of the particles as measured with an Aerodyne Aerosol Mass Spectrometer (AMS). The peak cloud droplet number concentrations (N_d) are ca. 200 cm^{-3} on flight 1 and 500 cm^{-3} on flight 2. The measured light extinction by the clouds is higher on flight 2 despite similar or lower cloud liquid water contents (LWC). Simulations of N_d from an aerosol-cloud adiabatic parcel model agree to within 10% with the observed maximum N_d. Approximately 30% of the increase in the N_d between the two flights was due to a higher updraft speed on flight 2 and about 70% was due to the increased N_a. The organic addition to the aerosol on the second flight increased the N_d through its effect on the size distribution of the sulfate and by changing the growth rates of the droplets. For a range of reasonable water solubilites, the presence of the organic slows down the growth rate of the larger fine particles, relative to pure sulfate. The reduced rate of water condensation on these particles leads to a slightly higher cloud supersaturation enabling the activation of the particles with the larger organic fraction and smaller sulfate particles. The resulting increase in the N_d is predicated on the observed higher updraft speed; for the lower updraft speed observed on flight 1, the model indicates that the organic particles slightly reduce the N_d. Depending on the chemical size distribution and the updraft speeds, even organic material of relatively low solubility can contribute to an indirect effect.

4:15 PM

1E3.2

Atmospheric Kinetic Energy Spectrum Simulated by the AFES Global Atmospheric Model

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We have run control simulations of the global atmospheric circulation with the Atmospheric Model for the Earth Simulator (AFES). The unique computing power of the Earth Simulator provides an opportunity to simulate simultaneously a wide range of atmospheric phenomena from global scales to the mesoscale. We performed simulations using AFES with horizontal resolution varying from T39 to T1279. An encouraging result is that the upper tropospheric spectra from the high resolution versions display clear -3 and -5/3 power low regimes in accordance with aircraft observations. The dependence of the mesoscale spectrum on such factors as the convective parameterization, vertical resolution and subgrid-scale hyperdiffusion employed will be examined. The very important issue of the appropriate scaling of the subgrid-scale diffusion coefficient with model resolution is also addressed. Our results suggest that, for the AFES model, the hyperdiffusion timescale at the truncation scale needs to become shorter as the truncation limit is extended.

4:30 PM

1E3.3

Radiative forcing and response of a GCM to maximum-random overlap of homogeneous clouds

Howard Barker [1], *Jason Cole* [5], *Petri Raisanen* [4], *Eugene Clothiaux* [3], *David Randall* [2], *Marat Khairoutdinov* [2]
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Previous studies that used small numbers of 'exemplary' cloud fields to study the dependencies of radiative fluxes on horizontal variability of cloud and cloud overlap found large dependencies. The implication was that omission of these cloud properties by GCMs could cause TOA and surface radiative biases of up to several dozen Watts per square metre (W/m^2). The NCAR Community Atmospheric Model version 1.8 (CAM-1.8) that utilized a 2D cloud system-resolving model (CSRM) in each of its columns was used here in conjunction with the Independent Column Approximation (ICA) to assess the forcing set-up by the common assumption of maximum-random overlap (MRO) of homogeneous clouds. It was found that the MRO's global TOA biases are less than 3 W/m^2 with substantial error compensation by the MRO and homogeneity approximations. It was found that a simple parametrization of cloud variability and overlap decorrelation length was capable of accounting for almost 90% of the variance in the simulated TOA radiation budget. Moreover, 3D radiative transfer calculations were performed diagnostically on the CSRM clouds. The error due to the use of the MRO model is significantly larger than neglect of multi-dimensional radiative transfer. While this only weakly implies that multi-dimensional radiative transfer is a second-order consideration for modelling of global climate, it strongly implies that the MRO model should, and can, be replaced by a more elaborate ICA-based approach. The CAM-3 was then used to assess the dynamical impact of the MRO. Results will be presented in this poster.

4:45 PM

1E3.4
Assessing the response of several GCMs to the McICA radiative transfer methodology
Howard Barker , Jason Cole Meteorological Service of Canada , Eugene Clothiaux The Pennsylvania State University , Jiangnan Li Meteorological Service of Canada , Jean-Jacques Morcrette European Centre for Medium-Range Weather Forecast , Robert Pincus NOAA-CIRES Climate Diagnostics Center , Petri Raisanen Finnish Meteoroligical Institute , Graeme Stephens Colorado State University
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Recently, the Monte Carlo Independent Column Approximation (McICA) was introduced as a new approach for parametrizing radiative transfer within global climate models (GCMs). The McICA computes domain-averaged, spectrally-integrated radiative fluxes by randomly sampling stochastically-generated subgrid-scale columns during spectral integration. The McICA is unbiased with respect to the full ICA, and because it removes the description of cloud structure from the radiative transfer code, it is flexible and computationally efficient. However, since the McICA is a Monte Carlo procedure, it generates conditional (unbiased) random noise. As an example of the impact of McICA noise, results are presented for an ensemble of annual-cycle simulations with varying levels of McICA noise performed by the NCAR Community Atmospheric Model version 1.8 (CAM-1.8). Given the range of nonlinear parametrizations in GCMs and their interactions with radiation, the impact of McICA noise may be model dependent. Indeed, McICA's success depends on these impacts being 'negligible'. Therefore, we are inviting GCM groups to participate in an experiment that aims to assess the impacts of McICA's noise. To date there are six GCMs involved in this intercomparison. In addition to results from CAM-1.8, this poster documents the intercomparison agenda.

5:00 PM

1E3.5
The role of shallow convection in the water and energy cycles of the atmosphere
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5:15 PM

1E3.6
A single scheme for representing cloud amount and condensate: Coupling a statistical cloud scheme with moist turbulence, convection and microphysics.
Colin Jones
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I report on the introduction of a moist turbulent kinetic energy (TKE) scheme into a Regional Climate and NWP model. The moist TKE scheme requires information on the cloud amount for calculation of vertical stability and the buoyancy

contribution in the TKE equation. In the original implementation of the scheme, cloud fraction was calculated in separate parameterisations, external to the turbulence and passed into the turbulence scheme for use. This approach proved numerically unstable, particularly at higher vertical resolutions.

This led us to build a statistical cloud scheme directly within the turbulence parameterisation. This approach allows the cloud fraction and cloud water/ice amounts to be diagnosed from the normalised saturation deficit directly within the turbulence parameterisation, using information on the degree of (turbulent) subgrid scale variability of water in the cloud fraction calculation. Results are shown from a number of integrations using the HIRLAM/Rossby Centre single column model (SCM), with this combination of moist turbulence and statistical cloud scheme.

The SCM is used to investigate the representation of stratocumulus clouds, shallow convective clouds and deep precipitating convection. Results suggest the combination of moist turbulence with a statistical cloud scheme is a suitable configuration for representing all cloud types. The simulated clouds are evaluated against equivalent simulations using Large Eddy Simulation and Cloud Resolving Models and against observations where available. The key term in accurately diagnosing the cloud amounts and linking simulated cloud to turbulent activity is the subgrid scale variance of the saturation deficit.

4:00 PM

1E4.1
Latest Measurements from the Measurements Of Pollution in the Troposphere (MOPITT) Instrument
James R. Drummond , J Kar , J Liu , F Nichitiu , J Zou
(Presented by / Présenté par ***Jay Kar***)
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MOPITT is aboard the Terra spacecraft and has been retrieving vertical profiles of CO globally since March 2000. The retrievals have been validated extensively by comparison with in-situ aircraft measurements through a regular program as well through special field campaigns. This validated global dataset is now being used effectively to study the role of CO in tropospheric chemistry, its role as a tracer of transport processes and in inverse models to better constrain the emissions. The retrievals have been shown to have sufficient vertical information to distinguish the upper troposphere from the middle troposophere. This is being exploited to study the upper tropospheric phenomena.

We shall present some salient recent results from the analysis of MOPITT data. These include :

1. The first observational confirmation of the Asian summer monsoon plume of CO that is created by deep convective uplifting of boundary layer pollution during the south Asian monsoon. The MOPITT retrievals capture the upper tropospheric enhancement in CO and its time evolution.
2. Possible detection of stratospheric intrusion events into the upper troposphere using MOPITT CO data in combination with supporting evidence from meteorological analyses and models.
3. Evidence of "fronts" in MOPITT CO data when CO concentrations vary by 50-100% within a horizontal distance of 100 kms across the sharp boundary delineating the fronts. Along the front, this phenomenon spans 500 -1000 km, appearing at altitudes of CO retrievals from 850 hPa to 250 hPa and lasts one to several days.
4. In a case study on large forest fires in Northwest United States in 2000, it was found that the spatial CO plumes match remarkably well with the location and density of fires and wind direction, and the spatial and temporal variation of CO emission can be captured by MOPITT in 3-day composites.
5. Globally, we found that for a year with normal fire activities, CO annual cycle is closely influenced by biomass burning in South America, Africa, and Australia, while in other regions, it is more controlled by other CO source/sink terms. However, the normal cycle in different regions can be disturbed by anomalously strong fire activities in those regions in other years.

4:15 PM

1E4.2
Space-based constraints on emission inventories of nitrogen oxides
Randall Martin , Chris Sioris Harvard-Smithsonian Center for Astrophysics , Kelly Chance Harvard-Smithsonian Center for Astrophysics , Lyatt Jaegle University of Washington
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Global emission inventories of nitrogen oxides (NO_x) remain uncertain to a factor of 2 with substantial implications for understanding of surface air quality, atmospheric oxidation, and climate. We will discuss recent progress in improving NO_x emission inventories by combining traditional bottom-up inventories with top-down constraints from the GOME and SCIAMACHY satellite instruments. The resulting optimized surface NO_x emission inventory features lower uncertainty, and noteworthy differences in emissions from soils, biomass burning, and fossil fuel combustion.

4:30 PM

1E4.3
The Atmospheric Chemistry Experiment (ACE): Mission Overview
John C. McConnell , Peter Bernath
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ACE (Atmospheric Chemistry Experiment) is part of the Canadian Space Agency's SCISAT-1 program, and was successfully launched by NASA on August 12, 2003 for a 2 year mission. The first results for ACE will be presented. The ACE mission goals are: (1) to measure and to understand the chemical and dynamical processes that control the distribution of ozone in the upper troposphere and stratosphere, with a particular emphasis on the Arctic region; (2) to

explore the relationship between atmospheric chemistry and climate change; (3) to study the effects of biomass burning in the free troposphere; (4) to measure aerosol number density, size distribution and composition in order to reduce the uncertainties in their effects on the global energy balance. ACE is making a comprehensive set of simultaneous measurements of trace gases, thin clouds, aerosols, and temperature by solar occultation from a satellite in low earth orbit. A high inclination (74 degrees) low earth orbit (650 km) gives ACE coverage of tropical, mid-latitudes and polar regions. A high-resolution (0.02 cm-1) infrared Fourier Transform Spectrometer (FTS) operating from 2 to 13 microns (750-4100 cm-1) is measuring the vertical distribution of trace gases, and the meteorological variables of temperature and pressure. ACE is providing high quality data to confront model predictions and will monitor polar chemistry as chlorine levels decline. Aerosols and clouds are being monitored using the extinction of solar radiation at 0.525 and 1.02 microns as measured by two filtered imagers as well as by their infrared spectra. A dual spectrophotometer called MAESTRO was added to the mission to extend the wavelength coverage to the 280-1000 nm spectral region. The principal investigator for MAESTRO is T. McElroy of the Meteorological Service of Canada.

4:45 PM

1E4.4
The effect of parametrised convection on the vertical distribution of trace gases.
Carlo Buontempo , J. McConnell , J. Kaminsky , L. Neary , A. Lupu
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Convection plays a central role in the transport of heat and mass from the PBL toward the upper troposphere. In all the atmospheric models that are not cloud resolving the convection has to be parameterised. In the last 40 years several different schemes have been developed according to computer constrains and grid resolution. The adoption of a particular scheme may largely influence the simulated distribution of trace gases.
We have analysed the vertical distribution of CO and ozone derived from the adoption of two schemes: the Zhang-McFarlane and the Kain-Fritsch scheme. Both the tropopause layer and the PBL concentration have shown a significant dependence on the cumulus scheme adopted. The CO concentration in the upper troposphere has been compared with satellite data.

5:00 PM

1E4.5
Ground-Level Ozone Trends in Canada 1994-2003
Amy Hou , Fred Conway
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1994-2003 trends in ground-level ozone, NOx, and oxidant were analysed by applying a linear regression model to data for stations across Canada and in adjoining portions of the US. The effects of reduced urban NOx emissions on local ozone concentrations were studied by examining urban oxidant (ozone plus nitrogen dioxide) trends. The analysis found considerable site by site variation, but overall and for this time period ozone levels were found to be stable or increasing and NOx levels decreasing. In many Canadian urban sites reductions in NOx emissions may be contributing to an upward ozone trend. Pollutant patterns were consistent across the international border.
Results will be discussed and compared with other published analyses.

5:15 PM

1E4.6
High Spring Time Ozone in Northern Latitudes
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Typical annual ozone patterns in most U.S. cities show higher levels during the summer and lower levels during winter. In most of Canada this pattern shifts such that the high levels occur during early spring and the lowest levels in early autumn. It was originally thought that the high levels during the spring were due to stratospheric intrusion. However, a combination of long range transport of ozone precursors and an increase in albedo due to snow cover may be contributing to the formation of ozone during the spring.

NO being emitted from industry and transportation mixes with the atmosphere and reacts with ozone to form NO_2. During winter the amount of solar radiation received in the northern Canada is not strong enough to photolyze the NO_2 to NO and $O3^p$. Therefore, the NO_2 builds up in the atmosphere. During spring the combination of the increase in solar radiation and the contribution in radiation from the albedo effect from the snow, is strong enough to photolyze the NO_2 which results in the additional ozone in the upper troposphere. The albedo of ultraviolet radiation for snow is higher than that for visual light. Total ultraviolet radiation during the spring, due to albedo, can be as high or higher than that received during the summer.

This presentation looks at the possibility of high springtime ozone being formed due to long range transport of pollutants and the contribution of increase solar radiation from winter to spring.

(INVITED/INVITÉ) 4:00 PM

1E5.1
The NEPTUNE Project: installation planning and challenges for Stage 1 of the Regional Cabled Observatory, northeast Pacific Ocean
Christopher R. Barnes
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NEPTUNE is a proposed innovative network of over 30 sub-sea observatories linked by 3000 km of powered, electro-optic cables covering the Juan de Fuca Plate, Northeast Pacific. Each observatory will host many scientific instruments on the seafloor, in boreholes, and buoyed into the water column. Continuous near-real-time multidisciplinary measurement series will extend over 30 years. Research themes include: structure and seismic behavior of ocean crust; dynamics of hot and cold fluids and gas hydrates in upper ocean crust and overlying sediments; ocean/climate change and effects on ocean biota; deep sea ecosystem dynamics; and engineering /computational applications. NEPTUNE Canada's installation is funded ($62.4M; 2003-2009); US NSF/MREFC funding is anticipated in 2007-11. Stage 1 in Canadian waters will be installed by NEPTUNE Canada (consortium of 12 Canadian universities, led by UVic). Current/recent activities include: a) reviewing bids for UVic's RFP 262 for the Wet Plant (cable/nodes) with a contract to be signed in Spring 2005, deployment in 2007 and most sensors deployed in 2008; b) arranging three Ocean Observing Systems workshops in 2004 that promoted 17 Community Experiments proposals to compete for up to $13 million available for observing systems; c) designing the prototype Data Management and Archiving System (DMAS); d) purchasing the former Teleglobe TPC4 Shore Station at Port Alberni; e) undertaking new seabed mapping; and f) establishing MOUs with partner agencies including NSF/ORION, HIA/NRC, and DND. VENUS and Stage 1 of NEPTUNE will form a linked coastal/regional observatory system and be among the first of many such cabled ocean observatories.

4:30 PM

1E5.2
SCOOP: Towards an Interoperable Network for Ocean Observing Data
William Allan Perrie [1], *Philip Bogden* [10], *Larry Flournoy* [4], *Ken Keiser* [8], *Tom Shyka* [9], *Sara Graves* [8], *Hans Graber* [7], *Harry Wang* [6], *Rick Luettick* [5], *Wei Zhao* [4], *Gabrielle Allen* [3], *Peter Sheng* [2]
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The Southeastern University Research Association (SURA) initiative called the SURA Coastal Ocean Observing and Prediction (SCOOP) program includes university, government and private industry partners who work together to implement Information Technology (IT) solutions. The SCOOP program is creating the "IT glue" to enable an integrated observation and prediction of extreme events in the U.S. coastal zone. The primary focus of the SCOOP program is storm surge, wind waves and surface currents, with the goal of predicting and visualizing phenomena that cause damage and inundation of coastal regions during severe storms and hurricanes. SCOOP emphasizes the transition of "pre-operational" research activities to operational status. These efforts create interoperable systems of systems by modularizing components and standardizing the interfaces between the modules. SCOOP partners are turning environmental measurement and prediction into a community effort and a real-time collaboration between research institutions and operational agencies.
In this presentation we also present our role within GOMOOS (Gulf of Maine Ocean Observing System – www.gomoos.org) to create a web mapping service (WMS) demonstration for SCOOP.

4:45 PM

1E5.3

WaMoS ll wave radar a means of determining ocean waves and surface currents using x-band marine radar.
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This paper will describe the *WaMoS ll* technology and then look at capabilities, specific areas of development and on-going research. In particular the research into the analysis of individual waves, extreme or "rogue" waves, the analysis of wave fields and "groups" and the new release of high resolution currents (40m grid spacing) will be described

The *WaMoS ll* wave radar is well established (mainly in Europe, although there are two operating on the Grand Banks) and accepted as a monitoring tool for ocean waves and surface currents. The instrument uses the data from a standard navigation X-band marine radar. A new directional wave spectra along with basic wave parameters such as wave height, peak period and direction is generated approximately every two minutes.

DRDC Atlantic is in the process of purchasing a wave radar and WaMoS ll is being demonstrated at the US Army Corps of Engineers Field Research Facility at Duck, NC this spring. Data from the DRDC trials last winter and some of the early results from the USACE demonstration will be available for presentation at the CMOS conference.

With an average range of 2.5 km, the *WaMoS ll* is an ideal instrument for monitoring the wave climate and surface currents of a coastal region, since it can be installed on the land overlooking the water. The technology enables data from up to nine separate areas within the 2.5Km radius footprint to be analysed.

Readers are encouraged to review WaMoS on our web site
http://www.sea-image.com/wamos_intro.htm

5:00 PM

1E5.4
VENUS - The Victoria Experimental Network Under the Sea
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Cabled ocean observatories are either under construction or planned at numerous sites around the globe. In Canada, there are three systems under development, the Bonne Bay Observatory in Newfoundland (Memorial University), the Victoria Experimental Network Under the Sea (VENUS, University of Victoria), and the North East Pacific Time-series Underwater Networked Experiments (NEPTUNE, University of Victoria). VENUS will install three separate arrays, one each in Saanich Inlet, Strait of Georgia, and Juan de Fuca Strait. These systems will offer ocean scientists the opportunity to connect instruments to an infrastructure facility with significant power and broadband communications. Researchers will issue commands and control from the convenience of their office, and receive data and imagery over the Internet. For VENUS and NEPTUNE, steaming data and data analysis tools will be accessible through a Data Management and Archive System. A project overview and the latest status will be presented.

4:00 PM

1E6.1
A Preliminary Climatology of Cold Lows over Alberta
Chris Wielki [1] *, D. Kania* [4] *, P.J. McCarthy* [4] *, S. Knott* [3] *, B. Kochtubajda* [2]
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There is little doubt of the important role played by cold lows in the evolution of mid-latitude weather. One recent example of the destructive nature of these systems was the rapid succession of several cold low systems in July 2004. Each of these systems produced high precipitation events over portions of Alberta, including the July 11th, 2004 Edmonton storm which caused an estimated 180 million dollars in damage. These precipitation events were particularly notable since much of Alberta had been experiencing drought like conditions.

Twenty years (1985-2004) of closed lows over Alberta, and surrounding regions, are examined during the summer months (June, July, August). Closed lows were analyzed for location and timing using archived 500 hPa maps. From the closed low data set frequency, seasonal cycle, duration, and common areas for closed lows over the Alberta area are observed. The closed lows were then correlated to the 24-hour precipitation data based on the Environment Canada climate-observing network. Forecasters will be able use these statistics to assess the potential of severe rainfall with an approaching closed low over Alberta.

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1E6.2
Edmonton Extreme Precipitation Event July 11, 2004
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On the afternoon of July 11, 2004 a thunderstorm complex associated with a cold low developed just to the southeast of Edmonton. The storm slowly tracked westward over the city of Edmonton resulting in an extreme precipitation event lasting 90 minutes. This event generated so much hail and rain that many road and highway underpasses were inundated with runoff making them impassable and hundred of basements were flooded. The West Edmonton Mall was evacuated for the first time in it's history. According to the Insurance Bureau of Canada there were 12 000 claims totaling 180 million dollars. A meteorological assessment of the storm environment associated with this event is presented.

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1E6.3
Large-scale circulation precursors to mesovortices in Alberta
Sébastien Chouinard , Eyad H. Atallah , John R. Gyakum , Isztar Zawadzki
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Using the reflectivity and Doppler data of the Carvel radar near Edmonton for the summers of 2000 to 2004, we produced a mesocyclone climatology for a region within 120 km from the radar using the mesocyclone detection algorithm of McGill Radar data Analysis, Processing and Interactive Display (RAPID) software system. The Upper level Vertically Integrated Liquid water content (UVIL) algorithm of the same software package has been used to detect strong convection. Two sets of dates were built. The first one consists of dates when strong mesocyclonic activity occurred while the other includes dates with strong convection but without strong mesocyclonic activity. A synoptic-scale analysis will be discussed in order to identify the main large scale differences between the two data sets. For that purpose a series of composite maps from the two sets of dates are produced. Mesocyclonic and non-mesocyclonic upper-level flows, moisture inputs and dynamic tropopause features are compared in order to detect a synoptic scale signal present prior to the occurrence of strong mesocyclonic days.

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4:45 PM

1E6.4
Pineapple Punch on Ice: Impacts and Implications for British Columbia
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Streams of atmospheric moisture originating from subtropical regions play a dominant role on the accumulation of snow and ice in Alpine regions of western North America. In this paper we examine the mechanisms leading to dramatic snowfall accumulation and sudden melt along the west coast of North America with a focus on British Columbia during winter of 2005 in comparison to earlier years. During 2005 winter, several unusually intense moisture streams (each called a "Pineapple Express") originated from near Hawaii in the subtropics. These "Pineapple Express" events occurred so often in the winter of 2004-2005 that another term was used by BC forecasters to better describe an even more intense stream from south of Hawaii in the Tropical Pacific (this record breaking mid-January storm was called a "Tropical Punch"). These terms were effectively used to communicate with public the potential hazards related to the heavy precipitation and dramatic warming that these weather systems presented. After the "Tropical Punch" event occurred so much snow was lost, freezing rain fell and heavy rain was dumped that the word "Pineapple" was scorned by skiers in BC and in the "Winter that Wasn't" was the term used to describe the exceptional lack of mid-winter snow and closed ski areas in nearby Washington State. During this same winter California Mountains were buried by record snow packs and periodically drenched by locally heavy rainfall – depending on the positioning of atmospheric blocking pattern that developed. During 2004-2005 a record number of strong tropical storms occurred and an unusually high amplitude (meridional) 500 mb flow pattern developed across the Northern Hemisphere. This set-up allowed the development of vigorous (and often back-building) subtropical and tropical vapor plumes which fed abundant moisture into these "Pineapple/Punch" disturbances. In the past thin mid-winter snowpacks , such as this year in southern BC, have critically reduced water supplies, power generation and fish survival when followed by a hot dry summer. Records from snow pack, glaciers and weather indices are examined to improve our understanding of controlling weather patterns and related climate change in Western North America.

4:00 PM

1E7.1
Assessing the bias in GPS derived atmospheric moisture in Southern Alberta during the A-GAME project
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Two intensive radiosonde campaigns were undertaken during the summers of 2003 and 2004 to assess the capability of the GPS network in Southern Alberta to accurately derive atmospheric moisture. The radiosonde campaigns, which took place in July of 2003 and 2004, involved the launch of over 100 radiosonde instrument packages at three locations. In 2003, over 70 radiosonde observational flights were made during an 11-day period from the airports at Airdrie, Old-Didsbury, and Sundre. In 2004, approximately 45 flights were made over a 27-day period from the airports at Airdrie and Olds-Didsbury. Each of the three radiosonde sites were associated with nearby GPS receiver installations and the intercomparison between GPS and radiosonde derived atmospheric moisture is focused on these co-located sites. Observations made with the radiosondes are also used to validate GPS derived atmospheric moisture data observed by network receivers not co-located with radiosondes. Results from 2003 and preliminary results from 2004 show a favourable agreement between these measurement techniques. Potential research applications for GPS derived regional atmospheric moisture are examined including diurnal trends and intra-regional variability.

4:15 PM

1E7.2
Comparison and Validation of Different Tropospheric Tomography Models in a Regional GPS Network
Natalya Nicholson , *S. Skone* , *M.E. Cannon*
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GPS satellites transmit signals that can be used to effectuate positioning and navigation solutions for users on Earth. These signals are affected by a number of error sources that must be removed in order to attain the accuracy and precision users require. Range delays due to propagation through the neutral atmosphere consist of a hydrostatic component dependent on air pressure and temperature, and a wet delay dependent on water vapour pressure and temperature. If precise surface pressure data is available, the hydrostatic component can be mitigated to millimeter level using existing models. Water vapour pressure at altitude however is not well correlated with surface measurements and must therefore be estimated using a different approach. By recovering line-of-sight wet delay observations from a network of GPS receivers, it is possible to reconstruct the horizontal and vertical structure of water vapour over a region using tomography techniques.

Tomographic approaches used in wet refractivity modeling discretize the overlying atmosphere in some fashion. One method commonly employed uses three-dimensional volume boxes, voxels, and holds the wet refractivity value within each constant. Constraints may be applied to improve the solution for under-determined voxels. Another method uses a functional approach to describe the wet refractivity within discrete layers of the troposphere. The wet refractivity values of each layer are related via covariance information. Both methods have independently been used to recover wet refractivity fields with varying degrees of success, depending on network scale and geometry.

A regional GPS network has been installed in Southern Alberta by the University of Calgary.
This network consists of fourteen GPS reference stations, ten of which are co-located with MET3A meteorological sensors. Variable weather conditions occur in the foothills of the Rockies near Calgary, and the Southern Alberta network allows great opportunities to assess detection and modeling of severe weather events using GPS. In this paper, we conduct implementation and testing of 4-D wet refractivity models in the Southern Alberta network.
The model results will be evaluated against truth data from radiosonde soundings.

4:30 PM

1E7.3
Capping Lid/Dryline Interactions during A-GAME
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One of the applications of the Alberta GPS Atmospheric Moisture Evaluation (A-GAME) is a study focussed on atmospheric moisture and boundary layer processes during the pre-storm and initiation stages of thunderstorms over the Alberta foothills. The two main goals of this sub-project are to document the frequency and intensity of *drylines* in the first detailed study of drylines in Canada, and to evaluate a hypothesis that attempts to explain interactions between *capping lids* and *drylines,* and their role in triggering Alberta thunderstorms.

These features were documented for 2003-04 A-GAME cases using data from three radiosonde sites along the eastern edge of the foothills, precipitable water estimates from the network of 16 GPS receivers encompassing the plains and foothills, surface data from a line of six autostations running into the foothills, plus one mobile unit recording transects of pressure, temperature, and humidity into the foothills where a dryline was suspected. Storm cells were documented using the two Alberta operational radars (at Stony Plain and Strathmore) operated by Environment Canada, plus a third radar operated by Weather Modification Incorporated at Old-Didsbury Airport. In addition, 15-hr runs of the 2.5-km version of the GEM model will provide detailed simulations of the dynamics and thermodynamics for at least four A-GAME case studies. This presentation will summarize results from two or three case studies.

4:45 PM

1E7.4
Monitoring of Ground-Based GPS Observations in Preparation for Assimilation in the Canadian Meteorological Centre's Analysis and Forecast System
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Near real-time observations of zenith tropospheric delay (ZTD) from networks of ground-based GPS receivers in the United States (US) and Europe are received at the Canadian Meteorological Centre (CMC) since August and December 2004 respectively. The ZTD is related to the total atmospheric mass (surface pressure) and integrated atmospheric water vapour above the GPS receiver. Observations of surface temperature, pressure and relative humidity are also available at most of the US sites and some European sites.

The CMC operational three-dimensional variational (3D-Var) data assimilation system has been modified to accept ground-based GPS observations (ZTD and surface meteorological reports). Incoming GPS observations (O) are monitored in near real-time, through comparisons with first-guess values (P) obtained from 6-h forecasts of the CMC Global Environmental Multiscale (GEM) model. Results of the monitoring reveal relatively constant site-specific O-P biases in ZTD and surface pressure. Possible causes for these biases are discussed as well as the method chosen for bias correction, an essential step in data processing prior to actual assimilation.

A report will be given on progress to date on assimilation cycle experiments with GPS observations towards eventual inclusion of GPS data in the new 4D-Var system at CMC.

5:00 PM

1E7.5
An investigation on the performance of regional GEM zenith delay products in the Canadian Arctic
Reza Ghoddousi-Fard [1], Peter Dare [2]
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Numerical Weather Prediction (NWP) models have been used by geodetic researchers in order to assist tropospheric modeling in GPS and VLBI data processing. It has been found that NWP models can model the neutral atmosphere more

accurately than the models which are based upon a standard atmosphere. However, only very limited measurements in far north regions are assimilated into NWP models because fewer surface and upper air stations (such as radiosonde launch sites) are available in these regions. This means the density of observation stations is much reduced there as compared to southern regions.

Recently, the Canadian Meteorological Centre (CMC) developed a new regional Global Environmental Multiscale (GEM) model at 15 km resolution and 58 "eta" vertical levels. For the purpose of dissemination, model data are interpolated onto 28 isobaric levels, which is a more commonly used vertical coordinate for general meteorology and is not dependant on the characteristics of the model. This new model replaces the 24 km version at 28 vertical levels. The increased horizontal and vertical resolutions allow a more precise computation of the forecast and a better definition of the geophysical features. Furthermore, additional satellite data are incorporated into the regional system.

In this paper Zenith Hydrostatic Delay (ZHD) and Zenith Wet Delay (ZWD) will be derived trough ray tracing of radiosonde stations available in the Canadian Arctic. On the other hand, pressure, temperature and humidity profiles of GEM will be interpolated to the same locations and the derived ZHD and ZWD will be compared to the ray tracing values. The same products resulting from the European Centre for Medium-Range Weather Forecasts (ECMWF) model (for all International GPS Service stations) are provided by the Vienna University of Technology. These will be compared with GEM products. However this may not be an independent comparison as the radiosonde data are usually assimilated in to NWP models. Further investigation on the performance of GEM will be carried out in the future by using a meteorological sensor and a Water Vapor Radiometer. The instruments will be placed on a research vessel in the marine areas of the Canadian Arctic - a region that usually has no meteorological stations available for assimilation.

5:15 PM

1E7.6
FTIR Spectroradiometer Retrievals of Temperature and Moisture During the 2004 Southern Manitoba Convective Season

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The vertical temperature and moisture structure in the lower atmosphere are critical for summer convection analysis. An ABB Bomem FTIR spectroradiometer was operated at the University of Manitoba during the 2004 summer convective season to examine its utility for temperature and moisture profiling in the lower 3 km of the atmosphere. The retrieval software was provided by the Space Science and Engineering Center (SSEC) at the University of Wisconsin. The early AERI (Atmospheric Emitted Radiance Interferometer) system hardware designed and built at SSEC to retrieve temperature and moisture profiles is different than the Bomem hardware, and very few results obtained from a Bomem system are available. The instrument was configured to produce profiles every 15 minutes between 1 June and 31 August 2004 (92 days). Approximately 50% of the time, profiles were produced. No profiles were possible at other times due to weather/cloud contamination as well as likely data quality issues. The Prairie and Arctic Storm Prediction Centre (PASPC) in Winnipeg launched 32 rawinsondes between 17 June and 31 August, which allowed direct comparisons to the FTIR retrievals. Preliminary results will be presented outlining sonde/FTIR comparisons (and error sources) and likely data quality issues.

(INVITED/INVITÉ) 8:15 AM

2A0.1
Boreal Forest Fire Smoke: Current and Future Issues

Brian Stocks , David Lavoue Meterological Service of Canada , Michael Flannigan Canadian Forest Service
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Awareness of the impact of boreal forest fire smoke, at local, regional, and global scales, has grown substantially in recent years. An increasing number of large fires, particularly in Canada, Russia and Alaska have resulted in smoke transport over large distances, often to populated areas. The mixing of forest fire smoke with urban pollution is raising public health concerns and disrupting public transportation. Boreal forest fires are high-intensity events, with sustained high spread rates and levels of fuel consumption often resulting in the development of towering convection columns that can directly reach the upper troposphere and lower stratosphere. This results in long-range transport that can have global implications. In recent years smoke from Canadian and Alaskan fires has been reinforced by smoke from Siberian fires and traveled completely around the circumboreal zone. With boreal fire activity and severity expected to increase significantly with a changing climate, with major impacts on terrestrial carbon storage, and the global carbon budget, smoke issues and impacts will continue to escalate. In an average year carbon emissions from forest fires are equivalent to approximately 20% of Canadian fossil fuel emissions. This presentation deals with our current knowledge of forest fire smoke chemistry (trace gases and carbonaceous aerosols) and its potential impacts on human health and climate. Current dynamic modeling of fire behavior and emissions, including convection column dynamics, smoke injection heights, and smoke transport modeling are also summarized. Some projections of forest fire activity and impacts under a changing climate are also included.

(INVITED/INVITÉ) 9:00 AM

2A0.2
Fast Living in the Deepsea

Verena Tunnicliffe
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The classic image of the deepsea: dark, cold, bleak and slow. However, when the opportunities present themselves, the inhabitants can respond rapidly. In 1998, a deep volcano erupted on Juan de Fuca Ridge. The new hot vents were colonized within months. By 2001, the community structure was very similar to long-established vents. Some of the most successful vent animals were the slowest to arrive. The composition of developing communities depends on both availability of recruits and chemical conditions. Another erupting volcano on the other side of the Pacific has attracted only a few species to its highly unstable peak; yet one of those species broods – not disperses – its larvae. In a final example, the prodigious capacity of deep-sea clams to colonize sunken wood will demonstrate responsiveness of sparse animal populations to new habitat availability.

10:30 AM

2B5.1
Cloud retrievals from measurements by the SciSat-1 satellite
James Sloan , Alexandre Zasetsky University of Waterloo , Maxim Eremenko University of Waterloo , Fuquin Yang University of Waterloo
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During the past decade, we have developed methods to identify the composition, phase (solid or liquid) and size distributions of atmospheric cloud and aerosol particles from their infrared spectra. Using these methods, we have retrieved the above information from the infrared measurements recorded by the ACE FTIR instrument on the SciSat-1 satellite, which was launched in 2003. Since its launch, this high resolution FTIR has recorded spectra of cirrus clouds, polar stratospheric clouds and polar mesospheric clouds. In this presentation, we will report examples of the compositions, phases, particle shapes and size distributions for some of these clouds and discuss the implications of these results for improved modelling of climate and meteorology.

10:45 AM

2B5.2
Interactions between gravity waves and convection in shallow cumulus clouds
Terry Clark
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Shallow cumulus convection is investigated using two dimensional large eddy simulations (the Weather Fire Integrated System (WFIS) model. Initial two-dimensional experiments employing initial conditions and large-scale forcings taken from the Barbados Oceanographic and Meteorological Experiment (BOMEX) model intercomparison study showed that increasing the horizontal domain of the experiments from 6.2 km to 30 km allowed the excitation of vertically propagating gravity waves. However, unless the vertical extent was also increased substantially from 3 km to, say 20 km these waves were reflected off the upper model lid and contributed to model noise. Runs with the large horizontal and vertical domain showed that even with as little as 10 W/m^2 sensible heating gravity waves with amplitudes between .2 and .4 m/s were generated. The effect of these gravity waves on the small cumulus is still under investigation.

Further results from two-dimensional BOMEX experiments assessing gravity wave dynamics will be presented. The experiments continue to use the Siebesma et al. (2003) initial conditions and thermal and latent heating rates. Some experiments use increased sensible heating rates of 20 and 40 W m^{-2} in order to evaluate when the clouds convert from their thermal behavior to a more shear influenced response expected from their interaction with the thermally excited gravity waves. All experiments are performed using a horizontal domain of 30 km or larger and a vertical extent of about 25 km. This size domain permits the excitation and free vertical propagation of gravity waves. A challenge is to design an experimental setup that can be used in three-dimensions. Approaches testing the use of both vertical grid stretching and two-way interactive grid nesting with grid refinement will be presented. The gravity wave transmission/reflection characteristics at the elevated nest interface are evaluated and techniques to improve the model's performance will be presented.

11:00 AM

2B5.3
Extended time large-eddy simulations of equilibrium marine boundary layer cloud anomalies
Quanzhen Geng
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We use extended-time 3-d simulations of the marine boundary layer to examine the sensitivity of the layer equilibria to changes in large-scale surface and atmospheric forcing. The model used is the CSU System for Atmospheric Modeling (SAMS v6.2, Khairoutdinov and Randall, 2003) 3-d LES run with a horizontal resolution of 100 x 100 m, a vertical resolution of 20 m and a time step of 2 s on a domain of 6.4 x 6.4 x 3 km. We first examine the model's ability to attain equilibrium end points for abrupt transitions between forcings and initial profiles as specified in 3 GCSS intercomparisons: FIRE (nocturnal stratocumulus), ATEX (transitional cumulus) and BOMEX (trade-wind cumulus). Each of these cases is run to equilibrium, requiring roughly 3 days of simulation time. We then impose abrupt transitions from FIRE to ATEX

and ATEX to BOMEX; in each case the simulation equilibrates over a 5 day period to equilibrium profiles which are in close agreement with the idealized observations.

11:15 AM

2B5.4
Dynamics and Predictability of Shallow Cumulus Clouds
J. Kyle Spyksma , *Peter Bartello*
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Simulations from a simplified cloud model can give new insights into the characteristics of non-precipitating cumulus clouds. In this talk, we will present statistical results from two series of studies. The first takes a closer look at the well-known moist-bubble simulation, while the second is a predictability study of moist microscale atmospheric dynamics.

10:30 AM

2B6.1
The Warning Decision Support System -- Integrated Information (WDSS-II): A decision support system for severe weather analysis and forecasting
Valliappa Lakshmanan [1] , *Travis Smith* [1] , *Gregory Stumpf* [1] , *Kurt Hondl* [2]
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The Warning Decision Support System -- Integrated Information (WDSS-II) is the second generation of a system of tools for analyzing and visualizing remotely sensed weather data. WDSS-II ties together a number of automated applications (algorithms) for analyzing and predicting severe weather in the short term with interactive visualization tools.

WDSS-II was designed with two balancing goals. One was to act as a platform for research with weather data from multiple radars and multiple sensors. Thus, it provides an environment for quickly writing applications that can access real-time and archived data, do computations on that data and test the usefulness of derived information. Thus, WDSS-II provides an excellent resource for researchers to test hypotheses on large amounts of data. The second goal of WDSS-II was to be a showcase of next-generation decision support tools for weather forecasting. To this end, WDSS-II comes with a variety of automated analysis algorithms and displays that have been built using the WDSS-II infrastructure. All of these algorithms and displays are capable of being run in real-time on geographical domains ranging from the stormscale to the mesoscale to a continent-scaleIn this paper, we describe the various components of WDSS-II: the infrastructure, the displays and the algorithms. We describe the advantages that accrued in designing a decision support system with a simultaneous research goal.

10:45 AM

2B6.2
The NCAR Auto-Nowcast System and forecaster role
James Wilson , *Cynthia Mueller* , *Tom Saxen* , *Rita Roberts*
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The practice of nowcasting requires the forecaster to review and assimilate a variety of disparate observations and model results within the context of their knowledge of how the atmosphere works. By the nature of the nowcast problem, the time available for a human to review data and make a nowcast is always very limited. Data fusion techniques mimic much of what is normally done by the human (but without feeling the time stress). The NCAR Auto-nowcast system (ANC) provides a unique human-computer interface which allows forecasters to enter boundaries and regions of potential storm initiation. Forecaster-entered predictor fields are used along with predictors derived from NWP (RUC), Variational Doppler Radar Analysis System (VDRAS), observations, extrapolation, and feature-detection algorithms to provide detailed forecasts of convective initiation, growth and decay with 30 and 60 minute lead times. These forecasts are displayed on decision support systems to help improve safety and efficiency of aircraft and range operations. The NCAR Auto-Nowcast System runs in the northeastern US (Illinois, Indiana and western Ohio) as part of the FAA Aviation Weather Research Program, White Sands Missle Range (New Mexico) as part of the Army Test and Evaluation Command (ATEC) and in Dallas/Ft. Worth Weather Forecast Office (WFO) as part of National Weather Service Aviation Initiative.

The ANC provides extrapolation and trends of current storms and zones where storms are forecast to initiate. The forecasts are separated because specific (deterministic) forecast are possible for pre-existing storms. The same specificity is not possible for forecasts of storm initiation therefore a region where storms are likely to initiate are predicted. The predictor fields which are integrated to create the storm initiation forecasts are divided into the following categories; large-scale environment (stability and large-scale forcing), boundary-layer structure, boundary (lines of boundary-layer convergence) characteristics, and cloud type and vertical development (as indicated by cooling IR temperatures). Forecaster input is used to define boundary locations and to suppress or enhance regions of the forecast. Large-scale environmental conditions were added to the ANC in 2004. The forecaster input and addition of environmental conditions have helped capture storm initiation while limiting the number of false alarms.

11:00 AM

2B6.3
The Nowcast Decision Support System: A Complete Approach to Decision Making
John Conway , Michael D Eilts , JT Johnson , Chip Barrere
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Weather Decision Technologies (WDT) has integrated state-of-the-science nowcasting technologies from McGill University, the National Severe Storms Laboratory (NSSL), and those developed by WDT to provide a complete nowcasting system. This Nowcast Decision Support System (NDSS) ingests multiple data sources to provide forecasters with meteorological and hydrological applications with both workstation and Web based displays. The NDSS also provides two display systems, 3D Sigma – a complete three-dimensional radar analysis tool, and WxScope ™ - a Web Browser Plug-in that provides highly interactive viewing of weather information over an Intranet or Internet. NDSS utilizes base data from Doppler radar along with lightning, model, satellite and sounding input. Meteorological components of the HDSS provide detections and short-term predictions of weather phenomena such as storm movement and evolution, hail, lightning, damaging winds, precipitation accumulation, downbursts and storm-scale circulations. The NDSS hydrological component is a GIS based rainfall accumulation package that integrates a number of data sources to produce predictions of precipitation accumulation, rainfall runoff, flash flooding, and precipitation type.

NDSS data and algorithm outputs are customizable and presented at a level equivalent to the meteorological understanding of the customer. The purpose of this paper will be to briefly discuss the available algorithms, the display systems, and the realm of applications of NDSS. Along with high-level meteorological and hydrological users, the NDSS has applications in transportation, aviation, recreation, energy, insurance, construction, and water management industries.

11:15 AM

2B6.4
Target identification with a dual polarized C-band radar
David R. Hudak , Jim Young , Janti Reid
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In 2004, the C-band Doppler radar at the MSC King City Radar Facility was upgraded to add a dual polarization capability. One of the key objectives of this modernization project was to investigate the operational benefits of the dual polarimetric parameters for extreme weather detection and short term forecasting. To support this task, a set of hydrometeor classification algorithms (HCA) was implemented to derive radar target identification. The HCA decision support system was based on a fuzzy logic approach developed at the National Severe Storms Laboratory (NSSL) in Oklahoma. Two versions ("simple" and "summer") of the HCA were tested. The simple classification types are meteorological, biological, and ground clutter. The summer classification further subdivides the meteorological class into various precipitation types. To help validate the results of the decision support system, a customized tool (XRADAR) was developed to allow researchers to interact with the radar data and classification output.

The HCA was tested on polarimetric radar data collected in the summer of 2004. XRADAR was used to adjust the fuzzy logic functions and examine changes in the resulting classification type. The results revealed changes in membership and weighting functions within the fuzzy logic framework were necessary to apply the NSSL HCA algorithms. This reflects the need to take into account the characteristics of the radar (e.g. C-band instead of S-band) and the meteorological conditions (e.g. for southern Ontario). Once mature, the target identification decision support system will serve as an important input to operational meteorologists in their decisions pertaining to severe weather detection and forecasting.

11:30 AM

2B6.5
The Mixed phase precipitation storm of 23 December 2004 in southern Ontario. Part 1: Meteorological Aspects
Patrick King [1] , Sarah Wong [3] , Paul Ford [4] , Bryan Tugwood [3] , Michael Leduc [3] , David Hudak [2]
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A major winter storm crossed southern Ontario on 23 December 2004 bringing a mixture of heavy snow, freezing rain and rain. Freezing rain causes serious economic and safety problems and accurate and timely forecasts of its occurrence are very important. This event was a classic case and illustrates many of the challenges a forecaster faces in forecasting the boundary between snow and mixed phase and rain areas. In this paper we describe the evolution of this storm using conventional surface and upper air data and model data. In particular we will make a detailed examination of the evolution of the warm layer aloft using Doppler VAD winds and soundings from the recently deployed Aircraft Meteorological Data Relay (AMDAR) System. We will also illustrate the usefulness of forecast sounding in such cases. A companion paper will discuss the identification of snow/mixed phase boundaries using polarimetric radar.

11:45 AM

2B6.6
The Mixed phase precipitation storm of 23 December 2004 in southern Ontario. Part 2: Analysis using polarimetric data

Patrick King [1] *, David Hudak* [2] *, Michael Leduc* [4] *, Paul Ford* [3] *, Norman Donaldson* [2]
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On 23 December 2004 a major winter storm crossed southern Ontario bringing a mixture of heavy snow, freezing rain and rain. Freezing rain causes serious safety and economic problems and accurate and timely forecasts are important. 'Bright bands' in conventional radar data have been used for many years to identify melting layers aloft associated with mixed phase precipitation events. However In more recent years Doppler VAD winds have proved useful in showing areas of warm and cold advection associated with the development of warm layers aloft. The newly-installed polarimetric radar at King City may provide an even more powerful tool to delineate the horizontal and vertical structure of such storms. In this paper we describe the evolution of the storm structure using both PPI and cross-sections of polarimetric radar data. We will make comparisons with surface and other data to show an excellent correspondence between phase changes and features in the cross-correlation coefficient (rhoHV) and the differential reflectivity (ZDR) fields. Some of the data shown here were provided to the Ontario Storm Prediction Centre in real-time and resulted in a timely extension of the freezing rain warning already in effect. A companion paper discusses the meteorological aspects of this storm.

10:30 AM

2B7.1
Modeling Landfast Ice
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Landfast ice is sea ice which forms and remains fast along a coast, where it is attached either to the shore, an ice wall, an ice front, or between shoals or grounded icebergs. Landfast ice is important because it fundamentally modifies, relative to pack ice, the momentum exchange between atmosphere and ocean and thus the location of upwelling and downwelling zones. It also affects the heat and freshwater exchange between air and ocean and consequently impacts where dense waters are produced. Current-generation sea-ice models are not capable of reproducing certain aspects of the processes of landfast ice formation, maintenance, and disintegration. In this study, we alter the standard sea-ice rheology so as to include tensile stresses. These stresses are formulated as a function of sea-ice salinity, temperature, age, and thickness. Using a limited-domain, high-resolution model, an ability to model landfast ice features is demonstrated.

10:45 AM

2B7.2
Arctic Dipole Anomaly (DA) and Arctic sea ice
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Based on the diagnosis of the NCEP/NCAR reanalysis dataset and using a coupled ice-ocean model developed by Wang et al. (2002, 2005), we investigate the response of the Arctic Ocean climate (or ice-ocean system) to the second mode (or so-called dipole anomaly, DA), and to the Arctic Oscillation for comparison. Seven high AO index winters and six low AO index winters (similarly, the high and low DA index winters) were simulated by the coupled ice-ocean model under forcing provided by the NCEP/NCAR reanalysis. Statistical analyses and tests were applied to the composite differences between the high and low AO indices. For the high AO index phase that predominated during the 1990s, the results showed a reduction of sea ice in the Arctic Basin accompanied by an increase of sea ice in the Labrador Sea. This pattern resembles the North Atlantic Oscillation seesaw pattern (Roger and van Loon 1979; Wang et al. 1994). During the high AO phase, the Arctic surface salinity increases and the surface temperature decreases, implying that more new ice was produced. The enhanced ice production is a consequence of greater ice export from the Arctic Ocean in response to anomalous cyclonic wind stress. From the subsurface layer to the Atlantic water layer, there is also a seesaw pattern in ocean temperature between the Barents and the Labrador Seas. During the high AO phase, the model reproduces the anomalous temperature intrusion of the Atlantic Water. While both the anomalous surface wind stress and the thermodynamical forcing contribute to sea ice and ocean variability, statistical analyses (EOF, regression, etc.) and significance tests (T- test and F-test) show that the wind stress accounts for a greater portion of these changes during the high AO phase than the thermodynamical forcing. During the DA positive phase, it is found that anomalous sea ice is transported to the Barents Sea and the Greenland Sea, compared to its negative phase. A dynamic mechanism leading to this finding is interpreted using the coupled model results, which can be validated by observations.

11:00 AM

2B7.3
Neural networks: windows to nonlinearity?
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The massive amounts of data from observations and from numerical models have traditionally been analyzed by classical multivariate statistical analysis, e.g. linear regression, principal component analysis (PCA), and canonical correlation analysis (CCA). Unfortunately, as these classical methods are linear, they have led to an overly simplified view of our environment. For instance, dominant modes of climate variability in the atmosphere and in the ocean have been extracted as standing oscillation patterns. Since the late 1980s, neural network methods have become popular for performing nonlinear regression and classification. More recently, neural network methods have been extended to perform nonlinear PCA and nonlinear CCA. As these nonlinear methods have successfully extracted the nonlinear modes of climate variability (El Niño-Southern Oscillation, Arctic Oscillation, stratospheric Quasi-Biennial Oscillation, etc.), they offer a new window to view our nonlinear world.

11:15 AM

2B7.4
The nonlinear association between the Arctic Oscillation and North American winter climate
Aiming Wu [1] , *William Hsieh* [1] , *Amir Shabbar* [3] , *George Boer* [2] , *Francis Zwiers* [2]
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Nonlinear projections of the Arctic Oscillation (AO) index onto North American winter (December–March) 500-mb geopotential height (Z500) and surface air temperature (SAT) anomalies via a neural network reveal pronounced asymmetric atmospheric patterns associated with positive and negative phases of the AO, suggesting nonlinear impacts of the AO on the North American winter climate. In a linear view, Z500 anomaly field associated with positive AO resembles a positive North Atlantic Oscillation (NAO) pattern with statistically significant positive and negative anomalies stretching zonally into central-eastern USA and Canada respectively, resulting in a cold climate anomaly over northeastern and eastern Canada, Alaska and the west coast of USA, and a warm climate anomaly over the rest of the continent. In contrast, the nonlinear pattern associated with both positive and negative phases of AO, indicates negative Z500 anomalies centered over the west coast of USA and the North Atlantic and positive Z500 anomalies at higher latitudes centered over the northeastern Pacific and northeastern Canada, accompanied by cooler than normal climate over the USA and southwestern Canada and warmer climate over other regions of the continent. This nonlinear (quadratic) behavior with respect to the AO is verified by a polynomial fit.

A similar analysis is conducted on the data from the Canadian Center for Climate Modelling and Analysis (CCCma) coupled general circulation model (CGCM2). The nonlinear patterns of North American Z500 and SAT anomalies associated with the AO in the model simulation are generally consistent with the observational results.

11:30 AM

2B7.5
On the Genesis of Prolonged Droughts in Canada
Amir Shabbar
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Large-scale relationships between summer Palmer Drought Severity Index (PDSI) patterns in Canada and previous winter global SST patterns are analysed using maximum covariance analysis (MCA). The matrix for the covariance eigen-problem is solved in the EOF space in order to obtain the maximum covariance between the singular values of the SST and the PDSI. The robustness of the relationship is established by the Monte Carlo technique, in which the time expansion of the primary EOF analysis is shuffled 1000 times.

El Niño-Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO) explain approximately 48% of the squared covariance, thus making interannual ENSO phenomenon and ENSO-related interdecadal variability the most significant process in the determination of the summer moisture availability in Canada. The trend in global SSTs and multidecadal variation of the Atlantic SST explain approximately one-third of the squared covariance. It is reflective of both the warming trend in the global southern oceans and the influences of the Atlantic Multidecadal Oscillation (AMO) variability. The six-month lag relationship between the PDSI and large scale SSTs provides a basis for developing long-range forecasting schemes for drought in Canada.

11:45 AM

2B7.6
On the reliability of ENSO dynamical predictions
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In this study, ensemble predictions were constructed using two realistic ENSO prediction models and using stochastic optimals. By applying theoretical framework, we have explored several important issues relating to ENSO predictability including reliability measures of ENSO dynamical predictions; and the dominant precursors that

control reliability. It was found that prediction utility (R), defined by relative entropy, is a useful measure for the reliability of ENSO dynamical predictions, such that the larger the value of R, the more reliable a prediction. The prediction utility R consists of two components, a dispersion component (DC) associated with the ensemble spread, and a signal component (SC) determined by the predictive mean signals. Our results show that the prediction utility R is dominated by SC.

Using a linear stochastic dynamical system, we further examined SC and found it to be intrinsically related to the leading eigenmode amplitude of the initial conditions. This finding was validated by actual model prediction results, and is also consistent with other recent work. The relationship between R and SC has particular practical significance for ENSO predictability studies, since it provides an inexpensive and robust method for exploring forecast uncertainties without the need for costly ensemble runs.

10:30 AM

2B8.1
Recent progress in urban meteorology in Canada
James A Voogt [1] *, T. R. Oke* [2]
(Presented by / Présenté par ***James Voogt***)
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An overview of recent developments in urban climate by Canadian groups involved in field observation programs conducted in Vancouver, Marseille, Basel and Toulouse and their associated modeling efforts. The review addresses the measurement and modeling of the surface radiation and energy balances, including development of parameterization of terms, application of radiative source area models, the specification of the urban surface properties necessary for accurate modeling (radiative and thermal properties, surface geometry and surface temperature), the measurement of urban heat islands and modeling of urban atmospheres. The review is situated in the context of work being
proposed for Canadian urban areas with applications related to the air quality, human health and comfort, and energy and water use.

10:45 AM

2B8.2
Overview of the 2005 Montréal Urban Snow Experiment (MUSE-2005)
Mario Benjamin
(Presented by / Présenté par ***Gilles Morneau***)
Environnement Canada - Région du Québec
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The MUSE field campaign took place in Montréal during March 2005, with the main scientific objective to document the evolution of surface characteristics and energy budgets, at a location in a dense urban area in conditions typical of Canadian winters, i.e. cold weather with the presence of a snow cover. Other objectives include a documentation of the evolution of snow in the urban environment (roofs, streets, and sidewalks) and its impact on the surface energy and water budgets. This will then allow to evaluate the performance of the Town Energy Balance (TEB) parameterization scheme in wintertime conditions, an aspect that has not been extensively examined so far. An overview of the main measurements needed to meet the scientific objectives will be presented. An urban site in Montréal has been instrumented with a 20-m telescopic meteorological tower to provide observations above the urban roughness sublayer of radiation budgets and turbulent fluxes, complemented with radiative observations of roofs, walls and streets, and of snow cover properties. Highlights of the preliminary results from the MUSE campaign will be presented.

11:00 AM

2B8.3
Methodology of urban cover classification for atmospheric modeling
Aude Lemonsu [1] *, Alexandre Leroux* [3] *, Stéphane Bélair* [4] *, Serge Trudel* [3] *, Jocelyn Mailhot* [2]
[1] Environment Canada, Meteorological Service of Canada, Meteorological Research Branch
[2] Environnement Canada /MSC/MRB
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To be able to run atmospheric models with an urban canopy parameterization, the land-use classifications must include specific urban covers, which characteristics and properties are different from those of natural covers. The Town Energy Balance (TEB) scheme has been recently implemented in the GEM and MC2 Canadian models, but the land cover database currently used for these models includes only water, ice, and various types of soils and vegetation covers. The objective of this work is to develop a general methodology that would provide urban land-use classifications in a semi-automatic way for the major Canadian cities, in order to represent the spatial distribution and the diversity of urban areas. This method is based on the analysis of satellite imagery and the evalutaion of building heights, and on a post-processing technique that allows the identification of urban classes following a set of relevant parameters: built fraction, density of buildings, mean building height, fractions of bare soil, low and high vegetation. Preliminary results obtained for Oklahoma City will be presented.

11:15 AM

2B8.4
Parameterization of Urban Covers for Mesoscale Models
Aude Lemonsu [1] , Stéphane Bélair [2] , Jocelyn Mailhot [2] , Radenko Pavlovic [2]
(Presented by / Présenté par ***Auide Lemonsu***)
[1] Environment Canada, Meteorological Service of Canada, Meteorological Research Branch
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The geometric parameters and material properties specific to urban covers induce micro-scale processes inside the urban canopy and between the canopy and the atmosphere that are quite different from those observed over natural canopies. They can play a key role in the local meteorology and in the structure of the atmospheric boundary layer. The Town Energy Balance (TEB) scheme represents both energy and water echanges between built areas and the atmosphere by using a realistic but simplified description of the urban canopy. This approach allows the simulation of large urban districts and even whole cities in mesoscale atmospheric models. In this work, we present the inclusion of TEB into the physics package of GEM and MC2. A first application in off-line mode and a 3D modeling exercise are conducted to evaluate the new configuration of the model within the framework of the Joint Urban 2003 campaign (Oklahoma City, OK, USA).

11:30 AM

2B8.5
Numerical Simulations of the Urban Boundary Layer Observed During Joint Urban 2003
Claude Pelletier [1] , Jocelyn Mailhot [1] , Stephane Belair [1] , Aude Lemonsu [1] , Radenko Pavlovic [2] , Najat Benbouta [2]
[1] MSC/MRB Environment Canada
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A prototype of an urban modeling system has been under development at MSC for some time, aiming at accurate prediction of urban flows and atmospheric dispersion over major North American cities. The main features of this new system include an assessment of the high resolution capability of the MC2 model for micro-alpha scale applications (down to about 200 m), an extension of our current turbulent diffusion scheme to 3D turbulence, the inclusion of urban processes with the Town Energy Balance (TEB) scheme, and the generation of surface fields characterizing urban type covers for use in TEB. As a first validation of the urban modeling system, high-resolution simulations will be presented that examine the impact of urban processes on the structure of the atmospheric boundary layer. These will be compared against detailed observations from two IOP cases of the Joint Urban 2003 (JU2003) field campaign held in Oklahoma City during July 2003.

11:45 AM

2B8.6
Development of a micro-scale 3-D urban energy balance model and its application to the study of intra-facet temperature distributions
Scott Krayenhoff , J. A. Voogt
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A micro-scale 3-D urban energy balance model is developed with the ability to predict urban surface temperatures for a variety of surface geometries and properties, weather conditions, and solar angles. The surface is composed of plane-parallel facets: roofs, walls, and streets. Facets are further subdivided into identical, square patches, resulting in a 3-D raster-type model geometry. The model code is structured into radiation, conduction and convection sub-models. The radiation sub-model utilizes the radiosity approach and accounts for multiple reflections and solar shading. Conduction is solved by finite differencing of the heat conduction equation, and convection is modelled by empirically relating patch heat transfer coefficients to the momentum forcing and the building morphology. The radiation and conduction sub-models are tested individually against measurements, and the complete model is tested against full-scale surface temperature and energy balance observations. Given the uncertainties in model input parameters and in the observations themselves, model-observation differences are acceptable. Subsequently, modelled inter-facet and intra-facet surface temperature distributions as functions of urban geometry are presented.

10:30 AM

2B9.1
Climatology of mountain waves over Eastern Canada
Ivan Dubé
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In comparison with major and well-known mountain ranges such as the Alps or the Rockies, significant mountain wave activity has not often been associated with the relatively modest orography of Eastern Canada. However, the study of conditions favourable to their development as well as numerous cases has led to the conclusion that mountain waves and their associated turbulence and downslope windstorms are very frequent over this area, to the point where it can be considered a daily challenge for operational aviation/public forecasters in Eastern Canada. A multitude of cases, featuring impressive satellite imagery and highlighting the different types of mountain waves as well as the various locations favourable to their development, are presented. Statistics such as area/frequency of occurrence and diurnal/seasonal variations are also included.

10:45 AM

2B9.2
Current and future challenges in diagnosing/forecasting mountain waves over Eastern Canada
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Considering the extensive coverage and high frequency of mountain waves over Eastern Canada, operational aviation/public forecasters are facing new challenges: diagnosing and forecasting mountain wave activity as well as their associated turbulence and/or downslope windstorms. The diagnosis part constitutes the first art they will have to master before attempting short/medium range forecasting. This presentation highlights some basic tools/procedures suggested to efficiently diagnose the different types of mountain waves as well as the occurrence/intensity of their most probable impacts. The difficulties associated with this high impact weather phenomenon as well as the scientific gaps that need to be filled in order to develop better diagnosis and forecasting skills are discussed.

11:00 AM

2B9.3
Low-Level Jets and Vertical Wind Shear in Mountainous Regions of the Eastern Canadian Arctic
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Strong surface winds and intense vertical wind shear within the lowest few hundred metres of the atmosphere commonly occur at several locations within the mountainous regions of the eastern Canadian Archipelago. These phenomena regularly create hazardous flying conditions and, in winter, are often associated with significant snowdrift, icing and reduced visibility in blowing snow near the surface.

To quantify the effects of local orographic and large-scale forcing on channelling and intensification of boundary layer winds, two parameters are derived that separately describe the acceleration of fluid elements along their trajectories and the local curvature of trajectories. It is shown that maximum acceleration by large-scale pressure gradients occurs for orographic flow directed at a right angle to the left of the overlying geostrophic motion. In combination with terrain induced pressure gradients responsible for the channelling, large-scale support for strong boundary layer flow is therefore associated with strong winds and wind shear aloft.

Climatologies of the occurrence of low-level jets and associated large-scale conditions are prepared for several operational weather observation sites in the eastern Canadian Arctic, where a comparison is made between topographically sheltered and unsheltered locations. At Iqaluit for example there is a well defined seasonal shift in prevailing surface wind direction from northwest in winter to southeast in summer. While northwesterly winds in excess of 10 ms^{-1} are predominantly supergeostrophic and associated with intense directional wind shear in the vertical, less frequent southeasterly winds of the same magnitude are predominantly subgeostrophic and associated with weak directional shear.

11:15 AM

2B9.4

Water Tank Modelling of Air Pollution Trapping in Daytime Upslope Flows

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The transport of air pollution by upslope flows during fair-weather conditions in the daytime is of critical importance to cities surrounded by mountains. Previous investigations indicated that there are two modes of transport: venting of air pollutants into the free atmosphere and trapping within the convective boundary layer.

To improve our understanding of these two modes we built a water tank model consisting of a plain, a 19-degree slope, and a plateau idealising the topography at Minnekhada Park in the Lower Fraser Valley, British Columbia, where slope flow measurements were taken during the Pacific 2001 Air Quality Field Study. By varying surface heat flux at the tank bottom and salt stratification of the water we can model dry atmospheric conditions covering the range of naturally occurring conditions. We injected dyes to study air pollution dispersion and measured two-dimensional velocity fields and vertical profiles of specific volume, corresponding to potential temperature in the atmosphere.

When the slope is heated homogeneously the boundary layer over the slope breaks up into a lower convective layer moving upslope and an elevated mixed layer moving downslope. When the convective layer grows strong enough it penetrates through the elevated mixed layer forming a deep convective boundary layer, which includes upslope and return flow. We believe that this mechanism causes the trapping of air pollutants when air pollutants are recirculated in the return flow. We also found that surface heat flux inhomogeneities over the slope lead to a splitting of the upslope flow and partial trapping.

11:30 AM

2B9.5

An Evaluation of Several Turbulence Closure Schemes for Modelling Slope Flows

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A one-dimensional high resolution model for studying slope flows is used to evaluate six turbulence closure schemes. The schemes are all so-called 1.5 order, including E-l closure, two versions of q^2l Level 2.5 and E-ε closure and its PBL modifications. All models use the turbulent kinetic energy equation together with either a diagnostic or prognostic equation for a turbulent length scale. A prognostic equation for eddy dissipation rate is used in the E-ε model. The different schemes are compared in terms of their influences on mean variables, vertical heat and momentum fluxes, turbulent kinetic energy, turbulence length scale, and eddy diffusivity. Model simulations are also compared with observations of katabatic flows. Some results are also available for upslope winds.

11:45 AM

2B9.6

Improvements of the MSFD model for Wind Energy Applications

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The Mixed Spectral Finite Difference (MSFD) model is a numerical code for atmospheric boundary-layer flow over complex terrain. It has been validated against wind tunnel measurements and field observations. Based on this model, MSFD-PC is designed specifically for estimating wind speed variations in wind energy applications. In recent years, there have been new developments and refinements of the MSFD model, including non-linear extension, a stably stratified version and extension to the planetary boundary layer. We will outline selected new features and possible improvements for wind energy applications. Computations for flow over Askervein will be used for illustration.

2:00 PM

2C5.1
Development in MOC2 of a Cloud Resolving Model embedded into the Canadian Regional Climate Model
Jean-Pierre Blanchet [1], *Rodrigo Munoz-Alpizar* [1], *Cristina Stefanof* [1], *Wanda Szyrmer* [3], *Alain Beaulne* [2]
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As part of the MOC2 network, the development of physically based cloud schemes in climate model is required to improve reliability of parameterized schemes. To reduce the large resolution gap between climate models and aircraft or satellite measurements, a strategy of cascade scaling is apply to implement a cloud resolving model within the frame of the Canadian Regional Climate Model (CRCM). The spatial resolution is progressively increased from 50 km to hundred of metres scale to drive a Cloud Resolving Model (CRM) with detailed aerosols (CAM) and adapted mixed phase cloud microphysics. In this approach, the boundary conditions constraining the explicit model are relaxed from typical CRM simulations. The CRCM provides more realistic boundary values and increasing the challenge for simulating clouds similar to those observed under corresponding conditions. The clouds microphysics in the CRM is represented by a 3 double moments scheme for liquid droplets, small ice crystals (< 100μm) and large crystals with significant sedimentation rate. The simulations are done for APEX3 that took place south of Japan in March-April 2003. The scheme is also applied to investigate interactions between aerosols and cirrus in Southern China, and diamond dust clouds during the Arctic winter.

2:15 PM

2C5.2
Drizzle category predicted with 3D-CRM
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The 2D/3D warm cloud resolving model (CRM), developed at University of Quebec at Montreal, which uses the MC2 dynamical kernel, has been extended to include a light precipitation (“drizzle") mode. The bulk scheme describing the drizzle category predicts two prognostic variables: concentration per unit mass (number mixing ratio) and mass mixing ratio (Khairoutdinov and Kogan 2000).

We are focusing on studies of cloud microphysics in warm clouds. Insitu aircraft
observations from Dynamics and Chemistry of Marine Stratocumulus (DYCOMS II) fields are being analyzed and compared with 3D warm clouds simulated by CRM. The comparison shows that the observed and modeled cloud amount agrees well.

2:30 PM

2C5.3
Effect of Inertia on Turbulent Cloud Droplet Collision Rates
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Observations of cloud droplet size distributions are broader than those given by classical cloud physics theory. Therefore, the predicted evolution of the drop size distribution and the subsequent onset of precipitation are much slower in numerical models than in the real atmosphere. Turbulence has long been postulated to accelerate the rain initiation time; however, due to the complexity of the problem the significance of turbulence on cloud droplet collision rates is still debateable. In this study we carried out direct numerical simulations of cloud droplet collisions in homogeneous, isotropic turbulence. This type of simulation has the advantage over previous studies of explicitly resolving the dissipation range eddies of the flow, which have been shown to have the most effect on the motion of small droplets.

The geometric collision kernel of droplets in a turbulent flow can change from the purely gravitational case in two ways, through changes in the relative velocities of colliding droplets due to the differential inertia effect and through changes in the spatial distribution of droplets due to the clustering of inertial droplets. Results have shown that the turbulent collision kernel is dependent on the radius ratio of the colliding droplet pairs and the eddy dissipation rate of turbulent kinetic energy. For collector droplets of sizes 10, 20 and 30 microns in radius and the lowest dissipation rate considered, 95 cm^3 s^{-2}, the turbulent collision kernel increased from the gravitational kernel by up to 1.1, 1.3 and 1.5 times respectively. For the highest dissipation rate considered, 1535 cm^3 s^{-2}, these values increased significantly to 3.4, 9.6 and 8.4 times. Separating these increases into the two physical processes that produce the collision kernel, the relative velocities and the clustering, has shown that for small radius ratios in low dissipation rate flows, the increase in the radial relative velocity is predominately responsible for the increase in the collision kernel, while for the larger radius ratios in the higher dissipation rate flows, the principal mechanism changes to the clustering of the droplets. The results of this study demonstrate that turbulence could play an important role in the broadening and evolution of the droplet size distribution and highlight the need to develop an accurate model of the collision kernel for sedimenting droplets in turbulent flow.

2:45 PM

2C5.4
Cloud Absorption of Solar NIR
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Measurements of transmission spectra indicate certain clouds strongly absorb NIR radiation; radiation codes such as MODTRAN4 do not model this strong absorption well. The absorption fingerprint in cloud spectra matches liquid water. A garden hose spray shows liquid water absorptionn. The same spectrum observed in transmission of drizzling fog, indicating it has an association with drizzle in clouds.

The spectral signature of liquid water absorption was observed from aircraft on the AIRS project in drizzle clouds. Precipitating clouds including Virga have a bimodal droplet distribution with water droplets> 200 mm radius. This liquid water absorption is not explained by Mie theory for cloud droplets of size from 10 to 20 microns using MODTRAN or GCM radiation codes. A modified MODTRAN4 simulation with added drizzle droplets > .5 mm only partially simulated the observed NIR absorption.

Daily measurements with 2 filtered pyranometers used to investigate the statistics of this effect. Under clear conditions, the ratio of NIR to Total short wave is about 40 %. Under cloudy conditions this ratio is reduced from 40% to 15 %. The absorbed flux is in the 50 to 150 W/m2 range . On a regional basis this effect corresponds to 20 W/m2 with estimated ground temperature impacts 2 to 10 K. The effect is 2.5 W/m2 or 0.5 K on a global basis.

Absorption of NIR short wave by drizzling clouds is a missing factor in GCMs, regional climate models and forecast models. This NIR absorption is missing in current radiation schemes; large droplets need to be included as bi-modal distributions. Simulations needed to test the impact of this error in models .

2:00 PM

2C6.1
Using Enhanced Graphic Production for Decision Support
Brian T. Greaves [1] , *David Sills* [1] , *Norbert Driedger* [1] , *Janti Reid* [1] , *Emma Bradbury* [1] , *Bob Paterson* [1] , *Byron Brodie* [2]
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It is generally well recognized that data visualization plays a crucial role in decision support. It is fairly axiomatic, but sometimes overlooked, that simplified graphics can enhance communication. For example, when planning a trip, people typically use a roadmap, not a high resolution satellite image. The roadmap is a simplified representation of pertinent spatial relationships. Frequently people want easy access to information and not the "thousand words" that a picture "says". Sometimes a simple phrase like "temperature falling to -1" is sufficient. Other times a schematic diagram is the best way to get a point across. Graphic information content can often be "enhanced" by simplification.

The Forecast Production Assistant (FPA) has often been associated with model manipulation. This association is unfortunate because the real strength of FPA is as a communications tool. Interpretation and communication go hand in hand. Each stage of weather forecast decision making involves some form of information extraction and transfer. It is desirable to make each stage as efficient as possible. The same data presentation should not be expected to work in all situations. FPA is a tool that makes it possible to both simplify information and present that information in multiple formats. In this sense, information provided for decision support is enhanced. An example from the Ontario Ministry of Natural Resources where FPA is used for both fire and flood weather forecasting will be presented.

Aurora is a research tool that extends FPA technology. Examples will be shown of how Aurora is used on the Research Support Desk of the National Lab for Nowcasting and Remote Sensing Meteorology. In this scenario, visualization is still the prime motivator, but abstracted weather objects, for example lake breeze fronts, also have the potential for supporting a decision process.

2:15 PM

2C6.2
Nowcasting Airport Winter Weather: AVISA and Beyond
G.A. Isaac [1] , *S.G. Cober Meteorological Service of Canada* [3] , *N. Donaldson Meteorological Service of Canada* [3] , *I. Gultepe Meteorological Service of Canada* [3] , *N. Driedger Meteorological Service of Canada* [3] , *D. Hudak Meteorological Service of Canada* [3] , *A. Glazer Meteorological Service of Canada* [3] , *J. Reid Meteorological Service of Canada* [3] , *P. Rodriguez Meteorological Service of Canada* [3] , *J.W. Strapp Meteorological Service of Canada* [3] , *F. Fabry McGill University* [2]
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Air traffic at airports can be considerably disrupted during winter weather such as a snowstorm and freezing precipitation. De-icing operations must commence, the total amount of traffic the airport can handle is often reduced, and delays and flight cancellations are common. In-flight icing is also a problem for aircraft on approach or taking off. MSC is developing a Nowcasting system to help provide decision makers (airport authorities, airline dispatch, ground de-icing crews, pilots, etc) with real-time, accurate, and up-to-date weather information to help alleviate the problems and to increase safety. The system is currently called the Airport Vicinity Icing and Snow Advisor (AVISA). This system uses numerical model data, pilot reports, ground sensor data (precipitation, ceiling, visibility, winds, etc) as well as remote sensing (satellite, radar, radiometer) information to provide the necessary Nowcasts out to approximately 6 hours. The limitations and strengths of some of the component inputs (e.g. model data, radar, radiometric, precipitation rate) will be discussed using experiences from the Alliance Icing Research Study II (AIRS2) which was conducted in the Ottawa-Mirabel area from 3 November 2003 to 12 February 2004. This project involved 5 research aircraft and several airport Nowcasting systems which were installed at Mirabel. Plans for future work will also be described including the difficulties associated with designing the system products, and implementing it operationally.

2:30 PM

2C6.3
The integrated system for production, monitoring and diagnostics at the Norwegian Meteorological Insitute.
Helen Korsmo , *Audun Christoffersen* , *Lisbeth Bergholt*

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The Norwegian Meteorological Institute has an ongoing process of developing an integrated system for production and monitoring of forecasts. The main diagnostic tool and visualiser software, Diana, is being extended with new modules for this purpose: both interactive production tools and automatic monitoring components.
We will demonstrate how this has been done for the production of text and aviation forecasts.
The meteorological workstation provides relevant information to the forecaster, and specialised tools are used for producing specific products.
Future plans include production and monitoring of quality controlled high-resolution fields, and automatic end products from these.

2:45 PM

2C6.4
Scribe Nowcasting - A Decision Support System
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An Integrated Nowcasting Sub-System (INSS) has been recently implemented into SCRIBE (Weather Forecast Product Expert System) and is currently available at all MSC forecast offices in Canada. The sub-system ingests and processes the latest observations and nowcasting model outputs. Then, it prepares a set of weather elements which can be used by forecasters to update interactively, in real time, the weather elements of the forecast in effect or the automated Scribe forecast. The INSS has been developed to minimize the necessary manual adjustments done by the forecaster to merge the current weather conditions with regular forecast. It can also provide a monitoring tool that can be used to anticipate the necessary updates and amendments.

Version 1.0 of the INSS currently uses surface observations, North American radar mosaic data and the lighting data from the Canadian and U.S. Lighting Detection Network. These observations are used to feed three different nowcasting models. A statistical model uses surface observations to provide very short-term forecasts of the different weather elements normally included in METARs. Radar reflectivities are forecasted for the next 6 hours with an algorithm developed by McGill University. This algorithm calculates motion vectors to displace the radar echoes. Finally, and algorithm has been designed at CMC to predict the future position of lightning clusters. All these observed and forecasted data are processed into a rule based system to determine the most likely sequence of weather elements. Thus, if the INSS is activated, the first hours (from 2 to 11 hours) of a forecast will be influenced by the nowcasting data.

Recent objective verifications indicate superior performances by the INSS when compared to the direct SCRIBE weather elements. Real case examples will be presented to demonstrate how the INSS can be used in an operational forecasting environment as a decision support system to monitor, prepare, update and amend weather element forecasts in SCRIBE.

3:00 PM

2C6.5
CMC colour image production and the Vizaweb interface
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An update on CMC's colour image production system is presented to highlight how CMC is now positioned to produce, in a timely fashion, a growing number of colour products for the operational and R&D communities. Vizaweb, a CMC's web-based interface, allows users to quickly navigate through the thousands of images produced daily from a growing list of NWP outputs. A number of recent improvements to the interface will be presented. More advanced functionality of Vizaweb will be reviewed to demonstrate how it presently offers operational meteorologists an attractive maintenance-free option for efficient viewing and comparing of a number of model outputs.

Vizaweb is located at: http://iweb.cmc.ec.gc.ca/cmc/htmls/vizaweb.html

2:00 PM

2C7.1
Simulations of water mass formation and circulation during the early-mid Holocene in a regional eddy-permitting ocean model of the sub-polar North Atlantic
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Orbital parameters for the early-mid Holocene were quite different from present day. An increase in orbital obliquity magnifies the amplitude of the seasonal cycle through altering the magnitude and spatial distribution of incoming insolation. Proxy-data show quite different features in sea surface temperature (hence heat flux) and sea-ice extent (hence sea-surface salinity) in sub-polar North Atlantic, which play key roles in the density and stratification of water masses, vertical convection and circulation. Surface forcing (momentum, heat and freshwater fluxes) output from an atmosphere-ocean coupled model during early (9000 BP) and mid- (6000 BP) Holocene is therefore used to force a regional eddy-permitting ocean model of the sub-polar North Atlantic under flux forcing and the properties of water mass formation and circulation in this region are examined.

2:15 PM

2C7.2
Quantifying the Effect of Vegetation Dynamics on the Climate of the Last Glacial Maximum
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The importance of the biogeophysical atmosphere-vegetation feedback in comparison with lower CO_2 and the presence of ice sheets at the last glacial maximum (LGM) has been investigated with the climate system model CLIMBER-2. Equilibrium experiments for the LGM reveal that most of the global cooling at the LGM (-5.1°C) relative to pre-industrial times was caused by the introduction of ice sheets into the model (-3.0°C, 58%), followed by the effect of lower atmospheric CO_2 levels at the LGM (-1.5°C, 29%). The synergy between CO_2 and ice sheets leads to an additional cooling of 0.1°C. The biogeophysical effects of vegetation changes were found to cool the LGM climate by 0.6°C (12%). This cooling is caused by the feedback of vegetation to the presence of ice sheets (-0.5°C, 9%), the vegetation feedback to the lowered CO_2 level (-0.1°C, 2%) and the vegetation feedback to the synergy of the lowered CO_2 and the ice sheets, which adds an additional cooling of 0.02°C. The biogeophysical effects of the vegetation changes are most pronounced in the northern high latitudes where the taiga-tundra feedback caused temperature changes of up to -2°C, while the radiative effect of lower atmospheric CO_2 in this region only caused a cooling of 1.5°C. Hence, locally the temperature changes induced by taking into account vegetation dynamics exceed the cooling due to lower atmospheric CO_2 concentration.

2:30 PM

2C7.3
Arctic sea ice modelling: introducing the UVic-granular sea ice coupled model
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We describe the challenges in Arctic sea ice modelling and the importance of a sophisticated thermodynamic/dynamic sea ice model to appropriately simulate the interactions of sea ice with the other climate components. We shall present the different sea ice rheologies used in sea ice modelling, introduce the granular sea ice model (Tremblay and Mysak 1997) and describe its strenghts and weaknesses. The spherical coordinate version of the granular sea ice model has been coupled to the UVic earth system model version 2.6 (Weaver et al. 2001). Modelling results of the climatological Arctic sea ice cover using the UVic-granular coupled model will be shown. The impact of the sea ice export on the meridional overturning circulation will also be discussed.

2:45 PM

2C7.4

Glacial abrupt climate changes and Dansgaard-Oeschger oscillations in a coupled climate model

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Large millennial (Dansgaard-Oeschger) oscillations are a common feature of the past glacial periods. Rapid transitions between cold stadials and warm interstadials occurred over several decades or less in these oscillations. The millennial oscillations also appear to have been significantly modulated by the nature of the glacial background climate. Here we show that these features can be simulated in the McGill Paleoclimate Model-2. A moderate global cooling forces the Atlantic Meridional Overturning Circulation (MOC) into an unstable state and hence causes the flip-flop of the Atlantic MOC between a strong mode and a weak mode. In a warm climate, the strong mode is stable, whereas in a cold climate, the weak mode is stable. The oscillations result from strong interactions between the atmosphere, ocean and sea ice. In addition to the background atmospheric and terrestrial conditions, internal oceanic feedbacks and sea-ice thermal effects, the process of sea-ice brine rejection is demonstrated to play a necessary role in the oscillations.

2:00 PM

2C8.1

Tools for the quantification of N2O emissions from Agroecosystems

Elizabeth Pattey [1] , *Grant C. Edwards* [1] , *Raymond L. Desjardins* [1] , *Dan Pennock* [2] , *Ward Smith* [1] , *Brian Grant* [1] , *Dave W. Dow* [1]
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The quantification of nitrous oxide, one of the greenhouse gases, from agricultural sources remains a challenge to researchers. However, over the past decade, considerable progress has been made towards developing the necessary tools for its quantification. These tools include those that are used at the local, and field scale (i.e., chamber and tower-based measurement) as well as those used at the landscape and regional scales (i.e., aircraft-based measurement and modelling). Agriculture and Agri-Food Canada (AAFC) have extensive experience with all these quantification tools to assess the N_2O budget from agroecosystems. The current estimate of N_2O's contribution to the total greenhouse gas emission from agriculture in Canada is estimated to be 60%. N_2O emissions are largely event driven, for example large emissions have been observed during the spring snow melt, therein lays the difficulty in assessing its contribution. Snow melt period average emissions of N_2O in the literature vary considerably showing dependence on many controlling factors. Cumulative emissions reported here range from 1.26 kg N_2O-N ha^{-1} in Eastern Canada to 0.05-0.06 kg N_2O-N ha^{-1} in Western Canada. A comparison of literature values for the snowmelt period from eastern and western sites shows the same trend reflecting differences in climatic zones and fertilizer management practices. DNDC model simulation of the snow melt periods showed good correspondence with observations, however N_2O emission models, in general, require uncertainty assessment and strategies to improve upon our ability to assess the N_2O budget.

2:15 PM

2C8.2

In situ dynamics of water soluble carbon and mineralization of liquid and solid dairy cattle manure in agricultural soils of contrasting textures.

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Decomposition rates of organic amendments in agricultural soils provide information on nutrient release and on changes in soil C stocks. They are usually determined during the incubation of soil samples under controlled conditions. Our objective was to study *in situ* the decomposition dynamics of liquid and solid dairy cattle manures following application to a loamy and a clay soil. Manures were applied in two consecutive years to silage corn fields at rates equivalent to 150 kg total N ha-1. Soil-surface CO2 fluxes, temperature, water content and water-extractable organic carbon (WEOC) were monitored weekly in manured and control plots. Manure addition only increased WEOC in the 0 to 10 cm soil layer but increases were not proportional to the amounts of dissolved organic C applied with manure. Lack of full recovery of manure dissolved organic C was attributed, at least partly, to rapid interactions of soluble C with soil particles. Following application of manures, initial decomposition rates were much slower in the first than in the second year. This lag phase was attributed to the time required by the soil microflora to adapt to the first addition of this exogenous organic substrate. During the first year, mineralization rates of manure organic C were higher in the loam (75%) than in the clay (35%) soil, presumably as a result of better aeration and lower physical protection of organic substrates in the loam. Identical mineralization rates of liquid and solid manures during both years in the loam soil indicated that the two manure types had similar decomposability. Slower decomposition of the solid than the liquid manure in the clay soil was attributed to poorer mixing with the soil (formation of clods) resulting in reduced contact between the manure organic matter and the soil particles, and thereby reduced access of decomposers to the substrates. The results of this study show that the measurements of *in situ* soil-surface CO2 emissions can provide estimates of the decomposition rates of organic amendments under field conditions. These estimates integrate the effects of soil bio-physical factors simultaneously affecting the soil C dynamics such as temperature, water content and substrate availability.

2:30 PM

2C8.3

Artificial Neural Networks (ANNs) Application for Prediction of the Date of Wheat Phenological Stages Occurrence Using Climatic Data

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Prediction of the time of crop phenological stages occurrence mainly strategic plants such as, wheat, corn and rice help us to achieve to the exact time in order to control pests, weeds and pathogens and also, to the best time for operating such as, fertilizing and irrigation.
The main purpose of such study is to estimate the occurrence of phenological stages in dry farming wheat at the time interval of short duration before their occurrence using meteorological data.
Recently, the application of Artificial Neural Networks (ANNs) has developed into a powerful tool that can compute most complicated equations and numerical analyses to the best approximation. According to the available data and information from different areas in Iran, this research was accomplished using Sararood station data in Kermanshah Province that has the most complete homogeneous statistics. In this study, the results of climatology for four meteorological factors in period (1990-99) including degree days (heat units), total daily rainfall, sum of sun hours and sum of water requirement for each of eleven phenological stages in wheat including sowing, germination, emergence, third leaves, tillering, stem formation, heading, flowering, milk maturity, wax maturity and full maturity were collected separately for each farming year and arranged in two matrices:
A matrix whose rows are repetitions of the statistical years (i) at each phenological stages of wheat (j) and the columns are meteorological factors (k).
A matrix whose rows form each of the statistical years (i) and the columns are meteorological factors (k) at each phenological stage (j).
In fact, statistical years (i), phenological stages (j) and meteorological factors (k) are the basic elements of 3-D matrix (M ijk) arranged as above.
Finally, different networks were made for each stage and the optimum values of network parameters were obtained by trial and error. It should be reminded that two of the eight-year farming were randomly excluded network training computations and the comparison of the estimated data with the real data for these two years were used to test the accuracy of the models. The model that obtained has the following capabilities:
1. Prediction of the date of phenological stages occurrence (From stem formation till full maturity) with maximum error 3 to 6 days at least one week before the occurrence of each stage.
2. Determination of the sensitivity of each phenological stage with respect to meteorological factors.

2:45 PM

2C8.4
Crop Phytomass Monitoring using Eddy CO2 Flux and Hyperspectral Reflectance
Elizabeth Pattey [1], *Matt Hinther* [1], *Jiangui Liu* [1], *Ian B. Strachan* [4], *John R. Miller* [3], *Christophe Forget* [1], *Driss Haboudane* [2]
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Remote sensing is seen as an important tool to provide necessary information for both monitoring global change and implementing sustainable management practices (Moran, et al. 1997). Hyperspectral reflectance (HR), in the visible near infrared spectral band, has a great potential for deriving biophysical descriptors such as leaf chlorophyll content, "green" Leaf Area Index (LAIg), and plant water content, which were recently developed. The study took place in several fields located on the greenbelt and Canadian Food Inspection Agency farms in Ottawa, (ON). Crops planted in the fields were corn (*Zea mays*) in two fields, soybean (*Glycine max*) and wheat (*Triticum aestivum*) in one field each. Three Compact Airborne Spectrographic Imager (CASI) acquisitions were performed on June 13, June 26, and July 19 during the 2001 season. Intensive ground data were collected from 20 m x 20 m study sites within the field in conjunction with the CASI acquisitions. Twin eddy flux towers were installed in the wheat field to monitor CO_2 and H_2O fluxes from areas which received sub-optimal and recommended N rates and to calculate dry phytomass accumulation and radiation use efficiency (RUE). In this study, we explore ways of integrating the biophysical descriptors for monitoring crop biomass accumulation, using remote sensing derived biophysical descriptors merged in relatively simple algorithms. For the early part of the vegetative growth, relationship between phytomass and LAI (and height when required) were developed, then, the model of Monteith (1972) relating biomass to intercepted Photosynthetic Photon Flux Density and RUE was used. Because daily RUE is highly variable and the HR index, sPRI, is related to instantaneous RUE, the Monteith-based model could not be operationally implemented to compute biomass at heading.

2:00 PM

2C9.1
Dynamics of forecast error in an NWP system
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A study is undertaken of the difference between the forecast and contemporaneous analysis fields of a particular weather prediction system, and the evolution of this pseudo-error field is examined and interpreted from a PV-perspective. The underlying rationale is two fold. First this perspective's intrinsic properties imply that :- (a) non-conservation of error PV signifies either isentropic advection of the error across an ambient flow's PV-gradient, the misrepresentation of diabatic or frictional processes, and / or error in the analysis field at the verification time; and (b) inversion of a particular feature of the error PV field can (- via attribution) account for error of a primary flow variable in the in-situ and far-field. Second the dynamics of rapid error growth has been linked to distinctive PV-features of the error field (e.g. via vertical realignment of *either* initially backward slanting monochromatic columns of error PV *or* initially compact vertically-stacked PV error features of differing sign.
Illustrations of the structure and evolution of the PV difference field derived from the ECMWF's prediction suite point to the inadequate development of the Rossby wave amplitude on the extratropical tropopause and to deficient diabatic effects. To further explore the nature of the difference field a series of hindcasts are conducted with a regional forecast model. This combined approach provides a compact and insightful description of the difference field's dynamics.

2:15 PM

2C9.2
A High-Resolution Global Modeling System for Medium-Range Weather Forecasting at Environment Canada
Stéphane Bélair [1] , Michel Roch [2] , Anne-Marie Leduc [2] , Paul Vaillancourt [2]
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A new version of the Global Environmental Multi-scale (GEM) model is currently being prepared for operational medium-range weather forecasting at Environment Canada. In this new version of GEM, the horizontal resolution has been substantially increased to 800x600 grid points for a grid size of 33 km at latitudes 49 degrees, compared to 400x200 for a grid size of 100 km for the current operational model. As well, the number of vertical levels has also been increased to 58 levels, instead of the 28 levels currently used in the operational system. The physics in this new version of GEM has been upgraded with several new schemes, including the Kain-Fritsch scheme for deep convection, a new scheme called Kuo-Transient for shallow convective activity, the Bougeault-Lacarrere mixing length for turbulent diffusion, and the ISBA land surface scheme with soil moisture initial conditions provided by a sequential assimilation of screen-level air characteristics. This high-resolution version of GEM was extensively tested over a large number of wintertime and summertime cases, for which the initial conditions were provided by a 3DVAR assimilation system. Objective evaluation against radiosondes show significant improvements over the operational model, especially for Asia, the Tropics, and the Southern Hemisphere. In other regions, such as North America and Europe, it appears that the increase in skill is not sufficient to compensate the increase in root-mean-square errors associated with the higher levels of variance in the new system. This aspect of the objective evaluation is currently under investigation. Objective evaluation against surface observations indicate that the new version of GEM produces better precipitation forecasts, with increased predictability up to 4 days. At the conference, the new configuration will be presented, together with objective evaluation results and an update concerning the eventual transfer of this new technology to the Canadian Meteorological Centre.

2:30 PM

2C9.3
On the use of ensembles in the forecasting process
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CMC puts a variety of products from the Canadian Ensemble System on the web each day. How can these be used in forecasting? Although ensemble prediction systems (EPS) have been operational in some centers for more than 10 years, their effective use by forecasters has been slow to develop. One possible reason for this is the slow development of tools to aid the forecaster in assimilating the vast quantities of information produced by ensemble systems. Using examples from the Canadian EPS wherever possible, this presentation will describe some ways in which eps information can be used to

enhance what is already available from the deterministic models, for example, early indication of the potential for extreme weather. The presentation will also include a survey of tools designed to aid in the use of ensemble forecasts.

2:45 PM

2C9.4
Performance of the CMC multi-model seasonal forecasting system
Normand Gagnon [1], *Juan Sebastian Fontecilla* [1], *Richard Verret* [1], *George Boer* [4], *Mike Lazare* [4], *Francis Zwiers* [4], *Jacques Derome* [3], *Bernard Dugas* [2], *Christiane Beaudoin* [2], *Gilbert Brunet* [2], *Benoit Archambault* [1], *Hal Ritchie* [2]
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A series of historical forecasts was conducted with four models: the CCCma AGCM3, CCCma AGCM2 and the RPN GEM and the RPN SEF. This second Historical Forecast Project (HFP2) follows the protocol established by the PCMDI for the SMIP2/HFP. It consists in 4-month forecasts for the period 1969 to 2000 for 12 rolling seasons (January-February-March-April, February-March-April-May, etc.). The system was used in a two-tiered approach. The sea surface temperatures (SST) were forecast using persistence of the anomalies calculated for the month preceding the integrations. The sea ice extent, snow cover and atmospheric conditions were initialized as well from respectively ERA-40 data, NCEP weekly satellites observations and NCEPRA-1. An ensemble of 10 members was run using a Lag Average Forecast technique (12-hour lag).

Currently the operational system in used at CMC is the following: 6 members of GEM and 6 members of AGCM2 for 0-3 month forecast. We will look at the expected performance of the future system using additional models: the CCCma AGCM3 and RPN SEF. Also, with the new HFP2 (SMIP2/HFP) runs we can increase our number of ensemble members from 6 to 10 for each model. Deterministic scores as well as probabilistic scores will be discussed for the new larger ensemble.

3:00 PM

2C9.5
Current status and future improvements in the Canadian Meteorological Center's operational forecasting suite
Richard Hogue , *Yves Pelletier* , *Lewis Poulin*
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The Operations Branch of the Canadian Meteorological Center (CMC) runs in a fully operational context the models and analysis systems that have been developed by the Development Divisions of CMC along with MSC's research groups. The current status of the operational forecasting suite will be reviewed. A series of major improvements were introduced in the past year since the IBM supercomputer has been running operationally in January 2004. They include:

- the operational implementation of the 15km regional GEM model (May 2004)
- a new version of the CHRONOS air quality model with particulate matter (May 2004)
- new observation types introduced in the data assimilation (September 2004)
- the SCRIBE Nowcasting system (fall 2004)
- Ensemble Kalman Filter data assimilation system (January 2005)
- 4D-Var data assimilation in the global system (March 2005)
- wave model (WAM) forecasts over the Great Lakes (summer 2004) and improved forecasts over the Atlantic and Pacific (spring 2005)
- Further improvements to CHRONOS air quality model (spring 2005)

Improvements to the operational system planned for the upcoming year will be presented. These include running GEM-LAM 2.5km version over selected windows, the implementation of the new GEM meso-global model as well a series of improvements to the main operational components such as the regional GEM model.

We will also provide an update on CMC operational products including those available on the interface called “Vizaweb” (web browser to view NWP outputs) and the availability of CMC GRIB data to external users.

4:15 PM

2E1.1
Assessing the Importance of Instrument Testing and Calibration in the Production of a Reliable Temperature Dataset

Gary Beaney
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For over a century, the standard instrument for measuring temperature in the Canadian Climatological Network has been the liquid-in-glass thermometer. Due to its prolonged use, the errors associated with this instrument are well defined and have been dealt with in a consistent and rigorous manner. Over the past 20 years the MSC has begun replacing liquid-in-glass thermometers with digital thermometers. With any new technology, come new sources of error. In order to ensure the same quality of data when new technologies are implemented, new sensors must be calibrated as rigorously as the old.

Using calibration data from over 14,000 liquid-in-glass thermometers, the range of errors encountered will be demonstrated and the sources of these errors will be discussed. In addition, this paper will show the amount of variability found in uncalibrated digital thermometers installed at the CARE test facility in Egbert, Ontario. It is the hope of this study to better understand the errors associated with digital thermometers, and help ensure the temperature record they produce is as consistent and reliable as that produced by liquid-in-glass thermometers.

4:30 PM

2E1.2
Measuring Longwave Radiative Flux Divergence

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There has been very little measurement of longwave radiation flux divergence since the urban studies of Fuggle, Oke and Nunez in the mid 1970's or the rural work of Funk in the early 1960's. Although radiative divergence has been widely ignored for sometime there is the belief that it may play an important role in balancing nocturnal energy budgets in a range of environments. For example, in urban environments surface temperature relates well to the energy balance whereas air temperature does not, even in non-turbulent conditions. This is probably due at least in part to the effects of longwave flux divergence. To help answer issues related to longwave divergence a new dual-channel infrared radiometer (DCIR) has been developed. The DCIR, as the name implies, measures the directional infrared radiation in two wavebands and can, through differencing of the signals and further signal processing, give a direct measurement of longwave radiative flux divergence. This complex procedure requires the conduct of a combination of numerical modeling and highly precise laboratory calibration. The DCIR was deployed over an extensive grass surface during the late summer of 2004 in Vancouver in an attempt to measure the longwave radiative flux divergence directly. This required not only the use of the DCIR but also a suite of other meteorological and longwave radiation instruments. The experimental set-up and results of this measurement campaign will be discussed.

4:45 PM

2E1.3
Validation of NO2 and Ozone Retrievals from the MAESTRO Instrument on SCISAT-1

James R. Drummond [1], CT McElroy [3], J Kar [1], C. Nowlan [1], D Dufour [1], J Zou [1], F Nichitiu [1], T Kerzenmacher [1], DI Wardle [3], P Bernath [2], K Walker [2], C Midwinter [1]
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Measurements of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation (MAESTRO) was launched on August 12, 2003 aboard the Canadian Space Agency's SCISAT 1 along with a Fourier Transform Spectrometer (ACE-FTS). MAESTRO is a diode array spectrophotometer and measures the atmospheric extinction In the occultation mode In the wavelength range 270-1040 nm. Vertical profiles of NO2 and ozone are currently being retrieved from these measurements. We shall present results from Intercomparison of these ozone and NO2 profiles with those

measured concurrently from other occultation Instruments like Stratospheric Aerosol and Gas Experiment III (SAGE III). In particular we shall focus on the validation of the data In the high latitudes, which are sampled extensively by both the Instruments thus providing a large number of coincident measurements. We shall also present comparisons with ACE-FTS as well as ground based measurements at EUREKA. Some salient results from these MAESTRO retrievals will be presented. These Include high concentrations of NO2 observed around 40-45 km In March 2004. These high values were possibly caused by solar proton events In October-November, 2003 at mesospheric altitudes and were then transported downwards to the upper stratosphere within the arctic polar vortex.

5:00 PM

2E1.4
Rainfall Analysis by Calibrating Weather Radar Images
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The traditional instrument for rainfall measurements is a rain gauge, which provides a daily record of rainfall measured at a specific site. To obtain region-wide rainfall estimates, an alternative method based, on analysis of archived weather radar imagery, was developed by the authors.

Radar images provide instantaneous measurements over a large area at defined intervals. However, the accuracy of precipitation estimates based strictly on radar data is limited by methods used to convert measured reflectivity in the atmosphere to actual rainfall experienced on the ground. An innovative technique was developed, using rain gauge measurements, to calibrate the radar images and produce daily rainfall maps. A computer program was written to read the radar precipitation images and then convert the colour map (RGB) values for each pixel in these images to a rainfall index, based on the associated colour scale on the radar images. The rain gauge data from stations in and around the region of interest were compared to data extracted from uncalibrated daily rainfall maps for the same locations. A calibration profile was created for each day. Calibration curves were developed from these plots to obtain calibrated daily rainfall maps covering the region of interest.

This technology has been applied to a case study in western Canada. The calibrated rainfall maps provided estimations of rainfall for large geographical areas where no rain gauge data were available.

5:15 PM

2E1.5
Development of the Canadian Aircraft Meteorological Data Relay (AMDAR) Program and Plans for the Future
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The Canadian AMDAR Program is a cornerstone of the modernization of the Canadian Upper Air Program. The development of AMDAR by the Canadian AMDAR Program Implementation Team (CAPIT) has not been typical because Air Canada had been restructuring, WestJet was concentrating on its growth, and VHF networks operated by ARINC and SITA do not typically extend north of 60N. Consequently Canada started developing its program from regional air carriers, meaning no simple solutions existed as these carriers usually operate older aircraft using less sophisticated sensors, avionics and datalink systems when such systems are available. No other country has been developing AMDAR programs from regional fleets such that Canada had no expertise to tap on and has been breaking grounds in developing "alternative" AMDAR systems. CAPIT membership includes Environment Canada, the Canadian air carriers, NAV CANADA, the Coordinator of the US MDCRS Program, and the Technical Coordinator of the WMO AMDAR Panel.

Nevertheless Canada now has a successful growing AMDAR Program with, as of 2 February, 2005, 41 aircraft from Air Canada Jazz reporting valid temperature and wind data. By February 2006 Jazz will be operating a total of 65 AMDAR-capable CRJ across Canada and by November 2005 about 67 DHC-8 will have been upgraded to provide AMDAR data. Data from Air Canada Jazz began distribution on GTS and internal EC circuits on 4 January 2005. The Canadian AMDAR messages are distributed by CMC as BUFR FM94 messages with the following headers in conformity with WMO guidelines: IUAA01 CWAO (for data 90W and east) , and IUAB01 CWAO (for data west of 90W). Each aircraft is uniquely identified by an aircraft identifier of the form CNXXXYYY where XXX are 3 alphabetic characters and YYY is a number. Real-time horizontal and vertical tephigram representations of the Canadian AMDAR data have been available from the FSL automated aircraft data web site (http://acweb.fsl.noaa.gov/java/) to the "ec.gc.ca" domain since 12 January

2005. In parallel, proof-of-concept AMDAR alternative systems for First Air, Canadian North and the smaller air carriers are about to be tested and WestJet is about to join the program.

Progress on the development of the Canadian AMDAR Program and plans for the future, including plans to expand the program to include humidity, icing and turbulence will be presented.

4:15 PM

2E2.1
Impacts of seasonal variability and temperature on foodborne disease
Manon Fleury [1], *Dominique Charron* [4], *John Holt* [2], *Abdel Maaroug* [3], *Brian Allen* [2]
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The incidence of enteric infections in the Canadian population varies seasonally, and will therefore be expected to change in response to climate change. In order to explore this possibility further, we investigated the potential shift in the seasonal patterns of selected enteric pathogens in Canada. The data consists of three enteric pathogens, *Salmonella*, *E. coli* and *Campylobacter*, from the National Notifiable Disease registry for two Canadian provinces, Alberta and Newfoundland-Labrador, for the years 1992 to 2000. The project looks at the relationship between weekly occurrence of enteric illness and temperature, looking particularly at the effect of seasonal adjustments on the estimated models. This paper also explores different types of methodology for time series analysis, the most widely used method in environmental health research, using generalized additive models. The results reveal a significant increase in temperatures and illness for the province of Alberta and this increase is more pronounced in the summer compared to the winter months. Data from Newfoundland-Labrador on the other hand, suggests very little response due to temperature but this may be the result of a large number of under-reported cases of illness in the province. Further analysis using zero-inflated methods should be considered.

4:30 PM
2E2.2
The BC Avian Influenza Outbreak: atmospheric transport as a possible propagation mechanism
Real D'Amours [1], *Caroline Dubé* [2]
(Presented by / Présenté par ***Real D'Amours***)
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An outbreak of Highly Pathogenic Avian Influenza (H7N3) occurred in the Lower Fraser Valley area of British Columbia, from March 8 until June 4, 2004. Despite the application of a high risk area where intense depopulation activities and movement restrictions where applied by the Canadian Food Inspection Agency, the virus spread outside this area. In total, three distinct clusters with high viral activity were observed. In these clusters, virus is believed to have spread not only by traditional methods such as contaminated equipment, vehicles, people, etc…, but also by the dispersion of contaminated dust particles in the atmosphere. Environmental sampling allowed the detection of viral material in the air at some distance from an infected barn during the outbreak, supporting this hypothesis.

The atmospheric transport hypothesis is analyzed in this presentation. Issues relating to virus production and emission rates through barn ventilation systems are discussed. Problems associated with short range dispersion in very low wind speed are presented. Results from simulations with numerical dispersion modeling are shown for specific cases and the likelihood infection propagation by dispersing plumes is evaluated.

This study received financial support the CBRN Research and Technology Initiative project CRTI 02 0066RD

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2E2.3
A possible role of high impact weather events in waterborne disease outbreaks in Canada, 1975-2001
M. Kate Thomas [1], *Dominique F. Charron* [1], *David Waltner-Toews* [5], *Corinne Schuster* [4], *Abdel R. Maarouf* [3], *John D. Holt* [2]
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Background:
An adequate supply of safe water is vital to health and wellbeing. Canadians' awareness of the risks associated with a contaminated water supply has been heightened by recent outbreaks of *Escherichia coli* O157:H7, *Campylobacter*, and *Cryptosporidium*. The main objectives of this research were to describe the incidence and distribution of waterborne disease outbreaks in Canada in relation to preceding weather conditions and to test the association between high impact weather events and waterborne disease outbreaks.

Methods:
We examined extreme rainfall and spring snowmelt in association with 168 Canadian waterborne disease outbreaks between 1975 and 2001, using case-crossover methodology. Explanatory variables including daily rainfall amount, air temperature, and peak stream flow were used to determine the relationship between high impact weather events and the occurrence of waterborne disease outbreaks.

Results:
We found that both total maximum degree-days above 0^{o}C and maximum accumulated rainfall percentile were associated with risk of outbreak. For each degree-day above 0^{o}C the relative odds of an outbreak increased by a factor of 1.007 (95% confidence interval [CI] = 1.002- 1.012). We dichotomized maximum accumulated rainfall percentile and found an increased risk at the 93rd percentile. For rainfall events greater than the 93rd percentile the relative odds of an outbreak increased by a factor of 2.283 (95% [CI] = 1.216-4.285).

Conclusion:
These results suggest that warmer temperatures and extreme rainfall are contributing factors to waterborne disease outbreaks in Canada. This could have implications for water management and public health initiatives.

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2E2.4
Weather and air pollution as triggers for heart disease
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Weather and air pollution have been implicated as triggers for heart disease. While the associations have also been studied for stroke, the findings have been equivocal. Many previous studies have been limited by the inability to adequately model short-term variations in exposure. We used a case-crossover design to evaluate the relationship between weather, air pollution, and emergency room visits for myocardial infarction and stroke in an Ottawa hospital between 1993 and 2000. A total of 2,042 emergency room visits were observed for myocardial infarction, and 5,597 discharges for stroke. Meteorological conditions and air pollution exposures were defined using hourly readings from fixed-site monitoring stations. Conditional logistic regression was used to compare meteorological conditions and air pollution exposure for various time-intervals leading up to the time of the visit to control periods occurring one week before and afterwards. Positive associations between cold temperature and snowfall were associated with an increased risk of visits for myocardial infarction among the elderly. For example, snowfall was associated with a 26% increase in the risk of an emergency room visit for myocardial infraction in following 12 hours. No associations with stroke were observed for these two factors. This study characterizes the joint effects of weather and air pollution on the risk of an emergency room for myocardial infraction and stroke. These analyses underscore the important of meteorology and air pollution as an important determinant of hospital utilization.

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2E2.5
An Automated Synoptic Typing Procedure to Predict Heat-Related Mortality Occurrence in South Central Canada
Chad Shouquan Cheng [1], *Qian Li* [2], *Heather Auld* [6], *Guilong Li* [2], *Monica Campbell* [5], *Nancy Day* [5], *David Pengelly* [4], *Don MacIver* [3], *Joan Klaassen* [2]
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Extreme heat waves are responsible for a greater number of deaths in the world than most other atmospheric hazards (e.g., floods, hurricanes, blizzards, ice storms). In this study, an automated synoptic typing and logistic regression analysis were applied together to predict occurrence of heat-related mortality for 4 selected cities (Ottawa, Montreal, Toronto and Windsor) in South Central Canada. Meteorological data used in the analysis included six-hourly surface observations and three atmospheric levels of six-hourly U.S. NCEP (National Centers for Environmental Prediction) upper-air reanalysis weather variables of air temperature, dew point, sea-level air pressure, total cloud cover, and wind speed and direction. The complete methodology was evaluated by randomly selecting one-third of the total years for the weather, air pollution and mortality data to validate the developed models. The remaining two-thirds of the total years were used for model development. The synoptic typing was comprised of principal components analysis, an average linkage clustering procedure, and discriminant function analysis. The classification procedures were able to identify the hot weather types. Stepwise logistic regression was performed on the days within each of the hot weather types to analytically determine the meteorological variables that can be used as forecast predicators for the likelihood of the heat-related mortality occurrence. There was a significant correlation between the occurrence of heat-related mortality events and the modeled results across the study area. The model detection accuracy was very high—85–100%—when using an elevated mortality forecast likelihood of 0.9, representing a 90% probability that excess mortality would occur that day due to heat. The heat-health prediction models resulting from this study could serve as the basis of a heat-health warning system for each of the cities, using the different likelihood thresholds of elevated mortality occurrence in practice (e.g., 0.9, 0.8, and 0.6).

(INVITED/INVITÉ) 4:15 PM

2E5.1
Confessions of A Weather Weenie
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In my job, I have had the good fortune to talk to thousands of Canadians in school gymnasia, community centres, cow barns, churches, curling clubs, a saloon on the Alaska Highway, and broadcast studios. I've spent half my career trying to figure out why Canadians are so outwardly disgusted by the weather, yet so secretly proud of the same weather often at the same time. I've answered questions about the weather, listened to complaints, and tried to explain meteorology to thousands of Canadians. Conveying scientific information about
the environment without oversimplifying the complexities and obscuring the uncertainties is an enormous challenge we face daily. In communicating science, it is important to never lose sight of your audience, their needs, concerns, and interests.

In explaining weather and climate, I use several vehicles to reach ordinary Canadians: through the media (print, radio and television); public talks; writings in publications; magazines; books and the Canadian Weather Trivia Calendar. I want to share with you my experiences - both good and bad – in talking about the weather especially through the media and to the public. I also want to explain why weather is so important to Canada and Canadians.

(INVITED/INVITÉ) 4:45 PM

2E5.2
Benefits Of An Operational Relationship Between A Television News Organization And The Portland, OR, National Weather Service Office
Matthew Zaffino
KGW TV
Contact:mzaffino@kgw.com

The benefits of a good communication and a positive working relationship between television meteorologists and their local National Weather Service Office will be presented.

5:00 PM

2E5.3
Hurricane Juan vs. the Tropical Punch ; Perfect Forecasts, Imperfect Perceptions
David Jones
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Even a perfect forecast can be judged a bust by the media and the public. Some communication strategies that succeeded with the Tropical Punch may have helped with Hurricane Juan.

(INVITED/INVITÉ) 5:15 PM

2E5.4
Open discussion: defining a broadcast meteorologist, and the role of CMOS in endorsing such an individual.
Claire Martin
Global TV
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CMOS has recently started to see applications for on-air endorsements of broadcast meteorologists rise. as far as a potential for a simple revenue generating program goes, this rise is welcome within the society.However, on a more fundamental and scientific level, there are valid concerns appearing on this somehwat lucrative horizon.

1. What is the definition of a broadcast meterologist? should CMOS, the government, wmo decide the definition?
2. How much academic background is considered "adequate" when someone wishes to be known as a meteorologist?
3. Knowing that roughly 90% of canadians get their weather information from the media (radio/tv/newspapers), should CMOS play a more active role in ensuring the quality of the broadcaster?

This open discussion will address some of these concerns. all are welcome and encouraged to take part.

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2E6.1
The Research Support Desk at the Ontario Storm Prediction Centre
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National Laboratories are being commissioned at MSC regional weather centres across Canada. Their goal is to enhance technology and knowledge transfer via co-location of MSC forecasters and researchers. The Research Support Desk (RSD) concept takes this one step further and facilitates the interaction of forecasters and researchers in real-time during high-impact weather events. Forecasters are exposed to new techniques, tools and data, while researchers get a chance to apply their work in real time and gain first-hand knowledge of the science gaps facing operational meteorologists.

A Research Support Desk was implemented on a trial basis during the warm season of 2004. The desk, located in the operations area of the Ontario Storm Prediction Centre, was staffed by a researcher familiar with the operational environment. The scientific focus was on mesoscale analysis and nowcasting of severe summer weather using an MSC-designed object-oriented prototyping platform called Aurora. At the end of the trial, a survey was conducted to gauge the forecaster response to the initiative. The survey showed:

- a high degree of comfort with a research presence in the operational area,
- a perception that the desk contributed positively during severe weather events,
- an enhanced learning environment was established, and
- a strong interest in continuing the initiative into the future.

More details on the Research Support Desk initiative and results from the first season will be presented at the Congress. Plans for the 2005 warm season will also be discussed.

4:30 PM

2E6.2
The Edmonton Hailstorm of 2004: Integrating Hail, Convective Precipitation and Lightning Forecasts
Julian Charles Brimelow [1], *Gerhard Reuter* [1], *William Burrows* [2], *Bob Kochtubajda* [2], *David Patrick* [2]
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On the afternoon of 11 July 2004, a severe hailstorm caused almost 200 million dollars of damage in Edmonton. Hailstones up to the size of golfballs were reported; hail also clogged stormwater drains, resulting in localized flooding. On the same day, baseball-sized hail was reported over southern Saskatchewan, making this an opportune day to test the ability of the GEM/HAILCAST model to predict the size and distribution of hail for two widely separated events.

Hail forecast maps produced using prognostic GEM soundings and the HAILCAST model for this day will be presented. While GEM/HAILCAST predicted the distribution and size of hail with a fair degree of accuracy, the area forecast to be affected by hail was much larger than the area from which hail reports were received. Previous research with HAILCAST has also noted this tendency to overestimate the area at risk of hail and to sometimes forecast hail on days when no deep convection was observed.

To address this shortcoming, the viability of using forecast convective precipitation and probabilistic lightning fields from the GEM model to identify convective initiation areas are also presented. It was found that by only accepting hail forecasts over areas where convective precipitation or lightning was predicted, the area forecast to be affected by hail could be reduced while still accurately identifying those areas where hail was observed. Results from this integrated approach to forecasting hail will also be presented for several severe hail days and null hail days across the Canadian Prairies during the summer of 2004.

4:45 PM

2E6.3
Satellite use for fog nowcasting and cloud phase detection
Ismail Gultepe , Janti Reid , George Isaac
(Presented by / Présenté par ***Janti Reid***)
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Satellite data can play an important role in a decision support system for weather forecasting. It is a continuous source for environmental and weather-related information on a large spatial scale, generally unmatched by other types of observations. In this study, observations from the GOES-12 satellite and surface stations are analyzed to detect fog areas and cloud phase. Two types of fog are examined: 1) warm fog when air temperature (T_a) > 0(C and 2) steam fog when T_a < 0(C. An algorithm is developed to recognize fog areas using GOES observations and results from a numerical model. Fog thickness is calculated using model surface temperature (T_s) and cloud (fog) top temperature (T_t) measurements obtained from the GOES infrared (IR) channel. A temperature difference | T_t-T_s | < 10(C is used as a criterion for removing high and mid-level clouds from the suspected fog areas. Cloud phase is then obtained using an algorithm involving a combination of GOES channels including near-IR (channel 2) and IR (channel 4) observations. The most important criteria in analyzing fog are the difference between channel 2 and channel 4 brightness temperatures and channel 2 reflectance > 8%, both which possibly indicate liquid phase. At colder temperatures, ice fog areas (e.g. steam fog in the winter time) can also be identified using GOES imagery. Fog and cloud phase detection for night-time conditions become more complicated when reflectance from the near-IR channel is not available. Results using this algorithm are found to be consistent with surface observations. Using empirical relationships, visibility and droplet number concentrations are also estimated when liquid phase is present. Such satellite-derived products can be valuable input to nowcasting systems, for example in producing short-term terminal area forecasts. These results show that a satellite-based fog detection algorithm has the potential to be used operationally every 15 minutes for nowcasting and in long-term studies of fog climate.

5:00 PM

2E6.4
A fuzzy logic based analog forecasting system for ceiling and visibility
Bjarne Hansen
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WIND-3 is a prototype analog forecasting system that produces probabilistic predictions of cloud ceiling height and horizontal visibility at airports. For data, it uses historical observations (climatology), current observations (METARs), and model-based guidance. To find analogs, it uses a fuzzy logic based algorithm to measure similarity between historical conditions and current conditions (a composite of recent METARs and model-based guidance). It uses the found analog ensemble (or nearest neighbors) to make probabilistic predictions of ceiling and visibility in the 0-to-24 hour projection period. WIND-3 has been tested by running continuously for six months producing forecasts for all major Canadian airports, and it produces highly accurate forecasts, based on summaries of POD, FAR, and CSI statistics, and compared to benchmarks (persistence and TAFs). WIND-3 produces a large amount of information every hour which is challenging for forecasters to routinely factor into their decision-making processes. We will discuss some types of visual displays of being considered to more effectively convey significant information to forecasters.

4:15 PM

2E7.1
Sea-Ice and Ocean Variability in Response to Different Wind Forcing Fields, with Application to the Little Ice Age
Jan Sedlacek [1] , *Jean-Francois Lemieux* [1] , *Bruno Tremblay* [2] , *Lawrence A Mysak* [1]
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The granular rheology sea-ice model, developed by Tremblay and Mysak (1997), has been transformed to spherical coordinates and coupled to the UVic Earth System Climate Model, version 2.6. In the first phase, the newly coupled model is run with different wind forcing fields to test the sensitivity of the sea-ice model in both hemispheres, and we investigate the interactions of the sea-ice cover with the global ocean circulation. This insight is then used to investigate different interactions during the Little Ice Age. This time period has received considerable attention during the past few years (e.g., Climatic Change Vol. 48 Iss. 1, 2001), but several questions are still unanswered. The focus of earlier work has usually been on atmospheric and oceanic processes and interactions (e.g., Crowley, 2000; Broecker et al., 1999), whereby the role of sea ice has been largely ignored. We use the UVic Model with the granular sea-ice rheology to investigate the processes and climate system interactions during the Little Ice Age that involve the sea-ice cover and its variability.

4:30 PM

2E7.2
Response of the ocean, climate and terrestrial carbon cycle to the receding Laurentide Ice Sheet
Yi Wang , *Lawrence A. Mysak*
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The "green" McGill Paleoclimate Model is run between 8 and 0 kyr BP under variable insolation (Milankovitch forcing), Taylor Dome CO_2 (radiative forcing) and four prescribed meltwater scenarios (freshwater forcing) due to the retreat of the residual Laurentide Ice Sheet. For each scenario, we constrain the total volume of meltwater to be 1.62×10^{15} m^3 (sea level equivalent of 4.62 m), which is obtained from reconstructed sea level change during 8 to 6 kyr BP and the work of *Paterson* [1972]. The model simulations indicate the followings: i) During each freshwater perturbation, the maximum Atlantic meridional overturning circulation (MOC) intensity is reduced, by amounts up to 8 Sv, but it rebounds to a higher level than the original state, within 10 to 20 years after the termination of the freshwater input. We argue that this rebound results from enhanced salt advection from the subtropical Atlantic. ii) The weakened MOC reduces the SST in the high-latitude North Atlantic and increases the SST in the Southern Ocean due to decreased northward heat transport. iii) The magnitude of freshwater perturbation has its most important impact on the Holocene climate and terrestrial carbon cycle. This is due to the enhanced cooling of 3^oC associated with the appearance of North Atlantic sea ice.

4:45 PM

2E7.3
The Scotian Slope Water and the Gulf Stream
Frederic Dupont [1] , *Charles Hannah* [2]
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The ocean region bounded to the south and east by the Gulf Stream and the north and west by the continental shelf-break, is called the Slope Water region. The primary sources of water to the region are warm salty water from the Gulf Stream and cold fresh water from the Labrador Current (McLennan, 1957; Gatien, 1976 and Fairbanks, 1982). The resulting water properties are colder and fresher than the Gulf Stream despite tremendous eddy activity. In numerical model simulations the failure to maintain a viable Slope Water mass is linked to poor Gulf Stream separation; the common problem where the Gulf Stream fails to separate at Cape Hatteras and remains in contact with continental shelf much further north. However the cause and effect relationships are not clear. Using four years of high resolution model output (Smith et al., 2000), we address the origin of the eastward Slope Water jet observed in hydrographic sections (Pickart et al., 1999).

5:00 PM

2E7.4
Paleotides in the Bay of Fundy and Gulf of Maine
D.A. Greenberg [1] , *Jason Chaffey Fisheries and Oceans Canada* [2] , *John Shaw Geological Survey of Canada (Atlantic)* [2]
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Scott and Greenberg modelled the paleotides in the Bay of Fundy and Gulf of Maine in 1983 (Can. J. Earth Sci.). Since that computation, more sophisticated models of the paleogeography (e.g Shaw et al., 2002. Quat. Sci. Rev) and the hydrodynamics (e.g Greenberg et al., 2005. Ocean Modelling) have been developed. In this presentation we use these updated tools to examine how the changing topography could have affected the tides. We speculate how in addition to different relative sea level changes, erosion might have had a strong influence. The factors influencing past tidal regimes are related to climate induced changes predicted for the next century.

4:15 PM

2E8.1
Water Balance of Forest, Clearcut and Regenerating Stands
D. Spittlehouse
(Presented by / Présenté par ***Dave Spittlehouse***)
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Forest cover influences the balance between input of water (precipitation) and output (evaporation and drainage) from the soil. Measurements of precipitation interception by forests and soil water content were used to determine the annual water balance of lodgepole pine forest, clearcut and a regenerating stands from October 2002 to October 2003. Snow and rainfall interception were measured for the forests, soil water content was measured using time domain reflectometry and drainage was calculated using a water balance model calibrated for the sites. Annually, interception of precipitation by a forest reduced the amount of water reaching the forest floor by 25%. Biweekly average evaporation rates (transpiration plus evaporated interception and soil evaporation) in the summer were about 2 mm d^{-1} for the forests and regenerating stand when the soil was moist and only slightly less than this for the clearcut. Soil drying during the summer reduced the clearcut evaporation rate to less than half that of the forests. Over the summer, evaporation of intercepted water and transpiration from a forested surface exceeded evaporation from a recent clearcut by 30%. Removal of forest cover increased the amount of water available for surface and subsurface runoff to streams by 50%. A large part of this was due to the reduction in interception of precipitation. Evaporation from the 10-year-old regenerating stand during the summer was similar to that from the forest. However, interception of precipitation was smaller so that 38% more water was available for runoff than in the forest.

4:30 PM

2E8.2

Investigation of Water Balance using CLASS on Goose Creek near Churchill, Manitoba, Canada

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Atmospheric changes in the state of Hudson Bay (HB) seem to exert a strong influence over the Hudson Bay Lowland (HBL) with regard to terrestrial hydrology, as well as surface and sub-surface biophysical processes. Land surface heat and water budgets will respond to varying temperature and humidity regime in response to a changing HB, which may in turn, provide feedback and affect HB. These processes will be measured and simulated as part of Theme 3 of the ArcticNet NCE project.

The purpose of this study is to investigate the energy and water balance over Goose Creek near Churchill, Manitoba, in order to understand the carbon processes of this area. As the land surface regime dominates terrestrial carbon storage, investigation of the water balance is required to understand interactions between carbon processes and water cycling. Energy fluxes from the land surface are affected by temperature and moisture phase changes in the subsurface; as well, water storage is also influenced by these same temperature and phase changes influences, especially those related to active layer depth.

The Canadian Land Surface Scheme (CLASS), a land surface parameterization scheme for use in large scale climate models, was assessed using the observed climate data in the Churchill area. CLASS treats the land surface as a composite of three main elements: vegetation, soil and snow. The drainage parameters related to vegetation and topography over the area of interest are set up using SRTM DEM and LANDSAT7 satellite images.

The flat topography of the area combined of the length of the cold winter season leads to inaccurate runoff measurements. Therefore, the observed runoff data from the Goose Creek basin requires significant manipulation to correct for the influences of spring flooding and ice conditions.

The observed runoff data and climate data are used for modeling. The CLASS model evaluates the water balance in terms of precipitation, storage, runoff and evaporation. Runoff and storage data from CLASS are used in the hybrid hydrological model, formerly known of WatCLASS, to generate basin runoff and streamflow. The structure of WatCLASS is

undergoing significant modification which will include a strategy for coupling carbon sequestration processes using the CTEM model (Arora and Boer, 2005).

4:45 PM

2E8.3
Atmospheric Modelling of Mountain Pine Beetle Dispersal
Peter L. Jackson , Brendan Murphy , Brenda Moore
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The mountain pine beetle (Dendroctonus ponderosae Hopkins) outbreak in the central interior of British Columbia has reached epidemic proportions affecting 4.2 million hectares of forest and over 176 million cubic meters of timber based on trees killed prior to the 2003 flight. The mountain pine beetles emerge from the bark of host pine trees after they have reached biological maturity on days during July or August in which the temperature is between 18 and 30 C, with light winds and no precipitation. Peak emergence occurs over a few days when temperatures are greater than 25 C. Upon emergence, the beetles seek new host trees to colonize and produce larvae, relying on mass-attack to overwhelm the resistance of the pine tree. The atmosphere transports, disperses and can potentially concentrate the mountain pine beetle. The movements of mountain pine beetle (and other scolytids) associated with pheromone seeking activities within the forest canopy has received considerable attention. Movements above the canopy, in which the mountain pine beetle is largely advected by the mean wind, while recognized as being potentially important for long-range movement that can rapidly spread the infestation especially during epidemics, has been largely ignored. This study therefore focuses on the above canopy transport of the mountain pine beetle by the wind. The atmospheric conditions associated with peak emergence (light regional winds, high temperature, no precipitation) are also associated with the development of thermal circulations (anabatic flow, and valley winds), and with afternoon instability which mixes down more rapidly moving air from aloft, especially in the afternoon. The CSU RAMS mesoscale atmospheric numerical model is used to simulate the atmosphere during periods of peak emergence. RAMS simulated meteorological fields are assessed by comparison with surface wind observations. RAMS output is then used to develop forward trajectories from areas of known emergence and back-trajectories from areas of known new infestation. Additionally, mountain pine beetle movements are simulated using HYPACT, a lagrangian particle dispersion model that utilizes RAMS fields as input. The simulations give a better understanding of the between-stand movement of mountain pine beetles, and can therefore give a more complete picture of the historical and future redistribution of the mountain pine beetle population.

5:00 PM

2E8.4
Development of high spatial resolution climate data for British Columbia
D. Spittlehouse [1] , Tongli Wang [2] , Andreas Hamann [2]
(Presented by / Présenté par ***Dave Spittlehouse***)
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Applying climate data in resource management requires matching the spatial scale of the climate and resource databases. High quality spatially distributed climate normals for the 1961-90 period generated by the PRISM approach of Daly et al. (2002) are available for the United States and parts of Canada. However, the low resolution of PRISM data limits its use. In this study we downscaled gridded PRISM monthly temperature and precipitation data to scale-free point data through the combination of bilinear interpolation for all variables and elevation adjustment to temperature variables for British Columbia, Yukon Territories, the Alaska Panhandle, and part of Alberta and US. Downscaled PRISM data significantly improved predictions of the monthly data for an independent set of weather stations. Equations were developed to calculate normals of 11 additional climate variables including degree-days, number of frost-free days, frost-free period and precipitation as snow from monthly temperature and precipitation data. Values for these variables calculated from downscaled monthly data for a set of weather stations agreed well with the published normals for these stations. We also applied bilinear interpolation to future climate change scenarios generated by global circulation models and applied these to the downscaled data. A stand-alone MS Windows application was developed to perform the downscaling, calculations of additional climate variables and integration of future climates to predict climate variables for specific locations. We can also produce climate maps at 400 m resolution using digital elevation models.

4:15 PM

2E9.1
Future role of humans in the forecast process.
Kent Johnson , Patrick McCarthy Meteorological Service of Canada, WInnipeg, MB
(Presented by / Présenté par ***Patrick McCarthy***)
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In ten years, the Canadian weather service will be substantially different than it is today. Canadians will demand better forecasts and warnings, and they will receive these through an integrated network of private and public agencies. Canada's weather service role will be to provide weather and environmental information critical to the safety and security of its citizens and infrastructure, and to the effective management of a sustainable environment, economy and society. The weather service will be led by a group of expert professionals who incorporate state-of-the-art science and technology to fulfill its role. Recently, a vision was developed by the "Future Role of the Operational Meteorologist Committee". Though "forecasting", as it is known today, may vanish, an exciting and challenging future awaits operational meteorologists.

4:30 PM

2E9.2
State-of-the-Science Weather Forecasting in the Private Scctor - The Butterfly Effect
James W. S. Young [1] , *Bosko Telenta* [3] , *Zivorad Radonjic* [1] , *Brian McEwen* [2]
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This paper will discuss the rapid evolution of weather forecasting models over the last 2-3 years and the ability to run a state-of-the-science model on a desktop personal computer. Typical hour-by-hour forecasts out 240 hours covering all of Southern British Columbia or Southern Ontario using a 4-kilometre grid are taking single processor computer times of less than 6 hours. Some details of the FReSH-4 Weather Forecasting System (running the next generation WRF model – NMM) will be given. Some examples of the application of this model for a 4-km grid in Canada, a 2-km grid in Switzerland and Macedonia and a 100-metre resolution in British Columbia will be presented. Finally an example of the "butterfly effect" will be demonstrated for one unstable atmospheric situation in British Columbia.

(INVITED/INVITÉ) 8:15 AM

3A0.1
Air pollution in the Lower Fraser Valley, B.C.: Evolution, Measurement, Modelling, and Management.
Douw G. Steyn , B. Ainslie , I.G. McKendry
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The Lower Fraser Valley of British Columbia, Canada has experienced an evolution of air pollution not unlike that seen in many western, industrialized cities. We will review the evolution of air quality in the LFV, showing how it was first ignored, then monitored, and finally managed. We will show how air pollution in this region has changed in pollutant species, how this change has been detected, and studied. We will describe the four tools that make up the air pollution management system in this region – an extensive monitoring network, a stringent emissions testing programme, an Air Quality management Plan, and an active research community engaged in the problem. We will close by providing a perspective on what the future might bring.

(INVITED/INVITÉ) 9:00 AM

3A0.2
The tsunami of 26 December 2004 and its message to Canada
R.E. Thomson
(Presented by / Présenté par ***Richard Thomson***)
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At 08:59 Local Time (00:59 UTC) on December 26, 2004, a $M > 9.0$ megathrust earthquake occurred along 1000 km of the subduction zone west of Sumatra and Thailand in the eastern Indian Ocean. The seafloor displacements associated with this massive crustal event generated devastating tsunami waves which were responsible for over 200,000 dead and missing, millions of homeless, and untold property and infrastructure damage along the coasts of Indonesia, Thailand, Sri Lanka, and India. Major destruction and loss of life was also inflicted on Malaysia, Myanmar, and the Maldives Islands, as well as Somalia and Kenya along the east coast of Africa. Waves in excess of 35 m inundated parts of Sumatra and southern Thailand, while waves of over 10 m amplitude struck the coasts of India and Sri Lanka. Following its generation, the tsunami propagated quickly to the far corners of the world ocean with recorded amplitudes ranging from a few centimeters to several meters on the coasts of Australia, New Zealand, South Africa, Antarctica, the east and west coasts of North and South America, and the Pacific Islands. Waves from the Sumatra event – which was the first major tsunami to be detected by satellite altimetry – arrived on the east and west coasts of Canada after 30.5 and 32 hours, respectively.

The Sumatra tsunami provided the proverbial "wake up call" for the nations of the world and unleashed an intense media frenzy unparalleled in recent memory. In Canada, the event triggered renewed interest in tsunamis generated by megathrust failures along the Cascadia Subduction Zone off British Columbia and by submarine landslides in coastal basins and in the open ocean off British Columbia and the Maritimes. Key problems are the establishment of a Tsunami Warning Service in the Atlantic and the mitigation of possible tsunami impacts on both the Pacific and Atlantic coasts of Canada. This talk will discuss the science of the December 26 event and what it has taught us about earthquake-generated tsunamis and other types of catastrophic tsunamis – formed by both seismic and non-seismic events – that might affect Canada in the near future.

(INVITED/INVITÉ) 10:30 AM

3B1.1
The Canadian Global Coupled Carbon Climate Model (CGC3M)

Ken L. Denman [1], Greg Flato [2], Nigel Roulet [1]
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The Canadian Global Coupled Carbon Climate Model (CGC^3M) is a research network supported by the Canadian Foundation for Climate and Atmospheric Sciences (CFCAS), the Meteorological Service of Canada, and the Department of Fisheries and Oceans. Researchers from U. Victoria, UBC, U. Alberta, McMaster U., McGill U., the Canadian Centre for Climate Modelling and Analysis (CCCma), and MSC Downsview formed the network to develop a dynamic carbon cycle model and couple it to the CCCma's Global Climate Model (GCM). In almost all of the future climate projections undertaken with GCMs, the time-evolving atmospheric concentrations of CO_2, CH_4, and other greenhouse gases are specified externally rather than being computed internally from specified emissions. Results from the very few existing coupled carbon-climate models diverge markedly in the second half of the 21st century, with some models indicating accelerating CO_2 buildup as a consequence of reduced ability of the biosphere to store carbon. Reasons for the differences between model simulations remain unclear; however this potential positive carbon/climate feedback has profound implications for quantitative projections of future climate change, and for the development of policy measures to mitigate future change. As part of this collaborative network, we have developed global carbon modules for the terrestrial, oceanic and atmospheric components of the climate system, and these will be coupled into the Canadian GCM in 2005. This talk will provide an overview of the carbon cycle modelling project and its objectives. The individual model components will be described in more detail in following talks. Meanwhile the CGC^3M researchers are developing 2nd generation carbon cycle modules for coupling with the next generation climate model in 2-3 years, based on experience gained from the first generation coupled carbon climate model.

11:00 AM

3B1.2
The Canadian Model Of Ocean Carbon and its equilibrium carbon climate

Konstantin Zahariev [1], Kenneth L. Denman [3], James R. Christian [2]
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A global ocean carbon model, the Canadian Model of Ocean Carbon (CMOC), is described in its version 1.0 as part of a global coupled carbon model. It consists of CCCma's ocean general circulation model with an embedded inorganic chemistry module, a four-plus-one-component NPZD ecosystem model with dynamic chlorophyll, and a parameterized carbonate pump. The inorganic chemistry generally follows OCMIP2 guidelines. Phytoplankton growth in the model is limited by light, nutrients, and iron. Iron limitation is applied as a geographical mask based on annual minimum observed nitrate concentrations. Phytoplankton loss also occurs through aggregation. Variable Chl:C ratio (as Chl:N through a constant Redfield ratio) has been implemented to account for phytoplankton photoacclimation to light availability. A simple representation of nitrogen fixation by diazotrophs has been implemented. Stand-alone CMOC integration to a preindustrial equilibrium shows the model ecosystem and global ocean carbon in general agreement with data estimates. CMOC reproduces both global mean estimates and spatial distributions of various indicators of the strength of the biological pump, and the spatial distribution of the air-sea exchange of CO_2 is consistent with spatial patterns of present-day flux estimates.

11:15 AM

3B1.3
Modelling the soil consumption of atmospheric methane

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The consumption of atmospheric methane in soils accounts for 5 to 10 percent of the global annual sink of this important greenhouse gas. This microbial oxidation process is primarily controlled by the ease with which gas diffuses through the

upper soil layers, which in turn is strongly modulated by soil moisture content. Factors of secondary importance are the surface air temperature and the methanotrophic oxidation rate. A successful modelling approach must therefore employ, at the very least, a variegated soil model coupled to a hydrological scheme and surface climatology. With a view toward future climate modelling applications, we formulated a diffusion-consumption scheme for methane for use with the Canadian Land Surface Scheme (CLASS). We base the treatment on an exact solution of the one-dimensional diffusion-consumption equation valid for homogeneous oxidation within the uppermost soil layer. By forcing CLASS with a 21-year global (land) meteorology, the spatiotemporal behaviour of methane consumption at various sites around the globe is revealed. Preliminary results of this project will be reported.

11:30 AM

3B1.4
An overview of the Canadian Terrestrial Ecosystem Model (CTEM)
Vivek Arora [1], *George Boer* [2]
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The Canadian Centre for Climate Modelling and Analysis (CCCma) is currently working towards a framework in which the concentrations of greenhouse gases (GHGs) are prognostically modelled rather than being externally specified. CO_2 is the primary GHG and terrestrial and oceanic ecosystem models that simulate the land-atmosphere and ocean-atmosphere exchanges of CO_2 are currently being implemented in the CCCma climate model. This presentation provides an overview of the Canadian Terrestrial Ecosystem Model (CTEM), the terrestrial ecosystem component of CCCma's coupled carbon-climate model, and illustrates the manner in which it models a variety of land-surface ecosystem processes. CTEM is a dynamic vegetation model that is able to grow vegetation from bare ground and incorporates the processes of photosynthesis, autotrophic and heterotrophic respiration, allocation, phenology, turnover, mortality, fire, competition between plant functional types (PFTs) and land-use change. In the coupled model CTEM serves two primary purposes 1) it provides fluxes of CO_2 that are exchanged between the atmosphere and the terrestrial biosphere, and 2) it provides time-varying climate-dependent estimates of vegetation structural attributes that are used by the Canadian Land Surface Scheme (CLASS) in its energy and water balance calculations.

11:45 AM

3B1.5
Holocene climate and carbon cycle dynamics: Experiments with the "green" McGill Paleoclimate Model
Yi Wang [1], *Lawrence A. Mysak* [1], *Nigel T. Roulet* [2]
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An inverse method is used to investigate the global carbon cycle from the early Holocene (8 kyr BP) to the end of the pre-industrial period (0 kyr BP) in an improved version of the "green" McGill Paleoclimate Model (MPM). In this paper we now take into account the vegetation-precipitation feedback and evaluate the terrestrial carbon cycle for the pre-industrial equilibrium. From our coupled transient simulation under orbital forcing, reconstructed (Taylor Dome) atmospheric CO_2 forcing and a prescribed retreating Laurentide Ice Sheet (LIS), we find a decrease of 70 PgC in total carbon storage in the Sahara desert, which is caused by the desertification simulated in the green MPM. The above decrease is partially compensated by an increase of 40 PgC in total carbon storage in the Southern Hemisphere from 8 to 0 kyr BP. From an analysis of the total carbon storage changes in the boreal forest, we can infer the following treeline changes: (1) a northward shift (increased carbon storage) from 8 to 6 kyr BP, and (2) a southward shift (decreased carbon storage) from 6 to 0 kyr BP. From our model results, we further conclude that the retreating of the LIS, associated with the vegetation-albedo feedback, causes the global terrestrial carbon storage to increase by about 20 to 31 PgC from 8 to 6 kyr BP. The application of the inverse method suggests that the first 10 ppmv increase in atmospheric CO_2 concentration from 8 to 6 kyr BP comes from the oceanic carbon pool (including the sedimentation process). Finally, in the model simulations, the total carbon release from the land from 6 to 0 kyr BP is about 68 to 95 PgC, which would produce about a 5 to 7 ppmv atmospheric CO_2 increase, based on the calculation of *Joos et al.* [2004]. Due to our model limitation (there is no ocean carbon cycle), we cannot conclude whether the overall oceanic CO_2 release from 8 to 0 kyr BP is due to outgassing related to SST changes or to calcite compensation as proposed by *Broecker et al.* [2001].

10:30 AM

3B2.1
Simulating the atmospheric energy cycle in AMIP models
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The atmospheric energy cycle reflects the basic "rate of working" of the system whereby available potential energy is generated, converted into kinetic energy and subsequently dissipated. The various forms and conversions of energy cycle components involve essentially all of the basic first and second order climate statistics (i.e. means, variances and covariances) of atmospheric quantities. The ability of models to reproduce the energy cycle is a basic test. Estimates of the terms in the energy cycle are obtained from reanalysis and compared with the results from the models in the AMIP intercomparison. The utility of the "mean model" concept is tested by comparison with the suite of model results.

10:45 AM

3B2.2
Sensitivity of the CRCM predicted climate change over North America
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Over the past several years, the Ouranos Climate Simulations group has generated several climate change projections over North America with the Canadian Regional Climate Model (CRCM) driven by CGCM2 transient CO2 simulations. During that period, new developments in both physical parameterizations and nesting techniques, made possible the use of the CRCM in different configurations.

A preliminary analysis of these simulations shows that recent and future simulated climates are affected by changes in the CRCM configuration. Although this ensemble of simulations is incomplete, the CRCM climate archives are now sufficiently large to estimate the sensitivity of the climate change signal to modifications in various parameters of the CRCM experimental setup.

Depending on the season, the climate of a domain sub-region can be dominated by dynamical or physical processes. The effect on the simulated climate of a change in the model configuration depends on the dynamical or physical nature of the dominant processes of the sub-region. Despite the fact that all climate simulations show some biases, the robustness of the predicted CRCM temperature and precipitation climate change signal over different regions will be investigated by comparing different seasonal climate statistics.

11:00 AM

3B2.3
On the Fingerprint of the Dehydration-Greenhouse Feedback
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In the context of global warming, the observed Arctic climate can deviate substantially from model simulations based on variation of greenhouse gases alone. On a regional basis, the indirect effect of aerosols on clouds and precipitations can modulate significantly the global trend. One of the identified modulating processes in the Arctic is the dehydration-greenhouse feedback. During the cold season, long range transported sulphur dioxide and sulphate compounds in the Arctic airmass, preferentially from Europe, are known to produce sulphuric acid coating onto all existing otherwise pristine aerosol particles. As a consequence, the homogeneous freezing point is depleted by as much as 10°C depending on acid concentration in wet aerosol mixtures. This effect inhibits the formation of ice crystals and favours production of fewer but larger crystals that sediments more rapidly and dehydrates the lower troposphere. In return dehydration rate controls the infrared cooling and the production rate of cold Arctic airmasses. Water, gaseous, liquid or solid, is by far the strongest greenhouse component in the Earth atmosphere. In this context, the potential for regional alteration of climate is very significant. The process has been investigated by several numerical simulations, leading to a fingerprint of the process. The

new challenge is to use new satellite instruments to detect and assess the predicted fingerprint of the dehydration-greenhouse feedback process.

11:15 AM

3B2.4
A Comparison of Two Downscaling Methods to Determine Site-Specific GCM-Simulated Temperature Changes in the NWT

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Current global climate models (GCMs) project an overall global mean temperature increase of 1.4 – 5.8ºC by 2100 relative to 1990 (IPCC, 2001). However, annual average Arctic temperatures are increasing more rapidly than elsewhere (ACIA, 2004). Melting permafrost in the in the NWT due to climate warming has significant consequences making the area an appropriate choice for temperature change analysis.

Due to local climate forcing, the coarse grid size of global climate models doesn't resolve local climate changes well. Impacts of climate change can be better assessed with projections from data on a smaller spatial scale. This study compares two approaches to generate higher resolution data: a statistical downscaling technique and a weighted average method. The Statistical Downscaling Model (SDSM), developed by Wilby et al. (2001), uses a predictor-predictand relationship to determine a set of climate variables. The weighted average method uses a central GCM grid cell and its eight surrounding neighbours. The cosine of each cell's latitude is used for calculating the areal weighting. These techniques were applied at 5 sites in the NWT including, Inuvik, Norman Wells, Yellowknife, Fort Simpson, and Fort Smith. The Canadian CGCM1 and the British HadCM3 global climate models were used.

The two downscaling methods were tested to determine how well they reproduced observed temperatures before comparing projected future temperatures. In general, both methods performed reasonably well in reproducing the observed temperatures. The overall average for the five sites showed the SDSM produced temperatures -0.04˚C from the observed and the weighted average produced temperatures 0.7˚C from the observed. The averages are quite similar. However, the maximum variation for the weighted average method ranged as much as 10.4˚C to -8.1˚C away from the observed temperatures overall, while the SDSM only ranged from 3.5˚C to -3.2˚C away from the observed. The majority of the far outlying values can be attributed to the CGCM1 model. The HadCM3 model produced better results than the CGCM1 model with both approaches.

Once the future temperatures were projected, both methods showed an increase of annual temperature in the area of study for three future time periods. These time periods are as follows: the 2020s (2010-2039), the 2050s (2040-2069), and the 2080s (2070-2099). The SDSM and areal weighted results both show a warming in the NWT areas to be consistent with GCM output. With the higher resolution data a stronger warming in the northern regions of the NWT, compared to the southern regions, is evident. The output from both approaches shows a projected temperature increase of approximately 2.5 – 5ºC by the 2080s.

References:
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3. Wilby, R.L., Dawson, C.W. and Barrow, E.M. Environmental and Modelling Software, 17. 2002.

11:30 AM

3B2.5
Internal variability in regional climate downscaling

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It has been shown that high-resolution fields generated by Regional Models are not fully conditioned by the information provided at the boundaries by Global Models or Objective Analyses. Usually called *internal variability*, this characteristic is, in global models, responsible for the total loss of correlation among integrations differing only in the initial conditions. In regional models; however, the magnitude of this correlation is dependent on the dynamics of each particular synoptic situation.

The aim of our study is to investigate the internal variability using an ensemble of simulations differing only in initial conditions with the Canadian Regional Climate Model (CRCM). This experiment considers the study of a single season and results show that in addition to the daily variation, differences among simulations do not become negligible after averaging for the entire season. As a consequence of the use of a large number of members in the ensemble, we are able to evaluate the geographical distribution of internal variability. This shows that in certain regions the spread is large enough to justify the use of ensembles of simulations when seasonal climate downscaling is performed.

11:45 AM

3B2.6
Climate variability from the instrumental record in northern British Columbia
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Climate records for 210 meteorological stations in northern British Columbia, spanning the period 1886-2003, were obtained from the Meteorological Service of Canada and analyzed for climate variability and trends. The study area extends from about 54^{o} North latitude to slightly north of the Yukon-British Columbia border (60 ^{o}). At each station, daily climate data were used to calculate monthly and yearly trends in total precipitation and mean, maximum, and minimum temperatures. Yearly analysis was completed only for the 160 stations with at least 10 consecutive years of data. The stations were grouped into 15 regions, defined on the basis of physiography and macroclimate. Regional trends were calculated using weighted averages to account for the different lengths of the station records.

Since the beginning of instrumental observation, precipitation has increased in 11 of the 15 regions in northern British Columbia. Three regions show no significant trend, and precipitation has decreased in the central Rocky Mountains. The largest increase in precipitation is approximately 18%, in the Northern Columbia Highlands/Northern Columbia Mountains/Western Continental region. All regions have experienced an increase in mean temperature, with the exception of the Northern Columbia Highlands/Northern Columbia Mountains/Western Continental region, where there is no significant trend. The greatest warming, 1.31^{o}C, is in the Skeena Mountains/Omineca Mountains region. Maximum temperature has increased in 9 of the 15 regions. Three regions, all east of the Rocky Mountains, have experienced a decrease in maximum temperature, and three regions have had no significant change. The greatest increase in maximum temperature, 1.14^{o}C, is in the Boreal Mountains and Plateau region. Minimum temperature has increased in 14 of the 15 regions, the lone exception being the northern Columbia Highlands/Northern Columbia Mountains/Western Continental region. Minimum temperature showed the largest change of the three temperature parameters; the greatest increase, 4.39^{o}C, is in the Fraser Basin.

Cumulative deviations from the station mean were also calculated for total precipitation and mean temperature to detect the influence of the Pacific Decadal Oscillation (PDO) in northern British Columbia. The shift from the cool to warm phase of the PDO in the mid-1970s was noted at most climate stations. Stations with the longest records also showed phase shifts in the mid-1940s (warm to cool) and the mid-1920s (cool to warm). Some stations, especially those close to the Pacific coast, show dry (wet) periods corresponding to the cool (warm) phase of the PDO whereas some inland stations show the opposite.

10:30 AM

3B3.1
Subtidal Current in the Narrows of St. John's Harbor
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St. John's harbor is located on the Northeast coast of the Avalon Peninsula on the Island of Newfoundland. During the summer and fall of 1999 and 2000, two observational programs were carried out in the harbor in order to determine the circulation in the Narrows and the influence of external forcing from the Avalon Channel. Observational current data in both years reveal significant oscillations at subtidal frequency (below 0.5 cycle per day). Empirical Orthogonal Function (EOF) analysis shows that mode 1, containing over 40% of the variance, is highly correlated with wind speed. Observational current outside the harbor is highly correlated with EOF mode 2, which contains 27% of the variance. A two-layer model driven by wind stress is used to simulate the subtidal current in the Narrows. The model results show high coherence with the observation data.

10:45 AM

3B3.2
Understanding Observed Seasonal Temperature Changes in the Labrador Sea
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Seasonal variations of near-bottom temperature have been observed at a depth of 1000m on a mooring over the continental slope off Labrador. Numerical simulations of the North Atlantic are conducted to examine the causes and spatial distribution of this deep seasonal signal. We find that the minimum temperature that occurs in spring is due to the mixing associated with the late winter deep convection, and the gradual warming from spring to winter is associated with advection of warm waters through the Labrador Sea by the prevailing cyclonic circulation. Whether the model is able to reproduce the observed seasonal variation depends crucially on the parameterization of eddy mixing. In addition to helping us understand the nature of the observed variability, our results help to constrain the range of parameters that should be used in numerical simulations.

11:00 AM

3B3.3
The Formation and Circulation of the Cold Intermediate Layer in the Gulf of St. Lawrence
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The local heat content and formation rate of the cold intermediate layer (CIL) in the Gulf of St. Lawrence are studied using a combination of in situ wintertime observations and a three-dimensional numerical model. The field observations consist of five moorings located throughout the gulf over the period of November 2002 to June 2003. The observations demonstrate a substantially deeper surface mixed layer in the central and northeast gulf than in regions downstream of the buoyant surface outflow from the St. Lawrence estuary. The mixed-layer depth in the estuary remains shallow (<60 m) throughout winter, with the arrival of a layer of near-freezing waters at depths of 40-100 m in April.

An eddy-permitting ice-ocean model with realistic forcing is used to hindcast the period of observation. The model simulates well the seasonal evolution of mixed-layer depth and CIL heat content. Although the greatest heat losses occur in the northeast, the most significant change in CIL heat content over winter occurs in the Anticosti trough. The observed renewal of CIL in the estuary in spring is captured by the model. The simulation highlights the role of the northwest gulf, and in particular an offshore Gaspé current, in controlling the exchange of CIL between the central and northern gulf and the estuary. An additional model simulation is perfomed with the Strait of Belle Isle closed to study the impact of cold inflow through the strait on CIL heat content. The total change in CIL heat content between the two model simulations accounts for only 61% of the heat flux through the Strait of Belle Isle. This difference is explained by the strong anticorrelation (r=-0.83) found for the heat flux through the Strait of Belle Isle with that through Cabot strait. With the Strait of Belle Isle closed, the outflow of CIL through Cabot strait is reduced by 61%. It is estimated that only 64% of CIL inflow through the Strait of Belle Isle in fall and winter contributes directly to the heat content of CIL present in the gulf.

11:15 AM

3B3.4
A Circulation Model for the Broughton Archipelago
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The Broughton Archipelago is a complex network of islands, channels, and fiords lying off the mainland of British Columbia, approximately 300km northwest of Vancouver. In addition to river and glacial runoff that enters from the nearby mountainous terrain, circulation within the archipelago is also forced by winds and the strong tidal and estuarine flows in Johnstone and Queen Charlotte Straits. Though relatively remote in terms of settlements and accessibility, the region has been become the primary location for salmon farms in British Columbia. In this talk we will describe the application of SELFE, the Semi-implicit Eulerian-Lagrangian Finite Element algorithm developed at the Oregon Health and Science University, to simulating the currents in the archipelago. Comparisons with available observations will be made and the implication of interesting circulation features on aquaculture problems will be discussed.

11:30 AM

3B3.5
Mean Sea Surface Topography of the North Atlantic Calculated Using an Ocean Circulation Model and Gravity Data from the Recent CHAMP and GRACE Satellite Missions
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The mean sea surface topography of the North Atlantic, defined with respect to an equipotential surface that approximates mean sea level, is calculated using two independent approaches. The first uses a numerical model of the North Atlantic that is forced by seasonal-varying surface fluxes, and nudged towards an observed climatology of temperature and salinity in frequency-wavenumber bands that match the space-time scales in the observed climatology. This allows variations outside of these climatological bands to evolve freely, including the strong mesoscale variability in the vicinity of the Gulf Stream. The model is integrated for 50 years after which time it has reached a statistical equilibrium and sensible mean and rms fields can be defined. The second approach is based on data obtained recently from the CHAMP and GRACE satellite missions, which are leading to significant improvements in models of the Earth's gravity field. By combining these gravity models with sea surface heights (above a reference ellipsoid) measured by space-borne altimeters, it is possible to obtain a 'satellite-only' estimate of sea surface topography with respect to an equipotential surface. In this talk we compare the independent estimates of sea surface topography based on the ocean and gravity models and discuss their accuracy. Implications for the assimilation of absolute sea surface heights into ocean models is also discussed.

11:45 AM

3B3.6
The scale and occurrence of surface wave-breaking
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Surface waves have been labeled the gearbox between the atmosphere and ocean. In particular, wave breaking plays an important role in the air-sea exchange processes of momentum, heat and gases as well as aerosol generation due to sea spray, dispersion of pollutants and underwater noise generation. Furthermore, wave breaking affects wave development as it dominates dissipation of wave energy and controls wave growth.

To improve our understanding of wave-breaking related processes a twofold approach is necessary: detailed process studies combined with knowledge of occurrence and scale of wave breaking.

Phillips equilibrium range theory, introduced two decades ago, includes a statistical description of wave breaking, its kinematics and dynamics. The required key quantity is $\Lambda(c)dc$, the length of breaking crests per unit area propagating with speeds in the range $(c, c+dc)$.

I will present open ocean observations of breaking wave properties with emphasis on $\Lambda(c)dc$ and the associated momentum and energy fluxes. The breaking rate peaks at intermediate wave scales, implying an inadequacy of the source functions currently incorporated in spectral wave models.

10:30 AM

3B4.1
Stability characteristics of dynamically coupled overflows and internal gravity waves
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Observations in the near-sill region of an abyssal overflow, for example, the Denmark Strait Overflow, show that the dynamics is governed by bottom friction, down slope gravitational acceleration and rotation, and that the overflow velocity can be supercritical. This suggests that "mesoscale frictional destabilization" can occur and that significant vertical mixing can be realized when the unstable modes dynamically interact with internal gravity waves. We describe the characteristics of the transition to instability, on a super inertial time scale, of supercritical abyssal overflows that are dynamically coupled to gravest mode internal gravity waves in the overlying water column.

10:45 AM

3B4.2
Upstream Internal Hydraulic Jumps
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In stratified flow over a sill, the character of the upstream response is determined by a Froude number, F, based on the stratification and flow near the surface. This is distinguished from the Froude number governing the response in the neighborhood of the sill crest which is based on the weak density step associated with a flow bifurcation. For moderate values of F, the upstream response consists of nonlinear waves or a weak undular bore. For larger values of F, a strong, quasi–stationary, internal hydraulic jump dominates the upstream response. At sufficiently large values of F, no steady-state upstream bore is possible. Acoustic backscatter and velocity data are presented for the case of a strong internal bore or gravity current in a tidally modulated sill flow. Numerical simulations with varying surface stratification are presented to illustrate the upstream responses at different values of F. The hydraulic theory of quasi-steady, two–layer flow is invoked to account for the development of the upstream jump.

11:00 AM

3B4.3
Wave Source Term Parameterizations and Energy-Flux Balances
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Studies trying to optimize formulations for wind input S_{in} and dissipation S_{ds} in relation to wave-wave interactions S_{nl} have been hampered by the large number of degrees of freedom within the wave spectra. This has led to the need to highly parameterize S_{nl}, for example through the well-known discrete interaction approximation, DIA implemented in WAM and related models. In this paper, we identify problem areas in present operational models, particularly regarding source terms (S_{nl}, S_{in}, and S_{ds}), in their representation of the equilibrium range, high frequencies, spectral peak region, etc.

We propose preliminary new formulations for S_{in}, and S_{ds}, related to a modern version of the TRW (Tracey - Resio –Webb) S_{nl} formulation, and we consider the problem of how the wave spectrum should approach full development. New S_{nl}, S_{in}, and S_{ds} formulations are tested using (a) SWAMP tests, and (b) selected field data, from dedicated experiments, for example SHOWEX, SWADE, etc. We consider the directional variation for β, fetch relations $\tilde{E}$ vs $\tilde{x}$, peakedness, etc.

Our approach is to treat the energy fluxes within the spectrum as a primary measure of the role of wave-wave interactions, including both direct and inverse energy fluxes. We evaluate the location of the "null point", in terms of conventional wave spectral parameters. This location is where no net energy is transferred via wave-wave interactions (i.e. a point where the direct and inverse fluxes are equal). The behavior of the null point and net energy fluxes onto the forward face of the spectrum are given.

The energy-flux balance, based on a theoretical and observational framework is used to show that the net momentum entering the wave spectrum is approximately constant over a wide range of wave age. When a fully-developed stage of growth is approached, the spectral shape adjusts and the amount of energy transferred to the forward face through wave-wave interactions greatly diminishes. In this context, a strong wave breaking source term S_{ds} (or some other strong energy sink term) on the forward face of the spectrum is not required to achieve energy balance in this stage of wave development.

These findings are important because: 1) in high wave conditions, third-generation wave models tend to underestimate wave heights, possibly because of their S_{ds} overestimation, and 2) important aspects of fetch-limited and duration - limited growth are interrelated through the degree of importance of this S_{ds} on the net energy balance within the spectrum.

11:15 AM

3B4.4
Finite amplitude development of time-varying abyssal currents
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A finite amplitude theory is developed for the evolution of marginally unstable modes of time-varying abyssal currents on a sloping bottom. The evolution of this abyssal current is modeled by a geostrophic baroclinic theory of convective destabilization which allows for large-amplitude isopycnal deflection and filters out shear-based barotropic instabilities. Linear stability theory is used to generate a marginal stability curve. There are two different situations to be considered. One is for marginally unstable modes not located at the minimum of the marginal stability curve. An amplitude equation shows that the modes eventually equilibrate with a new finite amplitude periodic solution. The other case corresponds to the modes at the minimum of the marginal stability curve.

11:30 AM

3B4.5
Observations of the Effect of Shear on Internal Wave Propagation
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Large amplitude internal waves were observed in the Strait of Georgia in the summer of 2002 using a combination of oblique aerial photography and in situ water column data. Case studies were made of more than ten waves: from the same wave packet, from different wave packets observed on the same day, and from different days.The individual internal waves were identified and tracked over a period of about half an hour. Wave amplitudes and shear profiles are estimated from the water column data and the wave phase speeds derived from digitized and photogrammetrically rectified photo images. An attempt at analytically modelling the observed waves using classic internal wave equations such as linear, KdV (Korteweg-de Vries),and BO (Benjamin-Ono) equations was made with and without added shear. It was found that the shear effect was significant in all cases and improved the comparison in most cases. When including shear effect, the Benjamin-Ono equation for deep-water waves clearly provided the best model for the observed propagation.

11:45 AM

3B4.6
Submarine Canyons: Does length matter?
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It has been postulated that long submarine canyons (canyons whose heads closely approach the coast) should have different dynamics than shorter canyons. In particular, one would expect that Juan de Fuca Canyon would have stronger effects and stronger enhanced upwelling than Astoria Canyon. A simplified model of Juan de Fuca Canyon was constructed and inserted into a rotating table tank. Upwelling favourable flow was driven over the canyon by changing the rotation rate over several inertial periods. Flow and upwelling was measured by tracking dye and particles. As expected the long canyon showed stronger upwelling than previous experiments with short canyons. Unexpected results included the position of the upwelling stream and the importance of the flow on the slope compared to that on the shelf. The dynamics of stratified rotating flows will be used to explain both of these results.

10:30 AM

3B5.1
Forecasting Tornadic Thunderstorms in Alberta using Environmental Sounding Data Part I: Wind Shear and Buoyancy

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This study investigates, for Alberta, whether observed sounding parameters such as wind shear and buoyant energy can be used to help distinguish between thunderstorms with severe (F2 to F5) tornadoes, thunderstorms with weak (F0 and F1) tornadoes, and non-tornadic severe thunderstorms. The observational data set contains 87 convective storms all of which occurred within 200 km of the upper air site at Stony Plain. Of these storms, 13 spawned severe (F2-F5) tornadoes, 61 spawned weak (F0-F1) tornadoes, and 13 had no reported tornadoes yet produced golfball-sized or larger hailstones.

The observations suggest that bulk shear contained information about the probability of tornado formation and the intensity of the tornado. Severe tornadic storms tended to have stronger shear values than weak tornadic or non-tornadic storms. All severe tornado cases had a wind shear magnitude in the 900-500 mb layer exceeding 3 m s^{-1} km^{-1}. Combining the 900-500 mb shear with the 900-800 mb shear increased the probabilistic guidance for the likelihood of severe tornado occurrence. Furthermore, strong veering in the low levels seemed to be correlated with the formation of a tornado. The data suggest that buoyant energy (quantified by the Best Level Convective Available Potential Energy) provided no skill in discriminating between tornadic and non-tornadic storms, or between severe and weak tornadoes. The findings for Alberta storm corroborate the major findings reported for storms in other regions such as Oklahoma and California.

10:45 AM

3B5.2
Forecasting Tornadic Thunderstorms in Alberta using Environmental Sounding Data. Part II: Precipitable Water, Storm Convergence and Helicity
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Sounding parameters are examined to determine whether they can help distinguish between Alberta thunderstorms that spawn severe tornadoes (F2-F4), weak tornadoes (F0-F1), or no tornadoes. Parameters investigated included Storm Convergence (C), Storm-Relative Helicity (SRH), and Precipitable Water (PW). The motivation for analyzing these parameters is that, in theory, they might affect the rate of change of vertical vorticity generation through vortex stretching, vortex tilting, and baroclinic effects.
Precipitable Water showed statistically significant differences between severe tornadic storms and those storms which produced weak tornadoes or no tornadoes. All severe tornadic cases in our dataset had PW values exceeding 22 mm, with a median value of 24 mm. Values of PW between 19-23 mm were generally associated with weak tornadic storms. Computed values of Storm Convergence, height of the Lifted Condensation Level (LCL) and Normalized Convective Available Potential Energy (NBLCAPE) did not discriminate between any of the three storm categories. The SRH showed a significant separation of severe tornadoes from both weak tornadic and non-tornadic storm groups. The Alberta data suggest that severe tornadoes tended to occur with SRH >150 $m^2 s^{-2}$ computed for the 0-3 km layer. Weak tornadoes in Alberta thunderstorms were typically formed for 30 $m^2 s^{-2} \leq$ 0-3 km SRH ≤ 150 $m^2 s^{-2}$. Interestingly, the threshold values of SRH are lower than those suggested in studies based on storm observations in the central United States.

11:00 AM

3B5.3
Severe Weather Linkages to Soil Moisture on the Canadian Prairies
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Soil moisture in the cropped grassland of the Canadian Prairies was specified on June 15th for years 1997-2003 using a crop model. Dry areas (crop available moisture <50% of capacity), and wet areas (crop available moisture >50% capacity) were delineated each year. The number of severe weather events (tornadoes, hail, heavy rain, strong winds and all) per 10,000 km^2 that occurred each year in the dry and in the wet areas during the remainder of the growing season subsequent to June 15 was correlated with the mean soil moisture in these areas. Weak positive correlations were found for each type of severe weather. The strongest correlations were between 15 June soil moisture and the subsequent occurrences of hail and strong winds. It follows that the number of severe weather events per 10,000 km^2 on the Prairies, subsequent to June 15th, is determined, in part, by the 15 June soil moisture. This suggests that areas that are initially wet supply the atmospheric boundary layer with moisture and CAPE during subsequent months, a necessary but not sufficient condition for deep severe convection, while the supply of water vapour mass and latent heat is lower in the areas that are initially dry. Results will also be presented for April 1 and July 15 soil moisture and the subsequent severe weather events beyond these dates. The use of soil moisture as a "predictor" for summer severe weather occurrences over shorter time interval (weeks to days) will be investigated in a future study.

11:15 AM

3B5.4
Canadian Lightning Detection Network: Performance Measurement, Flash Densities and Notable Statistics
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The Canadian Lightning Detection Network (CLDN) was established by Environment Canada in 1998 and provides lightning detection coverage for over 95% of Canadians. During 2004 and early 2005, several new real time Performance Measurement (PM) tools were developed for the CLDN that utilize novel methods of presentation via the internet. In

addition to demonstrating these PM tools, this paper will also provide Flash Densities for Canada and highlight some notable Statistics for Canadian Provinces and selected sites.

11:30 AM

3B5.5
Relationships between Lightning and Convective Rainfall in Canada

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The relationship between cloud-to-ground (CG) lightning and convective rainfall over Canada was analyzed. The Canadian landscape is diverse and spans many eco-climatic regimes. We selected 54 stations covering the cordilleran zone of the Pacific coast, the grasslands zone of the Prairies, the boreal, sub-arctic, and the temperate zones of the eastern Canada. The study period comprised the months of April to October from 1999 to 2003. The C-G lightning flashes were obtained from the Canadian Lightning Detection Network (CLDN). Precipitation data were obtained from the daily rainfall measurements reported at each of the stations on confirmed thunderstorm days from the MSC surface weather network. Thunderstorm days were considered dry if the rainfall amount was less than 3 mm, and wet if the rainfall amount was greater than 3 mm. We further stratified the wet days into 3 ranges (from 3.1 to 10 mm, between 10.1 and 25 mm, and greater than 25 mm).

The geographic differences in rainfall-lightning relationships reflect the complexity of thunderstorm characteristics and structure across the country. Our observations show that the storms producing the highest lightning frequencies are associated with those producing the highest rainfall fluxes. Rain yield values from dry thunderstorms were lowest in the grassland eco-zone and highest in the sub-arctic zone. The highest rain yield values from wet thunderstorms were found in the cordilleran eco-zone and the lowest values in the temperate zone.

(INVITED/INVITÉ) 10:30 AM

3B6.1
Atmospheric processes and the Mackenzie basin climate system
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The Mackenzie River Basin (MRB) accounts for about 20% of Canada's landmass; the region possesses some of the most variable climates on Earth, and strong climate change signals have been detected in the region. In addition, the basin is a major source region of atmospheric features, such as cold continental airmass and lee cyclones, that affect critically the cold season weather and climate of the continent; the fresh water in the region is among the most valuable resources for the country, and the discharge from the Mackenzie River is the largest North American source of fresh water into the Arctic Ocean. Because of these significances of the region, the Mackenzie GEWEX Study (MAGS) research network was established in the mid-1990s to better characterize the water and energy cycling in the region, to study the underlying physical processes that determine its water and energy budgets, and to subsequently improve our understanding and predictive skills of the MRB climate system. This is the concluding year of the research program and results from MAGS research activities that are relevant to attaining these objectives of the program will be reviewed in this presentation. In particular, the presentation will review the advancements achieved through MAGS research, with a focus on contributions from the atmospheric component of the program, in charactering aspects of the weather and climate of the region, in quantifying components of the water and energy cycle for this major northern river basin, in elucidating the large-scale atmospheric features and regional physical processes that govern the variability of its climate, and in modeling the system with regional climate models.

11:00 AM

3B6.2
The Impact of Climate Change and Western Pacific Extratropical Transition on the Mackenzie River Basin
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Several studies have recently indicated that there has been a significant increase in global temperatures, especially in the Northern Hemisphere, over the past several decades. This increase in temperature has been most notable during the cold season over the Mackenzie River Basin (MRB) with temperatures having increased almost 3º C over the last half century. Since the Pacific North American Pattern (PNA) is strongly correlated with surface temperature over the MRB, it is postulated that there has been in increase in the magnitude and persistence of episodes of the positive phase of the PNA. Furthermore, tropical cyclones undergoing extratropical transition (ET) often produce large poleward transports of heat and moisture which can result in amplification of the synoptic-scale flow regime, impacting the phase of the PNA. As such, trends in the flow regime over and upstream of the MRB, and the impact of ET on the these flow regimes is investigated.

Preliminary results indicate that over the past 50 years, there have been significant upward trends in the PNA, which is consistent with the observed warming over the MRB. However, the effect of ET on the flow regime seems dependent on the strength and eventual track of the storm in question. Storms tracking more to the east after recurvature often result in downstream ridging over the MRB (positive phase of the PNA) and a corresponding increase in the deep layer thickness. As a result, conditions over the MRB in these cases are usually unseasonably warm and dry. On the other hand, storms tracking northward toward the Kamchatka peninsula often produce cooler and wetter conditions over the MRB as the associated downstream ridging occurs over the central North Pacific, with troughing over western Canada (negative phase of the PNA). Further investigation is designed to try and elucidate whether the impact of the features is transitory in nature or can lead to episodes of atmospheric "blocking", where anomalous features persist for several days.

11:15 AM

3B6.3
Comparison of the Shortwave and Longwave Radiative Budgets of the Mackenzie River Basin from a Regional Climate Model and Satellite observations
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The Canadian Regional Climate Model (CRCM) is a major component of the modeling strategy used in the Mackenzie GEWEX (Global Energy and Water Experiment) study. Radiation at the surface is one of the important links between the CRCM and the land surface and hydrology models. The NASA Clouds and Earth's Radiation Energy System (CERES) satellite sensor is used to study the solar-reflected and Earth-emitted radiation fluxes at the top of atmosphere (TOA). The surface absorbed shortwave radiative flux is derived using the Li and Leighton algorithm which has been validated by surface measurements. Shortwave and longwave radiative fluxes both at the TOA and at the surface from the CRCM for the period of March, 2000 to September, 2003 are compared with those from CERES observations. It is found that the basin-average reflected shortwave solar flux at TOA at 19 UTC is overestimated by 28 Wm^{-2}, and the basin-average flux absorbed at the surface at 19 UTC is underestimated by 39 Wm^{-2} by the CRCM. The maximum differences occur in the summer (35 Wm^{-2} at the TOA and -51 Wm^{-2} at the surface, at 19 UTC), but there is a secondary maximum in the winter, when the differences are 32 Wm^{-2} at the TOA and -38 Wm^{-2} at the surface at 19 UTC. The basin-average longwave fluxes from the CRCM run agree very well with the satellite outgoing longwave fluxes at the TOA, the mean difference (CRCM-CERES) being –4 Wm^{-2}. A systematic underestimate of the outgoing longwave fluxes by the CRCM at the TOA (-8.8 Wm^{-2}) is found during the winter season, indicating that either the cloud fraction is overestimated or that the surface temperature is underestimated. The negative bias during the winter is present in both clear-sky and overcast conditions, but the biases for overcast conditions are much greater than those from clear-sky conditions.

11:30 AM

3B6.4
Moisture flux convergence into the Mackenzie River Basin using NCEP reanalysis data
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The moisture flux convergence into the Mackenzie River Basin has been studied for the period 1990-2000 using NCEP reanalysis data. An emphasis was placed on the 1994-95 water year as that was the year with a very low water vapor transport into the region. The vertical profiles of moisture flux convergence, as well as the spatial distribution, were compared to those of Liu et al. (2002) using very similar methods. Some agreement exists, but there are clear discrepancies as well. These will be explored. Better agreement is found in comparing the water years 1994-95, 1995-96 and 1996-97 with Strong et al. (2002), despite the difference in the methods.

It was found that out of the ten year period, the 1995-96 and 1996-97 water years had the largest moisture flux convergence, while the 1997-98 water year had the least. The 700 mb level for the 1994-95 water year was the most significant level of moisture flux convergence, which agrees with Liu et al.

11:45 AM

3B6.5
Integrated Hydrologic Modelling In MAGS
Frank R. Seglenieks [1] , *E.D. Soulis* [1] , *A. Pietroniro* [2]
(Presented by / Présenté par ***Frank Seglenieks***)
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The Global Energy and Water Cycle Experiment (GEWEX) is a WCRP program designed to improve understanding of the role of the water cycle in the climate system. The Canadian contribution relates to cold region processes. The Mackenzie GEWEX Study (MAGS) focuses on understanding and modelling the flows of energy and water into and through the atmospheric and hydrological systems of the Mackenzie River basin.
This paper describes WATCLASS, the distributed hydrological modeling system developed for MAGS where the vertical water and energy budgets are calculated by routines from Canadian Land Surface Scheme (CLASS) and the routing of lateral flow uses routines from WATFLOOD. Subgrid schemes integrate microscale parametezations from research basins and provide fluxes for two-way coupling with atmospheric models. The current modelling work is directed toward coupling WATCLASS with the Canadian Regional Climate Model (RCM) and with the Canadian NWP system.
The development of WATCLASS has brought together many of the MAGS projects. This has allowed many of the internal processes of the model to be examined and improved rather than solely relying on streamflow comparisons.

atmospheric P-E estimates, satellite radiation schemes, soil moisture indexes and ice jam flood estimates have been enhanced or have provided important feedback to the model development.
The major contributions of the integrated hydrologic modelling part in MAGS have included; closing the water budget at the basin scale on a monthly time scale, integration of microscale physics to large domains, GRU based routing strategy for mesoscale to microscale, and calibration strategies for large watersheds. Many legacy data sets have been created from this project that will be available for future generations of researchers while the model itself provides a framework to integrate the scientific legacy of the process studies that have been done as part of MAGS .

10:30 AM

3B8.1
Consensus Probabilistic Forecasting of Sensible Weather
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To make optimal decisions, end-users of decision support systems (e.g., electric utilities) require information accurately describing the uncertainty of the underlying weather forecasts. This probabilistic forecast information about sensible weather variables such as temperature, humidity, and wind speed will ideally take the form of a probability density function (pdf). Ensemble methods provide a natural approach for creating these types of forecasts. However, to create meaningful forecasts using ensemble methods generally requires production of a large number of realizations of a model forecast, which can be expensive in time and other resources. Moreover, calibration of the forecasts is often a concern.

An alternative statistical approach is proposed in which forecasts generated by individual models are interpreted statistically to generate individual pdfs for the variable of interest (e.g., temperature). The resulting forecast distributions are then combined using weights based on forecast performance. A benefit of the weighting procedure is that it allows generation of forecast distributions with multiple modes. This approach is a probabilistic extension of the DICast system, a successful automated "traditional" scalar forecasting system.

Results are presented for temperature pdfs produced using output from two operational numerical weather prediction models: the Eta and the Global Forecasting System (GFS), both provided by the U.S. National Centers for Environmental Prediction. The pdfs are evaluated using standard metrics such as the Continuous Rank Probability Score and its components. This allows evaluation of a variety of "events" ranging from extreme to average. Reliability diagrams and rank histograms provide other insight into the forecast quality. Evaluation of the pdfs generated by these models indicates that they provide relatively reliable and skillful forecasts when compared to the deterministic forecasts and simple probabilistic forecasts based on climatology. In addition, the rank histograms indicate that the forecast spread is generally approximately correct. Integration of the pdfs provided by the two forecasting systems results in notable improvements, particularly with respect to the resolution and reliability of the forecasts. This improvement is associated with the ability of the integrating process to apply stronger weights to the forecast model that is providing the best performance.

Results of applying this method for temperature forecasts based on only two NWP forecasts are encouraging; use of additional models or model realizations would be expected to show additional capabilities. Evaluations of forecasts for other variables such as wind speed are in progress; initial results indicate that application of this approach is also beneficial for these forecasts.

10:45 AM

3B8.2
A Comparison of methods for combining probabilistic forecasts
Matthew Pocernich
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In contrast to a point forecast of a meteorological variable such as temperature, a probabilistic forecast is expressed as a distribution of possible outcomes. Several methods exist for combining such forecasts. These include Nextcast/Dicast method developed by NCAR and Bayesian Model Averaging (BMA) developed at the University of Washington as well as simple model averaging. In this exercise, eight months of temperature data and forecasts from a selection of US cities is used to evalute these methods. The 24, 48 and 72 hour forecasts are considered. The models are built using a range of learning period. The periods need to be long enough to provide a reasonable amount of data while being short enough to avoid the larger issues of seasonality. The combined probabilistic forecasts are evaluated using sharpness diagrams, continuous ranked probability scores (CRPS) and reliability plots.

11:00 AM

3B8.3
The Winter Maintenance Decision Support System (MDSS): Project Status and Summary Results

William Mahoney
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The U.S. Federal Highway Administration (FHWA) Office of Transportation Operations Road Weather Management Program began a project in fiscal year 1999 to develop a prototype winter road Maintenance Decision Support System (MDSS). The MDSS capabilities are based on feedback received by the FHWA in 2001 from maintenance managers at a number of State Departments of Transportation (DOTs) as part of an initiative to capture surface transportation weather decision support requirements.

The MDSS project goal is to seed the implementation of advanced decision support services provided by the private sector for state DOTs. This has been achieved by developing core software capabilities that serve as a basis for these tailored products.

After the 2001 user needs assessment was completed, the MDSS program was extended with the objective of developing and demonstrating a functional prototype MDSS. A field demonstration of the prototype MDSS occurred in Iowa between February and April 2003 and a second field demonstration was conducted during the winter of 2004. The prototype MDSS test bed was moved to Colorado for winter 2004-2005 to explore issues associated with complex terrain.

The performance of the prototype MDSS and its technical maturity has improved each year. The weather and road condition predictions were more accurate and the treatment recommendations generated by the system were appropriate given the predicted conditions. Winter maintenance supervisors actively considered the treatment guidance and on occasion they successfully used the recommended treatments without modification.

This presentation will describe the status of the MDSS project, results and lessons learned from the field demonstrations, and future development efforts.

11:15 AM

3B8.4
Using Methods of Experimental Economics to Assess the Communication of Forecast Uncertainty
Mark Roulston [1], *Gary Bolton* [1], *Andrew Kleit* [1], *Addison Sears-Collins* [3], *Alberto Arribas* [2]
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Over the last five decades, experimental economists have developed a range of tools for studying individual choice in the laboratory. We illustrate how these methods can provide a framework for objectively evaluating how well people understand information provided in weather forecasts. Specifically, we use simulated decision-making tasks with performance based financial rewards to address the questions of whether providing information about forecast uncertainty improves decision-making, and what is the best way to present such information forecast users.

Financial rewards are used to induce preferences in participants so that decision-making can be studied separately from questions of how they form their preferences. The results, however, are applicable to situations where the costs and losses involved are not necessarily financial in nature.

We have found that people who were provided with extra information about forecast uncertainty can make better decisions than those provided with conventional forecasts lacking uncertainty information. They were able to increase their expected rewards while simultaneously decreasing their exposure to risk.

11:30 AM

3B8.5
A Probability of Event Occurrence Approach to Performance Estimate
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The accurate measurement of program performance demands comparison of a compete and matched set of program messages and events. In remote areas, many events go undetected making the estimate of program performance quite inaccurate.

In order to achieve a more realistic measure of performance, the probability of event occurrence can be estimated using remote sensing data. The probability that an event actually occurred can be estimated from the strength and pattern of the event signature as well as the number of different remote sensing data that identify the event. Performance measurement can be then completed using a series of event datasets. The 100 percent probability of event occurrence data set would include only those events that have been ground-truthed and absolutely confirmed. In contrast, the 75 percent probability of event occurrence data set would include all of the confirmed events as well as those deemed to have occurred with a confidence of 75 percent. The 25 percent probability of event occurrence data set would include all of the confirmed events as well as those deemed to have occurred with only a confidence of 25 percent. A continuum of performance measurements can be obtained by using the complete continuum of event datasets ranging from the confirmed to those that include events with only a low probability of occurrence. The program performance could then be plotted versus the probability of occurrence of the events comprising the associated event database. The shape of such a curve will reveal much about the likely performance as well as establish lower and upper limits on the program performance.

It is hypothesized that the performance versus event occurrence probability curve would be quite flat for regions with a high probability of event detection. It is also hypothesized that the shape of the curve in data sparse areas would be strongly peaked somewhere near the 50 percent probability of event occurrence.

It is suggested that for severe convection, the remote sensing data used could include conventional, doppler and polarized radar information, satellite data and lightning (type, polarity and quantity) data. Well established severe event signatures have been established in particular for volume scan radar data. Such an approach would also encourage the quantification of event signatures for satellite and lightning data. This approach would also yield more information on probable event distribution in time and space.

11:45 AM

3B8.6
Atlantic Ensemble Marine Forecast Validation against Regional 00HR GEM Forecasts

Serge Desjardins [1], *Mathieu Côté* [3], *Hal Ritchie* [2], *Garry Pearson* [2], *Bruce Whiffen* [2]
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Interest is rapidly growing in the marine user community for prediction products extending out beyond 5 days. Users generally have to plan well in advance when working on fishing grounds that require 2 days' travel in each direction. Significant safety concerns are at issue. Current marine forecasts in Canada are largely deterministic and only extend out to 2 days with an outlook for day 3. Mariners often indicate that they would like a measure of the confidence in the forecast products towards the end of the period. The Newfoundland marine community has been increasingly requesting products from the Meteorological Service of Canada (MSC) in recent years.

Ensemble prediction systems hold promise in fulfilling this need. Much work has been completed in the Meteorological Research Branch (MRB) and at the Development Branch of the Canadian Meteorological Centre (CMC) in order to provide ongoing operational runs of an ensemble system. The MSC National Lab for Marine and Coastal Meteorology has recently made use of this work in providing output focused on the Atlantic Region. In response to the requests from the marine community, experimental products have been prepared and made available to weather offices in the region. The purpose of the work presented here is threefold: 1) to examine the forecast skill as applied to marine offshore areas in the 5 to 7 day forecast timeframe; 2) to examine the methodology of presentation and interpretation of the information; and 3) to examine the operational potential of such a product.

(INVITED/INVITÉ) 1:30 PM

3C1.1
Sensitivity of the marine anthropogenic CO2 sink to ocean circulation
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The ocean is a critical sink for CO_2 and at present accounts for about 30% of all anthropogenic CO_2 emissions. Uptake is not uniform across the ocean, and the meridional overturning of the North Atlantic appears to be of particular importance. However, ocean models have suggested that this large-scale feature of ocean circulation may undergo drastic re-organization in response to continued fossil fuel CO_2 burning and climate change. This will impact on the rate of anthropogenic CO_2 uptake by the ocean. Without delving into the whole worm can regarding whether or not a future collapse in overturning is at all likely, we explore the sensitivity of the marine anthropogenic CO_2 sink to changes in ocean circulation. We present results from a new Earth system climate model – genie (http://www.genie.ac.uk/), in which model climatology is optimized against observed physical ocean properties and global surface air temperatures, while the coupled atmosphere-ocean-sediment carbon cycle is optimized against ocean tracer and sediment core-top properties. We take advantage of the numerical efficiency of this 3D model to characterize the evolution of the marine carbon cycle under a broad range of scenarios for fossil fuel CO_2 release and circulation mode on time-scales of 10^0 to $>10^4$ years. The coupled nature of the genie model additionally enables us to explore the importance of feedbacks between climate and marine carbon cycling.

2:00 PM

3C1.2
Interannual variability of carbon export and DOM in the Labrador Sea
Markus Pahlow [1], *Alain F. Vézina* [2], *Dan G. Wright* [2], *W. K. W. Li* [2]
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The Labrador Sea is a major site of deep water formation, which undergoes strong interannual variations. Recent advances in physical circulation modeling of the North Atlantic have made it feasible to examine effects of this interannual variability on carbon cycling in the Labrador Sea with biological models. We validate a 1D plankton-DOM (dissolved organic matter) model against climatological data and compare model predictions for seasonal and interannual variability with observations. We find strong interannual variability in organic carbon export related to accumulation and mobilization of DOM. DOM dynamics could potentially reverse the export of organic carbon from the surface to the deep ocean in some years, temporarily turning the biological pump into a two-way street.

2:15 PM

3C1.3
A biogeochemical patch model of the NE Pacific SERIES in situ manipulation experiment
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The SERIES iron fertilization patch has been modelled as a physically homogeneous slab that expands and contracts in both the horizontal and the vertical, entraining and exchanging fluid as prescribed by observations. The mixed layer depth was determined from 1-D GOTM simulations that were restored to CTD data on a daily basis. Horizontal patch expansion was estimated from surface tracer (sulphur hexafluoride) observations. An ecological model has been embedded both inside and outside of the patch. The model includes two size classes of phytoplankton (diatoms and non-diatoms), a detrital component, and zooplankton. Carbon, nitrogen, silicic acid and iron are modelled independently. Model formulation and parameters are constrained by chemical and biological observations during the SERIES experiment. The implications of dynamic biogeochemistry to nutrient cycling and availability over longer (annual to decadal) times scales will be discussed.

2:30 PM

3C1.4
The Response of Diatoms to a Mesoscale Iron Enrichment During the SERIES Experiment in the NE subarctic Pacific

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Diatoms are an important vector for the transport of carbon into the deep ocean. In large regions of the world's oceans, the growth of diatoms is regulated by Fe availability, which limits their biomass and thereby reduces the efficiency of the ocean's biological pump and the subsequent export of carbon. During the Subarctic Ecosystem Response to Iron Enrichment Study (SERIES), a 64 km^2 patch of seawater in the NE subarctic Pacific was enriched with iron. Over the course of the 26 day observational period, phytoplankton chlorophyll increased 20-fold and the patch size grew to an area larger than 1000 km^2. The bloom was largely dominated by the pennate diatoms *Pseudo-nitzschia*, *Neodenticula* and *Thalassiothrix* and the centric diatoms *Thalassiosira*, *Chaetoceros*, *Proboscia* and *Rhizosolenia*. At the peak of the post-iron algal bloom, the enhanced growth in these diatoms represented an ca. 45-fold increase in particulate carbon concentrations compared to the initial population. The diatoms which exhibited the greatest growth response and those which contributed the most with respect to algal biomass during the bloom will be evaluated. In addition, the processes which affect carbon export via diatom particulate matter will be presented. The results from SERIES provide new insights into the factors that regulate phytoplankton growth and diversity as well as the environmental conditions that influence the extent of carbon sequestration via diatom blooms.

1:30 PM

3C2.1
Winter warm spells in the Alps: Heat waves in a cold season?
Martin Beniston
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Investigations conducted for several Swiss mountain climatological sites, and in particular the Saentis high mountain site at 2,500 m above sea level, show that positive temperature anomalies during the winter season currently exceed those of all other seasons. These "heat waves" exhibit daily maximum temperature anomalies sometimes in excess of 16°C, and are observed to have increased substantially since the late 1960s. These events are related to the North Atlantic Oscillation (NAO) that exerts significant controls on snow cover and surface-atmosphere temperature feedbacks in the alpine region. A glimpse to the future is provided for the period 2071-2100, based on regional climate model simulations which suggest that warm winter spells may increase by 30%. The impacts of such events, particularly in terms of snow and water availability and the mountain economies that depend on these resources, need to be incorporated into future strategic resource and economic planning in the Alps.

1:45 PM

3C2.2
Honey, I shrunk the Ocean!
John Fyfe , Oleg Saenko Canadian Centre for Climate Modelling and Analysi
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Global climate models indicate that the poleward shift of the Antarctic Circumpolar Current observed over recent decades may have been significantly human-induced. The poleward shift, along with a significant increase in the transport of water around Antarctica, is predicted to continue into the future. To appreciate the magnitude of the poleward shift we note that by century's end the concomitant shrinking of the Southern Ocean is predicted to displace a volume of water close to that in the entire Arctic Ocean. A simple theory, balancing surface Ekman drift and ocean eddy mixing, explains these changes as the oceanic response to changing wind stress.

2:00 PM

3C2.3
North-American Climate as downscaled by an ensemble of CRCM simulations
Ramon de Elia [1] , H. Côté Côté [1] , D. Caya Caya [1] , S. Biner Biner [1] , A. Frigon Frigon [1] , M. Giguère Giguère [1] , R. Harvey Harvey [2] , D. Paquin Paquin [1] , D. Plummer Plumme [2]
(Presented by / Présenté par ***Hélène Côté***)
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For more than a decade the Canadian Regional Climate Model (CRCM) has been developed and used as a downscaling tool for the study of climate and climate change. As a result, an important database containing several simulations is now available. These resources make it possible to analyze the models performance on present-day climate over the North American region
using results from several simulations. The objective of this work is two-fold; first to produce a consensus climate that is somehow independent of model configuration choices, and second, to detect the geographical regions sensitive to these choices through the analyses of inter-climate variances.

A set of sensitive studies are also carried out in order to understand the individual effects of each of the parameters that were modified. The significance of these sensitivities were carried out by comparison against the climate noise generated by internal variability (climates from identical runs differing only in the initial conditions).

Results show that the model is able to reproduce most of the features of the North-American climate, although biases are present in different regions and seasons. Some of these biases are robust insensitive to parameter changes and others are more sensitive. Areas of large sensitivity to parameter choice represent a special challenge since they reveal the existence of a delicate balance between competing factors.

2:15 PM

3C2.4
Adverse Weather Trends in the Canadian Arctic
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This study provides an assessment of changes in the occurrence frequency of four types of adverse weather (freezing precipitation, blowing snow, fog, and low ceilings) and no-weather (i.e., no precipitation or visibility obscuration) events as observed at 15 Canadian Arctic stations between 1953-2004. The frequency time series was subjected to a homogenization procedure prior to a logistic regression based trend analysis. The results show that the frequency of freezing precipitation has increased almost everywhere across the Canadian Arctic during the past half century. On the contrary, the frequency of blowing snow occurrence has decreased significantly. The decline is most significant in spring. Changes in fog and low ceiling occurrences have similar patterns and are most (least) significant in summer (autumn). Decreases were identified for both events in the eastern Arctic in all seasons. In the southwest, fog frequency has increased significantly in all seasons, while the low ceiling frequency has decreased significantly in spring and summer. The regional mean rate of change in the frequency of the four types of adverse weather is 7-13% per decade. The frequency of the no-weather event has decreased significantly at most sites, with a mean decrease rate of 2% per decade. The decline in no-weather occurrence is not due to an increase in blowing snow or fog occurrence, but due to the increasing frequency of freezing precipitation and, most likely, other types of precipitation. This is consistent with reported increases in precipitation amount and more frequent cyclone activity in northern Canada.

2:30 PM

3C2.5
Results of present climate simulations performed with the GEM forecast model at RPN
Bernard Dugas [1] *, Katja Winger* [2]
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The GEM forecast model is routinely run in climate mode at RPN as a validation tools: Differences between the model's climate and that derived from recent re-analysis experiments such as ERA40 provide useful indications of GEM's strengths and deficiencies. We report on results obtained with the most recent model configuration, which closely resembles that of the upcoming meso-global forecast system at RPN/CMC. Even though the climate version of this system is run at a much lower horizontal resolution than the forecast version, surprisingly few adjustments are required. The new version's climate is much improved when compared to the previous one.

2:45 PM

3C2.6
The life cycle of the AO and the NAO: An observational study
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Since there is still some debate in the literature as to whether or not the NAO is simply a regional phenomenon of the AO, it is of interest to compare the life cycles of the AO and the NAO on a subseasonal time scale to shed some light on this controversy. The daily NCEP/NCAR re-analysis data spanning 51 years at 11 levels were used to obtain the vertically averaged temporal evolution of the AO and the NAO.
The frequency of the selected events as a function of these duration shows that more than 50% of the negative NAO cases last less than two weeks, giving the negative NAO a sharply decaying distribution of lifetimes. This feature of the frequency distribution is very similar to that of blocking high events. The time evolution of the spatial structures of both the AO and the NAO were explored. Results show that the AO and the NAO of both polarities have quite similar setup processes except that the negative NAO looks more like a regional phenomenon. They all start from a weak pattern of opposite sign one week before the "setup day" (when the amplitude crosses a fixed threshold) and an East Atlantic (EA) like pattern appears about two days later. The EA-like pattern evolves to form the northern center of the bipolar AO. The southern centers of the AO are found to develop in situ. Further separation of the negative NAOs shows that the negative NAOs that last less than two weeks share

many aspects with blocking highs. However, the negative NAOs with durations longer than two weeks become much more zonal one week after the setup day.

1:30 PM

3C3.1
Circulation off Newfoundland and Labrador: Annual mean and seasonal variability
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A three-dimensional prognostic finite–element model has been used to investigate the annual-mean circulation and seasonal variability off Newfoundland and Labrador. The model forcing consists of climatological monthly-mean wind stress and density fields and the M2 tide. The open boundary condition accounts for the effects of the large-scale wind-driven circulation, steric height, and additional barotropic inflow associated with the Labrador Current. The model solutions show year-round equatorward currents nearshore, along the shelf edge and along the lower continental slope, which are strong in fall/winter and weak in spring/summer. The model results point to the importance of both baroptropic and baroclinic components in the Labrador Current. A detailed comparison of the model results with observations indicates good agreement.

1:45 PM

3C3.2
A Lagrangian model for sea ice dynamics
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A Lagrangian model for sea ice dynamics has been developed using the Smoothed Particle Hydrodynamics (SPH) method. Previous studies have showed that this particle-based method can provide an attractive alternative approach to modelling sea ice dynamics, and results from idealized simulations with our model support this finding. For example, the model is able to handle large deformations, particularly along free boundaries. For an idealized simulation of sea ice forced by a vortex wind field, it is shown that the Lagrangian model gives results which are very close to those obtained with a more complex finite element sea ice model. However, more work remains to be done to decrease the computational cost and to improve the conservation properties of the proposed model.

2:00 PM

3C3.3
Simulation of the Northeast Pacific with spectral nudging
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The Parallel Ocean Program (POP) is used to simulate the circulation of the North Pacific Ocean. Our specific area of interest is the Northeast Pacific, focusing on the eddy activity of the currents along the coasts of British Columbia and Alaska. The model has 0.25 degree horizontal resolution and 21 vertical levels that increase in thickness from surface to bottom. The temperature (T) and salinity (S) fields of the model are initialized with either Levitus or observations obtained from the Institute of Ocean Sciences (IOS) in Sidney B.C. The other model inputs are COADS monthly climatological heat flux and winds. The low-frequency component of the model T and S fields are nudged towards the observed climatological T and S fields using a spectral nudging technique that nudges only specific frequencies. Nudging only the low-frequency component of the T and S fields allows model eddy fields to develop and evolve even though eddies are not present in the observed climatology. The modeled circulation is spun up from rest and is allowed to evolve for 20 years. Statistical analyses are performed on the last ten years of each model run to compare the model results with observations of sea-surface height from altimetry. Standard deviation and skewness are considered in order to provide measures of both the strength and the polarization of the variability. The observational estimates are compared with those from a number of different model runs both when nudging is used and when it is not. Sensitivities to both the observational estimate of the climatology and the choices made in the nudging techniques will be discussed.

2:15 PM

3C3.4
Constructing a Numerical Ocean Model with Local Domain but Global Boundaries(LDGB) and its Initial Applications to Tsunamis and Storm Surges

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This presentation will describe how to construct a hydro-dynamic model with a local domain but free of open boundary conditions. The local model can be preloaded with all the necessary knowledge of 1) the locations of the global ocean boundaries where we have real physical boundaries conditions, 2) the topographies of the global ocean, 3) the dynamical connections between the local domain and the rest of the global ocean. Although the ocean is subject to the ever changing external forcing and un-predictable events, the knowledge of the above aspects are invariant. Hence it is desirable, and feasible, to calculate the knowledge once and for all before running the local model for any instance. This technique may be called LDGB, standing for Local Domain but Global Boundaries.

As far as the linear dynamics is concerned, the LDGB will yield a solution in the local domain which would be identical to the part of the global model solution in the same area as if the global model had been run. In this sense, LDGB makes the specification of the open water boundary conditions no longer necessary; the open boundary is perfectly transparent to any signals leaving out of or entering into the local domain. For a non linear local model, using LDGB can provide the non-linear model with the linear solution as the conditions at open boundaries. In this case, the open boundaries are recommended to be chosen at the places where the non-linearity is weak.

The initial applications of LDGB to tsunami and storm surge problems will be demonstrated. Included in the demonstrations are the animations for the two real tsunamis: the Indian Ocean tsunami off the coast of Sumatra of Indonesia in December. 26, 2004, and the Atlantic Ocean tsunami off the Burin Peninsula Newfoundland Canada in November 18, 1929. How a local domain responds to a passing storm above its domain or even to a remote storm located outside of its domain will be also demonstrated.

2:30 PM

3C3.5
A Shared Atmosphere-Ocean Dynamical Core: First Validation
Francois Roy [1] *, Claude Girard* [2] *, Pierre Pellerin* [2] *, François J. Saucier* [3] *, Hal Ritchie* [2]
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The purpose of this study is to test the feasibility of converting an atmosphere model code into an ocean model code, hence producing a single code that is valid for both atmosphere and ocean modelling. There are several motivations for doing this. Recent developments on numerical methods in the atmospheric sciences have permitted the elimination of some approximations that are traditionally applied in the primitive equations (hydrostatic approximation; filtering sound waves). Oceanographic models use essentially the same set of primitive equations as atmospheric models. There will be increasing use of coupled atmosphere-ocean systems, which could be simplified by using the same code for both fluids. If this preliminary project is successful, a more general project will be proposed using a model with tangent linear and adjoint code for advanced data assimilation, thus facilitating future atmosphere-ocean data assimilation research and development.

Here the dynamical kernel of the Canadian atmospheric model MC2 (Mesoscale Compressible Community) and its generalized formulation for geophysical fluids (Girard *et al.* 2004) is evaluated for ocean modeling. The kernel offers an efficient non hydrostatic solution plus technical and computational advantages for Canadian modelers. With the addition of a seawater equation of state, the free surface and rigid boundaries, the MC2 semi-implicit semi-Lagrangian scheme is tested against idealized cases. A built-in eulerian second order centered scheme is also used to compare with the semi-Lagrangian scheme. Simulations of the classical lock-exchange problem are first presented. They show that the adapted fourth-order semi-Lagrangian scheme meets the precision of other widely used schemes: it is quasi-conservative, monotonic, and shape preserving. The introduction of rigid boundaries is illustrated with a 2D flow around a cylinder including the generation of Von Karman streets. The introduction of the free surface is validated through simulations of internal and external gravity waves as well as Rossby waves. Future work is planned for the introduction of ocean physics including vertical mixing and external forcing for the sea surface, bottom friction, and lateral boundaries. This would allow modeling realistic stratified coastal oceans while benefiting from the advantages of the MC2 kernel.
Reference:

Girard C., Benoit R., and Desgagné M. (2004) Finescale Topography and the MC2 Dynamics Kernel. Accepted in Monthly Weather Review

2:45 PM

3C3.6
Spectral nudging in the tracer and momentum equations
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Nudging is a simple method by which numerical model results are pushed towards observations by adding terms to the dynamical equations that are proportional to the differences between model and observational results. Spectral nudging is an extension of this approach that allows one to nudge specified frequency bands towards observations while others are permitted to evolve according to the model dynamics. The approach can be applied to any form of nudging, including the standard approach in which nudging terms are added to the tracer equations and the semi-prognostic approach in which nudging terms are added to the momentum equations. Here, we consider results obtained using each of these approaches. In either case, we find that the mean sea level and the depth-integrated flow and overturning circulations are significantly improved by nudging. However, both the tracer fields and the variability about the climatological conditions are more reliably represented using the approach in which nudging terms are added to the tracer equations. A simple transformation is used to show that the semi-prognostic approach can be represented as a special form of nudging in the tracer equations and this is used to interpret the differences obtained using the two approaches. The model errors that result in the need for nudging will be examined.

1:30 PM

3C4.1
Ensemble Air-Quality Forecasts over the Lower Fraser Valley, British Columbia
Luca Delle Monache [1], *Xingxiu Deng* [3], *Yongmei Zhou* [3], *Yan Shen* [3], *Henryk Modzelewski* [3], *George Hicks* [3], *Trina Cannon* [3], *Roland B. Stull* [3], *Colin di Cenzo* [2]
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Ensemble weather forecasts have been extensively evaluated over the past decade, and found to provide better accuracy than any single numerical model run. Different Numerical Weather Prediction (NWP) models usually perform better for different situations, and often their behavior cannot be anticipated. Hence, their combination into a multi-model ensemble is usually fruitful.

The ensemble technique can potentially yield similar benefits to air-quality (AQ) modeling, because there are similar code complexity and constraints. Different AQ models can be better for different air-pollution episodes, also in ways that cannot always be anticipated. For AQ, the ensemble-mean can be created similarly with different inputs (background concentrations, emissions inventories, meteorology), different parameterizations within a single model (chemistry mechanisms, rate constants, advection and dispersion packages), different numerics within a single model (finite difference approximations and solvers, grid resolutions, compiler optimizations), and different models.

Results of an AQ ensemble forecast system will be presented. The system includes the Community Multiscale Air Quality Model (CMAQ), driven by the Fifth-Generation NCAR / Penn State Mesoscale Model (MM5), and the Mesoscale Compressible Community Model (MC2). CMAQ is run with a resolution of 12 and 4 km. Furthermore, for each of the four mesoscale model/resolution combinations CMAQ is run four times with different settings, leading to sixteen different ensemble members.
The spatial domain considered in the simulation includes the Lower Fraser Valley (LFV) of British Columbia.

1:45 PM

3C4.2
Air Quality Forecasting in Ontario: A Review of Past and Current Activities, and Future Needs
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Historically, Ontario has been involved in air quality forecasting since 1970 with the development and use of an Air Pollution Index as a basis for action in an alert system to control or prevent air pollution episodes due to elevated levels of ambient sulphur dioxide and suspended particulate matter levels at the community level. This required forecasts of meteorological conditions conducive to elevated pollution levels which would persist for at least six hours.

In 1981 the Lambton Industry Meteorological Alert System was introduced in the Sarnia petrochemical valley to prevent the occurrence and persistence of elevated levels of sulphur dioxide on a regional scale. For this activity, alerts were issued when elevated sulphur dioxide concentrations reached a certain threshold and the meteorological forecast indicated that these conditions would persist for six hours or longer.

With the introduction of the Ontario Air Quality Index (AQI) in 1988, air quality forecast for up to six common contaminants were required, namely, sulphur dioxide, suspended particulate matter, ground-level ozone, nitrogen dioxide, carbon monoxide and total reduced sulphur compounds. Basically, the forecasts for this activity reflected the probability of occurrence of meteorological conditions that contributed to unacceptable AQI at specific locations. In this regard, ozone was the dominant driver of unacceptable AQI across southern Ontario and hence, the main emphasis was focused on forecasting, on a regional scale, elevated ozone levels and related synoptic weather conditions.

In 1993, the Ontario Ministry of the Environment and Environment Canada initiated a joint effort to issue smog advisories (initially called air quality advisories) when widespread elevated pollution levels due to ground-level ozone are forecast to occur within the next 24 hours. This was seen as a natural expansion of existing AQI activity. It was further enhanced in 2000 when the smog alert program was expanded to include a two-level air quality forecast that provides a three-day

outlook, in addition to the 24 hour smog advisory. More recently, fine particulate matter was added to the AQI and Smog Advisory program in 2002, and as a result, today's requirements include forecasting of widespread elevated pollution levels due to ozone and/or fine particulate matter, and as well, to address air quality forecasting issues related to local poor air quality incidents.

To assist in current air quality forecasting activities, a number of tools are available such as Environment's Canada CHRONOS (Canadian Hemispheric and Regional Ozone and NOx System) model forecasts for ozone and fine particulate matter, NOAA's WRF/CHEM and NOAA-EPA NCEP/AQFS model outputs for ozone and fine particulate matter, High Resolution Meteorological Forecast Maps for Southern Ontario and NOAA HYSPLIT Air Parcel Trajectories, and AirNOW near real-time ambient data of ozone and fine particulate matter for eastern North America. In addition, there is on-going discussion with meteorologists in Michigan on air quality forecasts so as to coordinate the issuance of smog advisories in Ontario and the issuance of Ozone Action Days in Michigan.

As a result of current activities underway to develop a national health-risk based Air Quality Index, future air quality forecasting requirements will likely be centred on four pollutants, namely, ozone, fine particulate matter, sulphur dioxide and nitrogen dioxide. This will require air quality forecast skills not only for elevated levels of these pollutants but also for the entire distribution of pollutants levels since heath effects for some of these pollutants can have very low thresholds.

This presentation will provide an overview of the role of air quality forecasting in Ontario and some of the challenges and opportunities ahead.

2:00 PM

3C4.3
Trans-Boundary Transport of Air Pollution over Nova Scotia with Implications on Air Quality Forecasting: Case Study: June 9-10, 2004.

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Airmasses travelling over heavily industrialized regions of Eastern Canada and the North-eastern United States often carry significant concentrations of pollutants including fine particulate matter, ground-level ozone and its precursors. Surface-based air monitoring networks in Nova Scotia report the air quality index and on June 9-10, 2004 indicated an episode of degraded air quality that encompassed the entire province.

The character and behaviour of this event will be explained in terms of the response from the air monitoring network and will include evidence in 'wind-profiler' data indicating that polluted-air transported at a higher altitude along the Saint Lawrence River corridor can be mixed to lower altitudes over Nova Scotia.

Particular attention will be paid to the transport patterns, local forcing and the resultant air-monitor response. Implications on air quality forecasting of these events will also be highlighted.

2:15 PM

3C4.4
Real-Time Weather and Air Quality Forecast Products in Support of ICARTT 2004 and Prairies 2005.

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During summer 2004, the air quality modeling applications group (AQMAG) provided real-time weather and air quality forecasts to support the ICARTT campaign. The numerical meteorological model "GEM" and the air quality models "CHRONOS and AURAMS" were run on a daily basis to produce a 48-hour chemistry-weather forecast over North America. Models results were used by weather and chemistry forecasters in the field for flights planning activities, as well as researchers for models inter-comparison studies. An ozone ensemble forecast was produced a posteriori with the different US and Canadian chemistry models.

2:30 PM

3C4.5
Integration of Real Time PM2.5 Emission Rates from Forest Fires with a Dynamic Model in order to Simulate Wildfires in CHRONOS to Improve the AQ Forecast

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Wildfires represent a significant source of PM2.5 in Canada and are a main concern for air quality. Smoke plumes generated by wildfires can travel over long distances and affect communities with very high concentration of PM2.5. Situations like this demand predictive capabilities for forest fire emissions. Currently, there is no operational air quality model available in Canada to take account of PM2.5 emission rates from forest fires.

The objective of this work is to integrate real time emission rates due to wild forest fires into a model such as CHRONOS. A dynamic biomass emission model was used to estimate the source emission rates (spatial and temporal) of PM2.5 (gas source and particle source) and apply these emission rates to a case study of the July 1-12, 2002 Quebec forest fire. Fire site reports such as total burned area (ha.), and the beginning and ending time for each fire location have been collected from the Quebec fire agency SOPFEU. These data were used to generate temporal and spatial distribution of field emissions. Surface and upper air meteorological variables such as temperature, relative humidity, wind speed and direction have been obtained from GEM 00Z and 12Z runs to characterize emission fields. These were then used to build hourly PM2.5 emission rates for all forest fire sites during the event.

The new field emission rates have been integrated into the PM CHRONOS model and run for the entire episode. Comparison between model outputs and observed hourly PM2.5 mass from US and Canadian surface air quality monitoring sites show good agreement in spatial and temporal distribution of the smoke plume during the entire period. A significant improvement in PM2.5 hourly concentrations of up to 30% over Quebec and 25% over the United States was observed.

All the results will be presented and future work will be discussed.

2:45 PM

3C4.6
Ozone Forecasting in Central B.C. Using Maximum Wind Speed and Hours of Bright Sunshine

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Ozone Forecasting in Central B.C. Using Maximum Wind Speed and Hours of Bright Sunshine

Abstract
Millions of dollars and time have been spent on improving the forecasting skills for predicting maximum ozone levels. Computer models have ranged from basic multiple regression to more complex chemical models. Depending on the location, one model may do a better job at forecasting maximum ozone than another. The approach in this presentation uses only wind speed and hours of bright sunshine. Comparing the predicted with actual gives a R-square of 0.64 using just these two parameters. Refining the model for the location can provide better results with a r-square of 0.71

1:30 PM

3C5.1
The Extratropical Transition of Hurricane Karen: Data and Modelling Studies
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In October of 2001, Hurricane Karen formed in the Atlantic Ocean near Bermuda, moved northward and eventually made landfall at tropical storm strength on the coast of Nova Scotia. The storm was undergoing a transition from a tropical system to an extratropical cyclone as it made its landfall. The processes and changes taking place in a storm undergoing this type of transition remain poorly understood, and numerical forecast models often encounter difficulties in forecasting transitioning systems. As a result, there were many forecast problems associated with this storm as it approached Canada's East Coast. In particular, the Canadian Hurricane Centre had difficulty forecasting the location of the storm's centre, and its associated rainfall amounts.

Shortly before the storm made its landfall, a Canadian research flight sampled meteorological data along and across the storm's path, by launching dropsondes. This presentation will highlight some of the information from these dropsondes, detailing some of the structure of the storm as it moved into higher latitudes and over colder waters. The presence of a very stable boundary layer is evident, with the warm moist tropical air residing above. In the second part of the presentation, the dropsonde data is used to try to improve the simulation of extratropical transition by a high resolution numerical weather prediction model. The conclusions point out some areas where improvements in the model and in its initial conditions might help in future modelling studies.

1:45 PM

3C5.2
Hurricane Juan: a diagnostic and compositing study
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A detailed analysis of the complex lifecycle of Hurricane Juan (2003) is undertaken to elucidate the structures and forcings that prevailed over the period leading up to the hurricane's landfall in Halifax, Nova Scotia, Canada. Despite the presence of easterly wave precursors, Hurricane Juan's initial development is shown to occur in a baroclinic environment beneath a low-latitude potential vorticity (PV) streamer. This feature interacts with a lower-level shear line and the incipient vortex begins to effectively focus convection. The system undergoes a slow tropical transition over a period of several days as the deep-layer shear over the developing storm decreases. The hurricane is repeatedly perturbed by sub-synoptic scale waves traveling along the leading edge of a large upstream trough. However, Hurricane Juan maintains its tropical structure despite its relatively high formation latitude (28ºN) and its northward trajectory.

The unusual persistence of the storm's tropical nature as it propagates northward is of primary interest in this study. In particular, the role of persistent ridging along the east coast of North America is investigated both in high-resolution analyses for Hurricane Juan and in a compositing framework. This ridge is shown to be a direct result of injections of low PV air from the central Pacific Ocean. Given the strength and persistence of the anomalous ridge-trough couplet both in the case diagnosis and in the composite fields, the study concludes that the presence of pre-storm, high-amplitude ridging along the east coast likely reinforced by diabatic ridging downshear of the storm itself produces an environment both dynamically and thermodynamically conducive to the high latitude landfall of hurricanes still in the tropical phase.

2:00 PM

3C5.3

Warm season precipitation events in the St. Lawrence River Valley
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(Presented by / Présenté par ***John Gyakum***)
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The problem of quantitative precipitation forecasting (QPF) continues to be a challenge. Large-scale numerical guidance is helpful, but improvements in QPFs have lagged those of the 500-hPa height forecasts. Substantial warm-season precipitation events include those that are associated with former tropical cyclones, mesoscale convective systems, or relatively weak baroclinic zones associated with elevated convection. This study focuses on illustrating the dynamics associated with extreme warm-season precipitation events for the complex topography in the St. Lawrence River Valley. These events were identified using the unified precipitation data set (UPD), a gridded data set available from Climate Diagnostics Center (CDC).

During the 50-year period (1948-1998), using the stipulation of a 7-day separation, we identified 53 extreme cases, 94 heavy cases, and 61 moderate cases. Extreme events, which are rare, were preferentially eliminated from the more common heavy events. In addition, dates before 1963 were eliminated owing to the poor quality of the available National Centers for Environmental Prediction (NCEP) reanalysis. To create composites comparable to the extreme cases, the same numbers (53) of heavy and moderate cases were used and were chosen at random.

The NCEP reanalysis and 30 year climatologies were used to construct composites of each intensity category. Preliminary results indicate that extreme events are associated with slow moving synoptic-scale systems with persistent anomalous ridging in the height and moisture fields over the St. Lawrence River Valley. Heavy events are associated with relatively well defined and steadily propagating trough-ridge couplets. The implication of these results is that extreme events are characterized by strong thermodynamic instability with moderate forcing for ascent while heavy events are characterized by moderate thermodynamic instability with strong forcing for ascent. Through the identification of large-scale anomalous circulation precursors to warm season precipitation events in and near the St. Lawrence River Valley, it is expected that forecasters will be able to recognize the intensity of an event in advance and improve forecast and warning lead times.

2:15 PM

3C5.4
Vortex Rossby Waves in Hurricanes: their importance for numerical weather prediction
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An innovative potential vorticity diagnostic tool called Empirical Normal Modes (ENMs) was applied to diagnose inner spiral bands formed in an explicitly simulated hurricane using the high-resolution PSU-NCAR nonhydrostatic mesoscale model MM5 in Chen et al. 2003 (J. Atmos. Sci. - JAS). The ENM method has the capability to decompose simultaneously wind and thermal fields into dynamical consistent and orthogonal modes with respect to wave-activities (Brunet 1994 JAS; Brunet and Vautard 1996 JAS; Charron and Brunet 1999 JAS; Zadra et al. 2002 JAS).

For wavenumber one and two anomalies, it was found that the leading modes are vortex Rossby waves that explain 40% to 50% of the wave activity in a period of 24 hours. The Eliassen-Palm (EP) flux and its divergence show that the vortex Rossby waves are concentrated in the inner-core region where the radial gradient of the basic state potential vorticity is large. In general, these waves propagate outward in the lower troposphere and inward in the upper troposphere. The vortex Rossby waves lead to significant wave-mean-flow interaction, as indicated by the divergence of the EP flux, with tangential wind acceleration or acceleration of order 1-2 m/s per hour in the vicinity of the eyewall region. The vortex Rossby waves show also characteristics typical of flow with critical level and sheared disturbances. Hence these mesovortices are responsible for the dynamical processes controlling the redistribution of angular momentum in the inner core.

A proposed follow-up study will apply the ENM diagnostics to tropical cyclones with higher resolution simulations, using the Meteorological Service of Canada MC2 non-hydrostatic LAM, which resolves the convective scale and the critical level. A collaborative effort between the Earth Simulator Center (ESC), Recherche en Prévision Numérique and McGill University is now focusing on simulating the full life cycle of hurricane Earl (September 1998). The goal is to produce a 1 km horizontal resolution forecast over a very large domain which covers the tropical and extra-tropical re-development of Earl. It will produce 8-9 days of simulation on a fine-resolution domain of size 11000 x 8640 x 67. This simulation and others with lower resolution will be used to comment the role of these vortex Rossby waves in the tropical and extra-tropical transition phases. We will point out the expected implication of these results in the context of numerical weather prediction at different space-time resolutions.

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2:30 PM

3C5.5
Observing systems and predictability on forecasting extreme weather events: a component of the THORPEX programme
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In the early 1990s, emerging techniques based on adjoint modelling suggested that it would be *practically* feasible to determine the specific aspects of the initial conditions that could translate into the most significant changes in the forecast at a given lead time of, say, 48 hours. This information could be extremely useful to *target* those sensitive regions by deploying instruments. The data gathered in this way are expected to have the most important impact on the forecast. This idea was put to the test during the FASTEX campaign of January and February 1997. The data collected have been used extensively to assess whether the targeted data (or *adaptive observations*) can influence the forecast as much as expected. One important conclusion was that the impact of the data is highly dependent on the assimilation method used, that is the manner in which the information contained in these measurements is extracted and combined with that contained in a background field obtained from improving numerical models. The targeted data provides information over key sensitive areas but the assimilation method needs to be able to translate this into dynamically significant changes to the background field used in the analysis. A key and important objective of THORPEX is to assess the impact of adaptive observations.

Over the next 10 years, many satellite instruments will provide impressive amounts of data that will increase the current volume of data used in operational systems by orders of magnitudes. The assimilation of this large quantity of new data within an operational context represents a significant computational challenge. Consequently, some thought must be devoted to determine the types of data that could most improve the analysis and resulting forecasts. This should be tested in a context with all existing observations to estimate the *added* information from a particular instrument. The focus of THORPEX being on extreme weather, new instruments must provide useful information in sensitive areas deemed to be crucial. Even though they provide a fairly global coverage, satellite data show weaknesses over cloudy areas where interesting weather is located (e.g., hurricanes). It may therefore be assumed that targeted data could be most beneficial in these areas. Such questions need to be examined in close collaboration with operational data assimilation groups.

1:30 PM

3C6.1
Convection, Lightning and Fire in the Mackenzie Basin
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Thunderstorms play an important role in the cycling of water and energy over the boreal ecosystem of the Northwest Territories of Canada during the warm season. Associated lightning activity can also initiate forest fires. Global distributions of lightning derived from satellite observations indicate that this region experiences a relatively large amount of lightning, given its high latitude location. However, no previous work has been directly applied to the Mackenzie River Basin (MRB). Our research objectives centre on enhancing knowledge of the interactions between the atmosphere, devastating fires and their ecological impacts in the Mackenzie Basin and other northern environments, and in user application development and transfer. This presentation will highlight the research contributions of the lightning studies to the objectives of the Mackenzie GEWEX Study.

A variety of data sets have been used to examine the lightning activity, cloud and convective processes in the water cycle and their impacts on the forests of the MRB. These include the archived strike data from the lightning detection network operating in the NWT, fire data from the Canadian Forest Service's national Large Fire Database, surface and upper-air station data, and historical gridded data from the Environment Canada and the National Centers for Environmental Prediction (NCEP) digital archives.

During the summer of 2004, a workshop/demonstration project was held to better understand and improve the current uses of lightning data, to illustrate how MAGS results could be used to address stakeholder needs, to identify knowledge gaps and areas of future research, and to strengthen links with stakeholders. The participation of forest and fire managers, emergency management personnel, weather forecasters and researchers from various provincial, territorial, municipal and national agencies, and researchers from the Canadian Forest Service and several universities, in this project underscores the interest in lightning research and application development.

1:45 PM

3C6.2
Atmospheric Circulation Patterns of Extreme Lightning Events in the Mackenzie River Basin
Andrew Way [1] , *Eyad Atallah* [1] , *Blaise Gauvin St-Denis* [1] , *John Gyakum* [1] , *Bob Kochtubajda* [2]
(Presented by / Présenté par ***Andrew M. Way***)
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Intense convection is a common occurrence in the Mackenzie River Basin (MRB) during the early and middle summer despite the region's northern location. This convection contributes greatly to annual runoff from the basin into the Mackenzie River and subsequently into the Arctic Ocean. Additionally, numerous cloud-to-ground lightning flashes are observed with convection within the MRB, and in many cases high lightning flash output occurs with little precipitation, raising concern for potential resultant wildfire activity. We wish to identify the atmospheric circulation patterns associated with extreme lightning events in the MRB, and determine whether the bulk of these events are dynamically or thermodynamically induced. To accomplish these objectives, lightning flash data from the lightning detection network operating in the Northwest Territories and gridded data from the National Center for Environmental Prediction global reanalysis are used.

A composite analysis of 38 extreme lightning events has shown that these events in the MRB are generally characterized by an anomalously-strong, persistent upper-tropospheric ridge that dominates the basin until event onset. The presence of this ridge increases evaporation from the surface, which leads to accumulation of water vapor in the atmosphere. The triggering mechanism of the majority of these events is cyclogenesis in lee of the Rocky and Mackenzie Mountains. Currently, we are stratifying the sample of extreme lightning events based on the events' longevity to determine whether there are major synoptic-scale differences between short-lived and long-lived events.

2:00 PM

3C6.3
Wildfire Aerosol Forcing on the Radiation Budgets over the Makenzie River Basin
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Atmospheric aerosols play an important role on the radiation balance of the earth-atmosphere system. Aerosol direct radiative forcing can influence the radiation budgets both at the top of atmosphere (TOA) and at the surface through scattering and/or absorption. Forest wildfires frequently happen in Canada and the US each summer, producing serious atmospheric and environmental impacts. The smoke aerosols produced by wildfire are usually dominated by absorbing aerosols. Several large forest fires in British Columbia in the summer of 2004 are selected to study the direct aerosol radiative forcing over the Mackenzie River Basin, which was directly downwind of the fires. The CERES and MODIS instruments on board the same satellite platforms (Terra and Aqua) provide the data to study aerosol radiative forcing. Solar fluxes at TOA are obtained from CERES dataset and solar fluxes at the surface are derived by using Li and Leighton algorithm. The aerosol optical depths and cloud amounts are retrieved from the MODIS MOD04_L2 dataset. The data are temporally interpolated and spatially gridded on to the same grid for each overpass for each sensor. Both the satellite data (scene identification from CERES dataset, cloud fraction from MODIS dataset) and regional reanalysis dataset will be used to classify the clear sky and overcast pixels. The optical thicknesses in clear sky pixels in British Columbia as high as ~3.0 and downwind impacts over parts of the Mackenzie River Basin with optical thickness as high as 1.8 have been seen. Results of the direct aerosol radiative forcing for shortwave radiative fluxes both at TOA and at the surface and longwave radiative forcing at TOA will be presented.

2:15 PM

3C6.4
Blowing Snow Sublimation in the Northern Mackenzie River Basin
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A physically based parameterization of blowing snow sublimation has been developed and fit to the results of the PIEKTUK model. Using archived meteorological data for Tuktoyaktuk, Inuvik, Norman Wells, Yellowknife, Fort Simpson, and Fort McMurray, the occurrence of blowing snow at each site is calculated using the criteria of Dery and Yau (1999), and the amount of sublimated blowing snow is estimated using the parameterization. Results demonstrate that, even with occurrences of blowing snow as high as 10% each winter (with T<0C), the amount of snow removed by blowing snow sublimation is less than 1% of the total precipitated snow. As a comparison, at Resolute, where the average occurrence of blowing snow is calculated as 16%, 12% of the precipitated snow is removed by blowing snow sublimation. The blowing snow sublimation parameterization has been added to the land surface scheme CLASS and tested against observed snow depth at Hay River. A simple ice model based on CLASS and routines in AGCM2 has also been developed and tested against observed snow depth on Great Slave Lake and Franklin Bay. CLASS generally over-predicts snow depth at all of the sites, suggesting that the amount of blowing snow sublimation may be greater than what is predicted by PIEKTUK. However, CLASS does not account for wind packing of snow, and the snow density measured at Franklin Bay is twice the snow density modelled by CLASS.

2:30 PM

3C6.5
Northern Lake Impacts on Climate
William Allan Perrie [1], *Zhenxia Long* [1], *John Gyakum* [5], *Murray MacKay* [4], *Wayne Rouse* [3], *William Schertzer* [2]
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It is well known that large lakes can perturb local climates through mesoscale circulations, for example, lake-effect storms and lake-breezes, and the impacts on fluxes of heat, moisture, and momentum. Weather events can greatly influence the hydrodynamic regimes of lakes, for example by surface layer mixing and upwelling, and in turn are affected the large difference in heat capacity, roughness length, and albedo of water compared with nearby soil and vegetation, as well as

differences in the vertical transfer of heat in the water column compared with that on land. For both large and small lakes, the importance of atmosphere-lake interactions in Northern Canada, is unknown.

The Princeton Ocean Model (POM) will be coupled to the Canadian Regional Climate Model (CRCM) for Great Bear Lake, as an attempt to examine the interaction between a large northern lake and the atmosphere. The work of Rouse et al. (2003) have suggested an important role for large northern lakes on the regional climate. Great Bear Lake, with a surface area of 31,000 km^2, is one of the world's largest lakes to straddle the Arctic Circle, and presents an excellent opportunity to study air-sea interactions at high latitudes.

Under the Canada's GEWEX programme a highly successful field campaign has produced a novel data set of atmospheric sounding and surface flux information. These data provide insight into the atmospheric planetary boundary layer response to varying synoptic scale regimes and the impacts of lake-atmosphere interactions. This study also allows us to check the traditional interfacial flux parameterizations for a high-latitude location, with the measured fluxes. Such parameterizations are normally tuned for low wind tropical or extratropical regimes in climate models. POM has already been successfully applied to extratropical regimes in the North Atlantic (see Ren et al. 2004, Monthly Weather Review).

2:45 PM

3C6.6
The Influence of Great Bear Lake on Atmospheric Boundary Layer Structure
Andrew Way [1] *, Eyad Atallah* [2] *, John Gyakum* [2]
(Presented by / Présenté par ***Andrew M. Way***)
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Great Bear Lake, located in the central Northwest Territories and recognized as the largest lake situated entirely within Canada, has recently become a major research interest regarding lake-atmosphere interactions. Since the summer of 2004, data have continuously been gathered on Lionel Island, a remote island in the center of the Great Bear Lake's Keith Arm, concerning the lake's thermal structure and heat fluxes from the lake. In addition, atmospheric soundings were taken on the island during August and September of 2004. We aim to understand how the presence of a very large lake in a northern region such as the Mackenzie River Basin affects the structure of the lower troposphere, as well as mesoscale phenomena such as lake-effect snow and lake breeze convection. We also wish to understand the local meteorological conditions privy to large latent and sensible heat flux episodes from the lake. Eventually, an incorporation of flux data from Great Bear Lake into high-resolution atmospheric models to investigate the effect of accurately represented fluxes on weather forecasts is desired.

Preliminary results thus far have shown dramatic differences in the structure of the planetary boundary layer between Lionel Island and nearby Norman Wells, just over 200 km to the west. Immense inversions in the first 30 to 40-hPa of the boundary layer have been observed in the mid-summer period at Lionel Island owing to the presence of a cold lake in a warm large-scale regime. Furthermore, we have observed thin superadiabatic layers in the near-surface boundary layer during the late summer during a moderate cold air outbreak over the lake. Already we have significant evidence of Great Bear Lake's influence on atmospheric stability and we recognize the potential benefits of these findings to atmospheric models. We are currently analyzing flux data trends corresponding to different boundary layer structures, and are relating these results to large-scale atmospheric circulation features.

1:30 PM

3C8.1
Development of Winter Severity Index for Winter Road Operations
Chris Marshall
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Winter road maintenance is a challenge for all road authorities. Significant resources are mobilized and expended to control snow and ice on roads across Canada to maintain safe and efficient travel. Road authorities with responsibilities for road winter maintenance include public and private entities such as municipal, provincial, national transportation and public works departments. Winter road maintenance is estimated to be a $1-billion a year-industry in Canada.

Given the high costs associated with winter road maintenance, as well as potential environmental impacts of road salt, there is pressure mounting to develop means of benchmarking the severity of a given winter season, on a provincial, municipal, and even road-segment scale. The development of a common severity scale depends on the application of information from point and remotely sensed sources of data, and in some cases will be extremely challenging due to limitations in data such as daily snowfall measurements, and questions related to the reliability and accuracy of pavement sensors.

The resulting system will need to develop an expanded suite of climate normals for items such as; number occurrences of pavement temperature passing through 0 C, total number of “ice warning” alarms reported from pavement sensors, days with trace, 2 cm, 5 cm snow etc. The resulting “*Road Weather Normals*” will provide a starting point for the development of location specific, winter maintenance performance measurement systems.

1:45 PM

3C8.2
RWIS System Deployment and Operation - The Alberta Approach.
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Road Weather Information Systems (RWIS) have been recognized and accepted by road authorities as a key tool to enhance winter maintenance services. All the provinces and territories have formed an RWIS for Canada working group, a national RWIS network envisaged to span from coast-to-coast with a minimum RWIS station deployment level along the National Highway System.

Alberta Infrastructure and Transportation have developed a deployment plan for Alberta's portion of the National Highway System. This plan calls for a network of 75 RWIS Environmental Sensor Stations across the province.

Alberta Infrastructure and Transportation with the services of IBI Group have developed a request for proposal (RFP) model which calls for a single entity to design, install, operate and provide forecasting services for a period of 10 years for the full provincial program. This unique Alberta approach to RWIS deployment and services could serve as a model to come for other regions across Canada.

This presentation will discuss some of the unique aspects to the structure and approach of the RFP, some of the advantages, disadvantages and challenges in developing the terms of reference for this type of a program. Some of the specific discussion areas include business models, technical standards, local expertise, data sharing and planned effect on local staffing levels.

2:00 PM

3C8.3
How Can We Achieve Greater Value from RWIS in Winter Operations?
Dale Keep
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The value of the information that Road Weather Information Systems (RWIS) provide during winter operations can be an advantage to the road maintenance industry when used properly. Operations staff must understand that air temperature alone will not provide the expected results of ice free and safe driving conditions. Knowledge of ground temperature and

how it correlates with chemicals can dramatically affect the number of applications applied. When ground temperature is used with proper maintenance procedures, the benefits include less chemicals being dispersed which translates into lower costs incurred by the client. Combining and understanding the proper use of the information derived from RWIS into the winter operation equation, equals proper chemical application, which is a win/win for the road maintenance service provider, the customer, the traveling public, and the environment.

2:15 PM

3C8.4
The Weather Network-Commercial Services: The Complete RWIS Solution
Bruce Caven
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This past fall, The Weather Network's Commercial Services Division, launched an "end to end" RWIS solution. Under this new service program, we provide complete site consultation, equipment provisioning and installation, data hosting and archiving, telecommunications interfaces, road and weather forecasts and on-going RWIS maintenance on a fee for service basis. Part of our weather forecasting tool kit includes the use of detailed site-specific RWIS atmospheric and pavement data, numerical prediction data from world renowned meteorological sources, radar and satellite imagery and our own leading-edge proprietary atmospheric forecasting system the "PFE". This service is unique to Canada as is the past, RWIS users would have been required to cover the capital, maintenance and operating costs of the RWIS systems themselves. The Weather Network is effectively offering an "RWIS" outsourcing model. This paper will focus on advances in road weather technologies employed by The Weather Network.

2:30 PM

3C8.5
Panel Discussion on Road Weather Technologies-1
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This is an opportunity for the attendees to ask questions of the speakers in this session on road weather. Claude Labine will guide the discussion.

3:30 PM

3E1.1
Tree migration after a breakdown of the North Atlantic thermohaline circulation
Jennifer Brauch , *Andrew Weaver*
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Fluctuations in the CO2 paleo-records have been linked to abrupt changes in the North Atlantic thermohaline circulation. It is still an open question what role the land vegetation played in this changes. We use an earth system climate model to investigate the reaction of several plant functional type to a breakdown of the thermohaline circulation. The surface air temperature is reduced over the North Atlantic which forces the boreal treeline to migrate south in northern Eurasia. The time frame and the reasons for the shift will be discussed in detail in the presentation.

3:45 PM

3E1.2
Seven years of CO2 and water vapour exchange measurements above a West Coast Douglas-fir forest
Kai Morgenstern [1] , *Andy Black* [1] , *Christopher Schwalm* [1] , *Tiebo Cai* [1] , *Paul Jassal* [1] , *Elyn Humphreys* [3] , *Zoran Nesic* [1] , *Dave Spittlehouse* [2]
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Over the course of seven years that include the El Niño events of 1997/1998 and 2002/2003, annual carbon (C) sequestration measured at a Douglas-fir stand on the Canadian west coast varied between 196 and 375 g C m^{-2} per year, while during the same period annual evapotranspiration was relatively constant at 206 to 232 mm per year. The stand was established in 1949 on the east coast of Vancouver Island, BC, Canada and is located on a 5 - 10% slope with trees 35 m in height. Eddy covariance measurements of CO_2 and water vapour fluxes were initiated in September 1997 and are ongoing. This unique data set has allowed us to analyse how the C and water balances of an ecosystem type typical of the Pacific Northwest change under climate variations induced by El Niño events.

To establish relationships between ecosystem photosynthesis (P) and evapotranspiration, P was calculated as the sum of net ecosystem productivity (NEP) and ecosystem respiration (R), i.e. P = NEP+R. R during the daytime was calculated from the relationship of soil temperature and nighttime NEP = - R, which was allowed to vary seasonally. This estimate usually agree to within 10% with R estimated as the intercept of the light response of NEP. Nighttime measurements were only used for the analysis when friction velocity was above a threshold of 0.3 m/s. The pattern of interannual variability did not vary with either this threshold or the use of an annual instead of a seasonal soil temperature relationship.

Analysis of monthly light response for P showed that maximum assimilation rates at high light levels varied from 10 mol m^{-2} s^{-1} in December and January to just under 30 mol m^{-2} s^{-1} in July and August. Low soil moisture in late summer led to the reduction of maximum assimilation. However, monthly totals of P were related linearly to downwelling photosynthetically active radiation and there was little interannual variation in the light use efficiency, which had an overall value of 0.25 g C / mol photons. Similarly, stomatal conductance tended to decrease with decreasing soil moisture, yet this was only important during late summer. Water use efficiency was also roughly constant seasonally as well as for different years. Using monthly values, the stand sequestered 6 g C / kg H_2O with monthly P as high as 380 g C m^{-2} per month in summer. The 1997/1998 El Niño event led to an unusually warm spring in 1998, leading to an increase in respiration and consequently low annual NEP of 301 g C m^{-2}. The 2002/2003 El Niño caused an unusually mild early winter in 2002 which again caused an increase in R.

4:00 PM

3E1.3
Large-eddy simulation of CO2 transport through forest canopies in complex terrain
Haizhen Sun [1] , *Terry Clark* [1] , *Roland Stull* [1] , *Andy Black* [2]
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Tower data are typically used to estimate net ecosystem-atmospheric exchange of CO_2 (NEE) using eddy covariance (EC) approach. This approach requires that advection be negligible. It is usually assumed that this approach is more appropriate

for flat and homogenous terrain. The complex topography at the West Coast Flux station raises uncertainties in the EC estimation of NEE. This study employed a large-eddy simulation model, WFIS, to study the role of mesoscale flows on EC measurements and the advection effects on NEE.

The model was refined to include tree-drag, radiation, a surface energy budget, a four-layer soil model and source/sink terms for CO_2. Over an idealized two-dimensional mountain of similar horizontal and vertical scales as Vancouver Island, the experiments captured the first-order effects of diurnal heating/cooling on the sloping terrain during fair-weather. The volume exchange of heat, momentum and CO_2 above and within the canopy appeared to be strongly affected by the local flows resulting from diurnal thermal forcing, land-sea breezes and convective thermals. Effects of synoptic-scale forcing were neglected. The simulated CO_2 concentration showed significant variation and gradients near the surface, captured the transport processes at night and quantified the contributions of advection. The estimated NEE, without reducing the effects of convection, resulted in strong fluctuations during the day and the underestimation of nocturnal respiration by about 40%. When we subtracted half-hour averages (as is done in the EC technique) the daytime fluctuations of estimated NEE were strongly reduced and the nocturnal respiration was within 20% of the prescribed source. These results suggest further development and utilization of the model is warranted to evaluate sampling techniques to improve NEE estimates, assess effects at other sites and consider synoptic forcing.

4:15 PM

3E1.4
Biogeochemical cycling of carbon monoxide in the Canadian Beaufort sea
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Carbon monoxide (CO) in seawater is produced primarily through solar photolysis of chromophoric dissolved organic matter and is lost by microbial consumption and gas exchange. This study reports the biogeochemical cycling of CO in the Canadian Beaufort Sea in fall 2003 and spring 2004. Diurnal variations of [CO] were observed in the fall but lacked in the spring. The mean surface-water [CO] in the spring (4.7 nM) was 13 times higher than that in the fall (0.36 nM) as a result of higher photoproduction and much slower microbial consumption in the spring. The first-year sea ice in the spring was highly enriched with CO compared to the nearby open water. In both seasons surface seawater was supersaturated with CO relative to the atmosphere, leading to a net sea-to-air flux of CO. Microbial CO consumption always followed the first-order kinetics in the fall while inhibition and saturation kinetics were observed in the spring. Apparent quantum yields of photochemical CO production were determined and the magnitude of the photochemical source of this compound in the Arctic Ocean was estimated.

3:30 PM

3E2.1
The Effect of Enhanced Greenhouse Warming on Freezing Rain in North America
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A transient enhanced greenhouse warming simulation using the Canadian Centre for Climate Modelling and Analysis general circulation model (CGCM) is analyzed for changes in the climatology of freezing rain resulting from global warming. The analysis technique is discussed and applied first to the ERA40 reanalyes in an attempt to reproduce the current day freezing rain climatology. The analysis technique is then applied to model data to determine

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3E2.2
The Impact of Climate Change on Northwest Atlantic Extratropical Hurricanes
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This study explores the possible changes, due to high CO_2 environments, for midlatitude extratropical transitioning hurricanes (ETs), experiencing significant intensification as they propagate from their genesis areas in the North Atlantic topical basin into the Northwest Atlantic. Simulations were performed with the Canadian mesoscale compressible community (MC2) model, as driven by control and high-CO_2 climate estimates from the global coupled atmosphere-ocean climate model, the Canadian Climate Centre CGCM2 model. The control condition, representing present climate, is constituted by years 1975 to 1994 in CGCM2. The high CO_2 conditions were obtained from years 2040-2059 of a transient +1% yr^{-1} CO_2 increase experiment with CGCM2, following IPCC IS92a scenario, which gives a nearly doubling of CO_2 concentrations by 2050, compared to the 1980s.

Compared with the current climate, the storm tracks in the climate change scenario more nearer the coastal area of North Atlantic, become less tightly distributed in space and tend to propagate slightly faster (~10%). A consistent increase in storm intensity is suggested in simulations, and composite storm structure does show change. Averaged winds around the storm center become stronger, and although the maximum low-level tropospheric winds are weaker, higher-level tropospheric winds show notable strengthening (~5%). In storm simulations, the net impact of the climate change scenario is to cause a slight tendency for increase in number of severe storms (~5%).

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3E2.3

An investigation of the summer precipitation simulated by the Canadian Regional Climate Model

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A 5-year baseline integration for the period 1987-91 is first carried out over a Pan-Canadian domain to validate the performance of the third generation of Canadian Regional Climate Model (CRCM). The CRCM simulates well the large-scale circulation over North America; it also correctly captures the seasonal variability of surface temperature and realistically reproduces the winter precipitation over North America. However, the CRCM systematically overestimates the summer precipitation over the continent.

Extensive experiments have been conducted to trace down the sources of error in the simulation of summer precipitation. Particular attention has been paid to the water vapour related physical parameterization processes in the CRCM such as the Bechtold-Kain-Fristch mass flux convection scheme. Experiment involving spectral nudging of the specific humidity towards the values of large-scale driving data enable us to link overestimation with excessive water vapour accumulated in the lower boundary layer and too much moisture stored in the soil. A strong boundary layer mixing process from the third generation of the Canadian Atmospheric General Circulation Model is then implemented into the CRCM along with the

adjustment to the soil water holding capacity. A final analysis of a 14-month experiment shows that the modifications in the mixing processes significantly improve the simulation of summer precipitation over North America without adversely affecting the simulation of winter precipitation.

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3E2.4
Correction of GCM seasonal forecasts using the leading forced SVD patterns
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In a series of seasonal forecasts with two global atmospheric models, the atmospheric response to the specified sea surface temperature (SST) anomalies is found to be model dependent, not only in its amplitude but also in its spatial structure. The forced variability contains the information that may be useful for seasonal predictions at sufficiently long lead times. An SVD analysis is used for each model's ensemble mean forecast 500 mb geopotential height over the Northern Hemisphere and the corresponding tropical Pacific SST. The leading SVD patterns represent the dominant forced patterns associated with the tropical Pacific SST anomalies in the particular GCM, which may or may not match the forced patterns in the real atmosphere. A statistical approach to correct the ensemble forecasts is formulated based on the regression of the model's leading forced SVD patterns and the observed 500 mb geopotential height. This technique is applied to the winter forecasts from the two models. The principal components (PCs) of three leading atmospheric patterns of the SVD analysis are used in the regression equation. The performance of the corrected forecasts is assessed by comparing its cross-validated skill with that of the original GCM ensemble mean forecasts. We are particularly interested in the forecast skill of the two major atmospheric patterns, i.e., the Pacific/North American (PNA) pattern and the North Atlantic Oscillation (NAO). In the case of the PNA, the technique significantly improves the skill of the less skillful of the two models, and does not modify significantly that of the other model, which produces very good PNA forecasts even before the correction. For the NAO, the correction significantly improves the skill of both models.

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3E3.1
Tidal and Sub-Tidal Current Dynamics in Bonne Bay, Newfoundland
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We present and discuss current and hydrographic data from Bonne Bay, a fjord in western Newfoundland. Several ADCPs were deployed on and around the sill, between September 2002 and September 2004. We obtained atmospheric data from a nearby Environment Canada weather station. We analyze the structural characteristics of both the tidal and sub-tidal flow. The tidal flow shows an asymmetry between inflow and outflow. The sub-tidal flow shows a two-layer structure. Correlation analysis shows that the sub-tidal flow is primarily forced by local winds.

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3E3.2
Tsunami generation by submarine landslides: Models and application.
Roy A. Walters
(Presented by / Présenté par ***Roy Walters***)
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Submarine landslides and the generation of tsunami are currently a subject of intense scientific study in several disciplines. Our objective is to develop dynamic models for submarine landslides and couple these to a numerical model that solves the Reynolds-averaged Navier-Stokes (RANS) equations and computes free surface elevations. Using theory, numerical models, and experiments, several dynamic landslide models have been developed and evaluated, along with several methods to treat non-hydrostatic pressure variations. The current set of models has been applied to simulate tsunami generation, propagation, and runup for locally-generated tsunami near Kaikoura, New Zealand. The results provide interesting insights into the evolution in time of tsunami generation and into weakly-dispersive wave dynamics.

4:00 PM

3E3.3
Tides and Sea-Surface Variability in the SW Pacific from TOPEX/Poseidon
Robert Bell [1] , *Michael Foreman* [3] , *Josef Cherniawsky* [3] , *Brian Beckley* [2]
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TOPEX/Poseidon (T/P) coverage dovetails with sea-level gauge data to span both coasts and oceans. Tides were extracted by a harmonic analysis of aliases in the SSH data from T/P for the first 300 cycles and compared with gauge data. Boundary conditions for a limited-area tidal model centred on New Zealand have been improved by the tidal analysis of T/P altimetry, which matches the NAO.99b global ocean tide model of Matsumoto. The residual sea-surface height exhibits a signature of seasonal and annual variability, which has partially interfered with an alias of K1. The highest variability in dynamic sea-surface height occurs off Australia's NSW coast and in the Antarctic Circumpolar Current to the south of the Tasman Sea. Outcomes of this work are the use of the revised limited-area tidal model and further insights into the seasonal variability of residual sea-surface heights across the SW Pacific.

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3E3.4
Tsunami run-up and damage on the Andaman Coast,Thailand from the Boxing Day seismic event.
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On Boxing Day, 2004, following the M9.0 earthquake to the west of Sumatra, a tsunami tragically struck many of the coastline communities in the Indian Ocean. Field surveys of the more western-style coastal developments on Thailand's

Andaman Coast highlight a number of lessons that can learnt on tsunami behaviour, run-up and the subsequent damage and loss of life. The paper presents an analysis of field survey results from Phi Phi Island, Phuket to Khao Lak followed by a set of key messages for other countries exposed to the threat of destructive tsunamis. In particular, resource planning and building design codes can provide only partial mitigation– primarily for such destructive tsunami, plans must focus on saving lives through an integration of timely detection, emergency planning, evacuation procedures, alternative refuge and ongoing public and institutional knowledge.

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3E4.1
An Example of Real-Time Emergency Response: The S03 Release in Valleyfield, QC.
Real D'Amours [1] , *Myriam Paquin* [2]
(Presented by / Présenté par ***Real D'Amours***)
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Late on the evening of August 8th 2004, approximately 6 tonnes of gas containing sulphur trioxide (SO_3) were accidentally released by the CE Zinc refinery located near Valleyfield, in South-western Quebec. The gas formed an atmospheric plume that was perceptible by people on the island of Montreal and as far as 50 km from its origin.

During and following the incident, authorities and the industry based their decisions on the information produced by reliable scientific tools such as atmospheric dispersion modelling and air quality monitoring. That information, together with other relevant facts, allowed the industry as well as the municipal, provincial and federal partners to better understand what had happened during that evening. Incidents like these are relatively rare and provide unique opportunities to test and verify Atmospheric Dispersion Models in complex settings ranging from semi-rural to urban environments.

A short description of the event is given. Dispersion results provided in real time are shown and compared with monitoring data from the Montreal Air Quality Network. The dispersion model shortcomings are analysed, and strategies for improvements are discussed.

3:45 PM

3E4.2
The Sea-to-Sky Highway Corridor Improvement Project. Predicting Future Air Quality.
Alex Schutte
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The British Columbia Ministry of Transportation (MoT) is conducting safety and reliability improvements to the Sea-to-Sky Highway also known as Highway 99, between Horseshoe Bay and Whistler. An air quality assessment for the 95km project was conducted. Modelling of future highway emissions were conducted using a hybrid technique of two models - one designed to estimate the impact from road sources and the other a diagnostic model (CALMET) which uses surface, upper air and prognostic meteorological data (MC2).

4:00 PM

3E4.3
Revisiting Canadian Air Quality Indices: A Health Risk Based Approach
Dave Henderson [1] , *Dave Stieb* [3] , *Philip Blagden* [2]
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Canada has made strides towards creating a health risk based Air Quality Index (AQI). AQIs are communications tools for real-time and forecasted air quality conditions. In the summer of 2001, Canada began a multi-stakeholder process to improve the state of their air quality indices. The review was precipitated by a number of scientific, national policy and technological drivers, e.g., adverse health effects can be experienced at pollutant concentration levels which were previously thought to be safe. National stakeholder recommendation has been the exploration of a health risk based AQI which addresses many of the short comings of the existing standards-based AQI. The formulation for a health risk AQI is based on pollutant risk coefficients for $PM_{2.5}$, O_3, NO_2 and SO_2. These are derived from epidemiological research carried out by Health Canada scientists and supported by a meta-analysis of international scientific literature. The talk will elaborate on the progress towards, outstanding challenges and the implementation of a possible new national index.

3:30 PM

3E6.1
Phoenix MET: Canadian contributions to a NASA/CSA mission to Mars
P.A. Taylor [1] , Diane V. Michelangeli [1] , Jim Whiteway [1] , Allan I. Carswell [4] , Thomas J. Duck [3] , Carlos F. Lange [2]
(Presented by / Présenté par ***Peter Taylor***)
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The NASA/CSA Phoenix mission, scheduled for launch in August 2007, and landing on Mars at 70 degrees North in May 2008, will include a MET package comprising temperature and pressure sensors and a vertically pointing lidar system. It will also analyse ice and regolith samples dug from below the surface with a Robotic Arm.

The Canadian Science Team has focussed its attention on lidar issues, involving dust and water ice clouds in the Martian atmosphere, but is also concerned with instrument characterisation, the analysis and interpretation of temperature and pressure data and has conducted a series of laboratory tests on issues related to the possible sublimation of ice samples awaiting analysis.

This overview paper will provide the background to a set of related talks or posters providing details of the work of the Canadian Phoenix Science Team.

3:45 PM

3E6.2
Large-Eddy Simulation of the Atmospheric Boundary Layer of Mars
Babak Tavakoli , P-Y Li
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The Atmospheric Boundary Layer (ABL) of Mars plays a critical role in its climate system, since all surface-atmosphere exchanges of heat, momentum, water, and dust occur in this region. This study investigates the fundamental nature of the Planetary Boundary Layer (PBL) by employing a Large Eddy Simulation (LES) model (the NCAR LES developed by Sullivan, P. P. and others) adapted for Mars. This model allows simulation of turbulence and convection in the highly convective Martian boundary layer. LES represents a fundamental fluid dynamics approach, one that has been successfully used for a wide range of terrestrial atmospheric and engineering problems. A major goal of this research is to gain insight into how the terrestrial PBL simulation can be adjusted and improved for applications on Mars as a critical preparation for analysis and comprehension of future data returns from the NASA/CSA Phoenix mission to Mars, scheduled for launch in 2007.

4:00 PM

3E6.3
Atmospheric Chemistry on Mars using the Global Mars Multiscale Model (GM3)
John C. McConnell , Youssef Moudden [2] , Ayodeji Akingunola [1] , Antonio Garcia Munoz [1] , Jacek Kaminski [1]
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The chemical stability of the atmosphere of Mars appears to be determined by HOx chemistry which in turn is related to the distributions of water and ozone. Using the GM3 as a host we have added a chemistry module. The dynamical model is based on a SL/SI dynamical framework employed in the Canadian Meteorological Service of Canada's weather forecast model, GEM (Global Environmental Multiscale) model. The model includes comprehensive physics and has been extended to over 150 km and been run in global uniform (at 1.3 degrees horizontal resolution) and zoom mode with an interior resolution of 10 km). The version that we will present has a top at about 160 km with uniform horizontal resolution. The chemistry added is fueled by photolysis of CO_2, water vapour, ozone and related products. Long-lived chemical species are subject to transport by the resolved circulation and by diffusion within the PBL and molecular diffusion in the thermosphere. At present the realism of the chemical species distributions in the lower atmosphere is limited by the

correctness of the simulation of the water vapour distribution. We will present current results of CO, water, ozone and H_2O_2 based on an empirical water vapour distribution.

4:15 PM

3E6.4
Sublimation of Ice particles on the surface of Mars laboratory simulations related to Phoenix.
P.A. Taylor [1] , *Konstantin Baibakov* [3] , *Stephen Brown* [1] , *P-Y Li* [1] , *Carlos F. Lange* [2] , *Luis Prieto* [2]
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As a part of the NASA/CSA Phoenix Scout mission to Mars it is planned to obtain samples of ice from just below the surface regolith at latitude 70 degrees North. Assuming that there is ice, the samples will be obtained using a Robotic Arm to dig a trench in the regolith and scrape the exposed ice surface to obtain small chips of ice. These will be accumulated on the surface in the trench to provide a 10cc sample pile prior to insertion into the MECA (microscopy, electrochemistry, and conductivity analyzer) and TEGA (Thermal Evolved Gas Analyzer) instruments for analysis. Ice particle sizes should be of order 1mm diameter or less for the TEGA sieve, and less than 3 mm for MECA instrument ports.

Ice particles exposed to the air at low relative humidity for extended periods could sublimate, partially or completely. This is a potential concern for this component of the Phoenix mission. As one means of assessing the potential for ice losses through this process we initially used a cloud-physics modelling approach for the case of spherical ice particles completely exposed to a stream of air and to the sun. We also ran preliminary field tests on ice particles exposed in the Earth's atmosphere and laboratory tests in a freeze drier unit before proceeding to a series of tests in the York University/CSIL Mars simulation chamber. The talk will focus on these laboratory simulations, and confirm that sublimation is a potential problem for temperatures above about -30C.

3:30 PM

3E8.1
A Road Weather Information System for Canada Update
Paul J. Delannoy [1] , Mario Ouellet [1] , Awtar Koonar [1] , Dave Denault [1] , Gilles Larose [1] , Claude Lapointe [3] , Henry Stanski [2]

(Presented by / Présenté par ***Paul Delannoy***)
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Driving in winter through most of Canada can be quite stressful and even treacherous at times. Winter weather has an enormous impact on transportation in this northern country and the increasing reliance on road salts to keep roads clear in winter has been closely studied by the Environmental Protection Service and found damaging to the environment. Great strides have been made in meteorology in the last decade with the result that excellent sensors and forecast services are now available to assist road maintainers and traffic managers in making more timely maintenance decisions. Careful Canadian trials of Road Weather Information Systems (RWIS) have shown that road salts can be reduced while at the same time enhancing road safety.

While not a panacea for all winter maintenance activities, treating roads proactively is the goal in most progressive winter maintenance organizations today. A hierarchy of approaches has evolved to provide the necessary meteorological support services. Fixed auto-spray technologies have proven their effectiveness for a specific critical or costly structure but are too expensive to implement on a grand scale. Point approaches over a limited domain such as a metropolitan area are an excellent alternative. Applying road weather technologies to a vast sparsely-populated country such as Canada however is a major challenge. New approaches were required to maximize the benefits of the substantial investments that transportation agencies needed to make in road weather instrumentation and services. Success hinged on making the most of a small number of installations and ensuring close collaboration between multiple levels of government and multiple sectors of the economy. Officials of the provincial and territorial transportation agencies across Canada came together in 2000 to begin a long process of close collaboration on road weather technologies. That close inter-agency collaboration has guided Canada's unique approach to developing a national integrated Road Weather Information System for Canada (RWIS-Canada).

An update of the current status of the formal agreements between the federal government in Canada, as represented by Transport Canada and by the Meteorological Service of Canada (MSC), and the provinces and territories will be provided. A summary of the key obligations of the parties under the agreements will be provided. The anticipated respective roles of the public and private sectors in providing safer, more efficient, and less environmentally damaging winter roads will be outlined. The overall architecture of the Road Weather Information Network (RWIN), the MSC application which will deliver the RWIS Canada data quality control (QC) and integration services expected by the provinces and territories will be described. A progress report of the RWIN project in the areas of data interchange protocols, metadata definitions, and pavement data QC will be provided. The close collaboration with the MSC's Data Management Framework (DMF) and the US CLARUS initiative will be described. A final element will be a review of the multi-year RWIN project plan.

3:45 PM

3E8.2
METRO 2, a new version of the road condition prediction model for general use.
Miguel Tremblay [1] , Yves Delage [2]
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The Meteorological Service of Canada (MSC) has developed in 1999 a numerical model for forecasting road conditions: METRo. Predictions made by METRo proved to be a great tool to assist winter road maintenance, making roads safer for motorists as well reducing the amount of salt used for road treatment. Following its decision to transfer road weather prediction to private sector, the MSC undertook the task of modifying METRo so that it could be used by external users. A new more flexible version of METRo, METRo 2, was thus conceived and developed by a team at the Canadian Meteorological Centre (CMC) for the needs of private sector. All read/write and pre/post-process operations are coded in python and documented in both official languages, making it possible for a user to understand what the model is doing and to apply corrections for special needs. Quality control operations could be added, for example, or some calculations, such as solar radiation, could be replaced by other algorithms. The physical processes at the heart of METRo remain in fortran

for efficiency at runtime and to ease transfers from other meteorological models traditionally written in fortran. Finally, I/O is in XML format so that METRo could easily be run within various architectures and protocols.

From the Fall of 2004, METRo licenses were sold to private companies and the CMC METRo team is active in giving support to them and in developing improved versions. The next step is to build an internal verification system for METRo using observations gathered by the new RWIN system.

4:00 PM

3E8.3
EnSim-WE: a fully Canadian meso/microscale low-level windmapping software for the private sector
Robert Benoit [1] , *Martin Serrer* [3] , *Wei Yu* [2] , *Anna Glazer* [2] , *Philippe Moinat* [2]
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Since year 2000, Environment Canada began developing a smallscale wind climate mapping system known as WEST (Wind Energy Simulation Toolkit) based on two modelling engines: MC2 and MsMicro. The system evolved through several specific applications in partnership with the private sector and gained maturity. A user-friendly version was then developed for Windows XP, embodying for the first time all the components of a meso/microscale system. The immediate goal is to enable the windpower industry to selectively enhance the resolution of the 5-km national wind atlas recently produced by Environment Canada. Ultimately, EnSim-WE would be capable of short-term windpower predictions for turbine clusters: this makes it an attractive software system for other environmental industries. The first version will be accessible early 2005.

4:15 PM

3E8.4
Panel Discussion on Road Weather Technologies - 2
Claude Labine
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This is an opportunity for the attendees to ask questions of the speakers in this session on road weather. Claude Labine will guide the discussion.

(INVITED/INVITÉ) 8:15 AM

4A0.1

Peeping through the keyhole at the mesoscale variability of atmospheric humidity, or examples and applications of radar refractivity mapping

Frédéric Fabry
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A technique has been developed to measure the refractive index of air by radar. Since refractivity is a function of temperature, pressure, and especially moisture, observations of the field of near-surface refractivity by radar gives us a unique albeit range-limited glimpse at the structure of the field of moisture at the mesoscale. In addition to making possible the observation of fronts, storm outflows, and boundary layer processes, refractivity can be used qualitatively, to identify convergence lines between air masses of different temperatures and/or moisture, as well as quantitatively to obtain fields of surface moisture. After a brief introduction of the principles behind this measurement, the presentation will focus on examples of data collected at McGill and in the U.S. as an excuse to illustrate some of the possibilities offered by refractivity measurements.

(INVITED/INVITÉ) 9:00 AM

4A0.2

Is There a Link Between Dust and Fish?: Examining Factors That Control Production in the North Pacific

Paul J. Harrison
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The NE Pacific has one of the longest open ocean time series, primarily as a result of the weathership station at Station P from the 1950s to 1981. In the 1960s and 70s, the observation that nitrate was never depleted by phytoplankton in summer, was explained by extensive zooplankton grazing and cloudy weather (light limitation). This turned out to be the wrong explanation because certain critical measurements were not available. In the mid 1980s, the late John Martin made the first relatively uncontaminated measurements of iron and revealed that iron concentrations were very low and limited phytoplankton growth. This was a revolutionary discovery, because up to that point, we thought that oceanic productivity was mainly limited by macronutrients such as nitrate and phosphate and possibly silicate and that micronutrients or trace elements were less important. Now there are at least three large areas of the world's oceans where nitrate is never depleted and chlorophyll (phytoplankton biomass) is low because of iron limitation. The N Pacific, equatorial Pacific and the Southern Ocean are referred to High Nitrate, Low Chlorophyll (HNLC) regions. Dust from the Gobi Desert in China is an episodic source of iron that reaches the NE Pacific. An episodic iron input was simulated in the recent mesoscale iron enrichment experiment at Stn P and some results will be presented. Through a series of large international/Canadian programs such as JGOFS and SOLAS, our understanding of how iron limitation influences the ecosystem dynamics of the NE Pacific is evolving.

10:30 AM

4B1.1
Assimilation of radar data in mesoscale numerical prediction models
Xingbao Wang [1] , *M. K. (Peter) Yau* [1] , *Luc Fillion* [2]
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Mesoscale numerical models, with horizontal resolutions of 1 to 15 km, are being developed for research and operational purposes to predict high-impact weather such as heavy rain and snowfall. It is known that the quality of the initial condition is crucial for a successful forecast. As radar data provide a valuable source for rain rates at high spatial (2 km) and temporal (~5 min) resolutions, there is a need to assimilate such data to improve quantitative precipitation forecast (QPF). In this study we use a mesoscale model (MM5) and a one-dimensional variational (1DVAR) approach to assimilate the US composite radar data to simulate the 1996 Chicago Flood. Our results show that assimilation of rain rates during the early stage of the simulation improves the subsequent evolution of deep moist processes and mesoscale convective systems. QPF is also improved indicating that the technique has promise and can be applied to improve the prediction of heavy rainfall.

10:45 AM

4B1.2
Evaluation of the operational 4D-Var data assimilation cycle at the Meteorological Service of Canada
Josée Morneau , *Stéphane Laroche* [1] , *Pierre Gauthier* [1] , *Monique Tanguay* [1] , *Simon Pellerin* [1] , *Pierre Koclas* [2] , *Nils Ek* [1]
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The three-dimensional variational data assimilation (3D-Var) for the operational global forecasting system has been extended to 4D-Var. The new variational scheme is now composed of several additional and improved features. First guess at the appropriate time from the full-resolution model trajectory is used to calculate the misfit to the observations. The tangent-linear of the global environmental multi-scales (GEM) model and its adjoint are employed to propagate the analysis increment and the gradient of the cost function over the 6-h assimilation window. The analysis is obtained after two outer loops: 40 iterations with only the vertical diffusion as simplified linearized physics are first performed, then after updating the full-resolution trajectory, 30 more iterations are done with a set of simplified physical parameterizations which includes vertical diffusion, subgrid-scale orographic effects, large-scale precipitation and deep moist convection. The data selection process has been modified for all observation types except the surface reports. The 6-h assimilation window is divided into 9 time intervals (rather than one in 3D-Var). For each interval, the data are spatially thinned to retain the observation closest of the middle of the time interval. This has considerably increased the number of frequently reported data such as aircraft, satwind and profiler data. Finally, the resolution of the analysis increment (T108), background error statistics and the data quality control remain the same as in 3D-Var.

An extensive pre-implementation evaluation of 4D-Var against the operational 3D-Var was conducted. Results from two-month assimilation periods in winter 2003-2004 and summer 2004 show a consistent improvement in the northern hemisphere with 4D-Var, a neutral impact in the tropics, but nearly 6-h gain in predictability in the southern hemisphere. The contribution of each additional 4D-Var component to the improvement has been assessed and will be discussed in this presentation.

11:00 AM

4B1.3
Monitoring 4D-Var data assimilation using observation sensitivity calculation
Simon Pellerin , *Stephane Laroche , Pierre Gauthier , Josee Morneau*
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The MSC has developed a 4D-Var data assimilation system planned to become operational in early 2005. The 4D-Var assimilates a large amount of observations of various types every six hours in support of numerical weather prediction. These observations have significant differences in term of impact on initial conditions and on the forecast error. Even if in a statistical sense assimilation of a large set of observations improves the analysis and the forecast, depending on the

instability of the atmosphere, a small change in the initial conditions induced locally by a subset of observations may have a large and global impact of forecast skill.
This presentation will describe an adjoint-based technique for assessing the value of observations assimilated by the 4D-Var. The method makes use of adjoint sensitivity gradients and innovations to calculate the impact of observation on short-range forecast error. This procedure could be used to monitor the assimilation and the quality of the observations to improve the observing network.

11:15 AM

4B1.4
Impact of a flow-dependent background error covariance model based on sensitivity functions in a 3D-VAR
Cristina Lupu [1] , *Pierre Gauthier* [2]
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The *a posteriori* sensitivity functions estimated as in Laroche *et al.* (2002) and Klinker *et al.* (1998) characterise the change in the initial conditions that will lead to an important modification in the short-term forecast (within a 24 to 48h range). To take into account the specificities of the flow characteristics, those sensitivity functions are introduced as structure functions within the background error covariance matrix of a 3D-Var assimilation system to allow the analysis to fit the observations while at the same time imprint a structure that can trigger the development of a weather system. This approach is referred to as the *adapted 3D-Var* was first proposed by Hello and Bouttier (2001). A different formulation has been proposed by Gauthier and Lupu (2004) in the full 3D-Var operational system of the Canadian Meteorological Centre (CMC). Experiments were carried out on the case of extra-Tropical transition of Karen in 2001. The analyses obtained with the adapted 3D-Var were compared with respect to those of the operational 3D-Var and to the sensitivity analysis in terms of their impact on forecasts. The adapted 3D-Var is shown to reduce the forecast error over the targeted area while at the same time improving the fit to the observations over the sensitive areas. Experiments were carried out with different definitions of the sensitivity functions to show their impact on the forecast.

11:30 AM

4B1.5
Characteristics of Key Analysis Errors: Application to Data Assimilation
Peter Zwack , *J-F. Caron* [1] , *S. Laroche* [2] , *P. Yau* [1]
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In recent years, various techniques have been developed to estimate the initial state errors responsible for poor short-range to medium-range forecasts. One of the methods is the so called key analysis error, mostly using the energy norm. The key analysis errors estimated by the Canadian Meteorological Center's (CMC) algorithm (Laroche *et al.*, 2002), which uses the energy norm and adjoint technique as proposed by Klinker *et al.* (1998), were analyzed with a particular attention to the dynamical balance properties of the initials corrections. Results show that both rotational and divergent part of the estimated key analysis errors are strongly out of balance initially and that the mass component of the initials corrections contains an important part of dissipating modes. Comparison with observational data and experiments in which the initial errors are known also raises important doubt on the realism of the key analysis errors estimated with the current methodology. Different ways to improve the estimation of the key analysis errors will also be discussed including a technique to separate the unstable and stable modes.

10:30 AM

4B2.1
An Assessment of the PRECIS Regional Climate Modelling System over North America

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PRECIS, Providing REgional Climates for Impacts Studies, is a regional climate modelling system developed by the Hadley Centre. The PRECIS system is based on the latest RCM version developed at the Hadley Centre, and it has been designed to be user-friendly and easily implemented on any fast PC running a Linux system.

The PRECIS system has been tested over North America at the resolution of 0.44°, selecting different regions with different domain-sizes. The multi-years simulations of PRECIS were generated by applying lateral boundary conditions (dynamical atmospheric information) from ECMWF ReAnalysis data provided from 12/1978 to 05/1992. Monthly and seasonal means fields have been used for the different realizations. Results obtained over different North American domains show PRECIS to be capable of accurately simulating the climate of these regions. The author presents results of these experiments and provides comparisons between PRECIS, the driving analyses (ERA) and observational datasets (e.g. CRU) in order to evaluate the added-value and the skill of the PRECIS system.

10:45 AM

4B2.2
Singular vector analysis for a fully coupled Atmosphere-Ocean-Land System

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Using a recently developed method of computing climatically relevant singular vectors (SV), the error growth properties of ENSO in a fully coupled global ocean-atmosphere-land climate model are investigated. In particular, we examine in detail how singular vectors are influenced by the phase of ENSO cycle; the physical variable under consideration as well as the error norm deployed. This is the first time such predictability studies have been carried out with a fully coupled global CGCM. Previously only models
with a relatively simple transient free atmospheric component have been considered.

The results show that the singular vectors share many of the properties already seen in simpler models. Thus, for example, the singular vector spectrum is dominated by one fastest growing member, regardless of the phase of ENSO cycle, the variable of perturbation or the error norm; in addition the growth rates of the singular vectors are very sensitive to the phase of the ENSO cycle, the variable of perturbation and the error norm. This particular CGCM also displays some differences from simpler models: Thus subsurface temperature optimal patterns are strongly sensitive to the phase of ENSO cycle and at times an east-west dipole in the eastern tropical Pacific basin is seen.
This optimal pattern also appears for SST when the error norm is defined using Ni\~{n}o4. Simpler models consistently display a single sign equatorial signature in the subsurface corresponding perhaps to the Wyrtki build up of heat content before a warm event.

11:00 AM

4B2.3
Climatology and changes of extra-tropical storm tracks and cyclone activity: Comparison of ERA-40 with NCEP/NCAR Reanalysis for 1958-2001

Xiaolan Wang [1], Val R. Swail [2], Francis W. Zwiers [2]
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In this study, a cyclone detection/tracking algorithm was used to identify cyclones from two gridded 6-hourly mean sea level pressure datasets: the ERA-40 reanalysis and the NCEP/NCAR Reanalysis (NNR) for 1958-2001. The cyclone activity climatology and changes inferred from the two reanalyses are intercompared. The cyclone climatologies and trends are found to be in very good agreement with each other in the northern oceanic areas, as well as in northern Europe and eastern North America. However, significant differences were identified over some land areas, especially the mid-latitudes

of Eurasia. Both data sets exhibit problems in mid-latitude Eurasia for years 1963-68, showing sudden changes or apparent outliers. Differences between ERA-40 and NNR are more extensive in the southern hemisphere than in the northern hemisphere. In particular, the ERA-40 shows significantly fewer cyclones over the Antarctic but more cyclones over the southern oceans, especially in the warm season.

The most notable changes in cyclone activity were found to be associated with the numbers and tracks of deep cyclones (central pressure < 990 hPa). In agreement with previous studies, changes during the past half century are characterized by a significant increase in the number of deep cyclones over the North Pacific in JFM and AMJ, and over the North Atlantic in OND and JFM. In particular, the North Atlantic storm track has shifted slightly northward in winter (JFM). Changes in the austral extra-tropics are characterized by more frequent deep cyclones along the Antarctic coastal areas, and fewer deep cyclones to the north of this region (around 60°S).

11:15 AM

4B2.4
'January Thaw' and other Singularities in a Warming Climate
G.S. Strong
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Canadian folklore suggests that the *January thaw* is a persistent warm cycle that returns briefly every winter in the midst of the coldest month of January. Published scientific studies on this phenomenon have been restricted almost exclusively to New England, one exception being a Canadian study by Strong and Khandekar (1975). There is now enough evidence to confirm that this phenomenon exists throughout most of the Northern Hemisphere at least, including the arctic, and is especially evident on the Canadian prairies.

The Canadian study was based on 1931-60 climate normals data, a period dominated somewhat by moderate climate cooling. The *January thaw* was one of several cycles noted in the wintertime mean daily temperatures from coast to coast in Canada, and even far northern latitudes. They occur with an average frequency of ~17 days, although the range can be from 7 to 27 days. The earlier study is re-visited for two main reasons: first, to see what changes may have occurred in the cycles in the independent 1971-2000 climate normals, a period of marked climate warming; second, to examine other parameters in addition to mean daily temperatures, including maximum and minimum temperatures, moisture, and various convective parameters, the latter using radiosonde information for the 30-year period.

Other motivations for this study include investigating whether such temperature and humidity cycles occur with the same frequency and amplitude during summer, whether they are masked by urban heat island effects, and to determine if these cycles provide clues for the onset and cessation of drought, and of summer convective outbreaks. Results will be presented for most of these effects.

11:30 AM

4B2.5
Climate change impacts on the hydrology of six North-American basins simulated by the Canadian Regional Climate Model
Laxmi Sushama , Rene Laprise
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The climate change impacts on the hydrology of six basins (Fraser, Mackenzie, Yukon, Nelson, Churchill and Mississippi) covering the major climate regions in North-America are simulated from differences between the control runs (1959-90) and scenario runs (2041-70) simulated with the Canadian Regional Climate Model (CRCM). Changes in precipitation and its distribution, evaporation, runoff totals and regimes and extreme flows (both high and low) are analysed. Interesting shifts in the water balance is noted, especially for basins at high altitudes such as Fraser. Results also suggest changes in high-flow frequencies for some regions, particularly in high latitudes experiencing snowmelt-flooding events. Shifts in the low-flow frequencies are also observed.

11:45 AM

4B2.6
The influence of climate regime shift on ENSO

Zhengqing Ye , William W. Hsieh
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Observations indicated that for the El Niño/Southern Oscillation (ENSO) there have been eastward displacements of the zonal wind stress anomalies and surface heat flux (short wave heat flux and latent heat flux) anomalies during El Niño episodes in the 1981-1995 regime relative to the earlier regime of 1961-1975 (without corresponding displacements during La Niña episodes). Numerical experiments with the Zebiak-Cane coupled model generally reproduced such displacements when the model climatological fields were replaced by the observed climatologies (of sea surface temperature, surface wind and associated atmospheric divergence) and simulated climatologies (of oceanic surface layer currents and associated upwelling) for the 1981-1995 regime. Sensitivity tests indicated that the background atmospheric state played a much more important role than the background ocean state in producing the displacements, which enhanced the asymmetry between El Niño and La Niña in the later regime. The ENSO period and ENSO predictability were also enhanced in the coupled model under the later regime climatology. That the change in the tropical Pacific mean state after the mid 1970s has produced the observed changes in ENSO properties is supported by our study.

10:30 AM

4B3.1
The assimilation of SSM/I brightness temperatures in clear skies at MSC
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In recent years the assimilation of satellite data has become a vital component of the global and regional assimilation systems at the Canadian Meteorological Centre (CMC). Specifically, the direct assimilation of satellite radiance measurements from AMSU-A (temperature sounder), AMSU-B (humidity sounder), and GOES, as well as automated motion vectors derived from GOES and MODIS observations, has resulted in notable improvements in the short and medium range CMC forecasts. This has been demonstrated in Observation System Experiments (OSEs) conducted by CMC.

In preparation for the operational assimilation of Special Sensor Microwave Imager (SSM/I) brightness temperatures in the soon-to-be implemented 4D-Var global assimilation cycle at CMC (spring 2005), 3D-Var experiments are conducted. Brightness temperatures from the seven SSM/I microwave channels are assimilated in clear skies and over open oceans using the fast radiative transfer model RTTOV7. Simultaneously, more strict filtering of AMSU data is applied. For example, AMSU-A CH3 (50.3V) and AMSU-B CH2 (150.0H) are removed due to their non-negligible sensitivity to clouds, and more aggressive filtering of AMSU-B CH3 (183.3±1 H), CH4 (183.3±3 H), CH5 (183.3±7 H) is invoked using CH2 to identify cloudy pixels.

With the new configuration, improvements are evident in the analysed Integrated Water Vapour (IWV) and surface wind speed fields when compared against independent observations. Furthermore, small gains are realized in the forecasts that are generated using the new analyses, when validated against RAOBS data. Other indicators such as anomaly correlation, RMSE, and QPF scores show a net positive effect.

10:45 AM

4B3.2
Assimilation of passive microwave brightness temperatures in tropical rainy areas over oceans
Godelieve Deblonde , *Jean-Francois Mahfouf* , *Bernard Bilodeau* , *David Anselmo*
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Currently, satellite brightness temperatures (Tb) in the CMC operational data assimilation system are only assimilated in clear skies. Pioneering work to extend the assimilation of satellite Tb in rainy areas over the oceans and in a variational assimilation context started in 2002 at ECMWF. A 1D-Var assimilation system is being developed along the same line that assimilates Tb from the SSM/I and TRMM instruments. By solving the 1D-Var, an optimal model state (given a background constraint) is found that minimizes the difference between an observed quantity and its collocated model state mapped to observation space. The latter is done with moist physics schemes that model hydrometeor profiles from the temperature and humidity profiles (control variables). Knowing the hydrometeor profiles then allows the modeling of Tb with a radiative transfer model. The background constraint is a short-range forecast (12-h) obtained with a research version of the GEM (Global Environmental Multiscale) model (58 vertical levels and grid-size of 0.45^o X 0.33^o). The moist physics schemes of the 1D-Var are consistent with those of GEM and the radiative transfer model is the RTTOV8.5 community model in which scattering processes in precipitating atmospheres are represented. 1D-Var analyses have been obtained for several tropical cyclone systems. Increments (analyses – background) of integrated water vapour are planned to be assimilated in the 4D-Var assimilation system (to be operational at CMC in March 2005). Before proceeding to the latter task, several avenues need to be considered to accelerate the execution of the 1D-Var system.

11:00 AM

4B3.3

Information projection as a way to gauge the value of added channels in satellite-sounding retrievals
Roland B. Stull
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For satellite sounding retrievals, the weighting function for any one channel has relatively broad vertical extent. It is well known that this causes different channels to have significant overlap, which implies that each channel does not provide independent sounding data.

This raises the question of the meteorological value of adding even more channels, given the large amount of overlap. The Europeans and Americans are launching new series of satellites with larger number of sounder channels. While it is suggested that these new data sets will help fill the Pacific Data Void, the question remains as to the actual value of these additional channels.

By expressing each channel weighting function as a conceptual vector in vertical-sounding space, we can estimate how much information from each additional channel projects onto existing knowledge from the other channels. The portion of each vector that does not project onto any other channel vectors measures the fraction of each channel that provides independent data.

Examples of this procedure will be illustrated with discretized approximations to the weighting functions for existing satellite channels, showing that the number of independent pieces of data from the retrieval are usually significantly less than the number of sounding channels.

11:15 AM

4B3.4
Statistical derivation of ground-based microwave radiometric retrieval coefficients of precipitable water vapour and liquid water path and mean radiating temperature from Maniwaki sounding data
Zlatko Vukovic , Walter Strapp
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The seasonal variations of water vapour path (WVP) and liquid water path (LWP) retrieval coefficients, and mean radiating temperature of the atmosphere (Tmr) are calculated using 40 years of Maniwaki radio sonde data. Subsets of radiosonde data are analyzed to determine the sensitivity of the retrieval coefficients to the season. Microwave radiometer manufacture's default retrieval algorithms normally use coefficients based on all seasons. The RMS difference of WVP and LWP, seasonal versus yearly, are thus compared using AIRS-1 (Mirabel) microwave radiometer data to assess potential improvement in accuracy.

11:30 AM

4B3.5
GRACE Satellite Observations of Terrestrial Moisture Changes and Drought Measurement in Western Canada
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Direct measurement of an integrated watershed storage amount may be considered a panacea for the ills of watershed modeling. Watershed models typically transfer moisture and energy between model "stores" using physically based transfer laws and conservation equations to produce streamflow hydrographs. Because of the problem of non-uniqueness in the generation of model hydrographs, it has become increasingly important to ensure the representativeness of model results. This is being accomplished by: a) performing model integrations over long, multi-year periods, b) applying models to watersheds with diverse hydroclimatic conditions, c) comparing model "stores" with measured components of watershed storage such as snow depth, soil moisture, groundwater levels, and lake storage. Many of these components, however, either are not regularly measured or have large uncertainties associated with their values. Lack of a true integrated storage measurement represents an unwanted degree of freedom in watershed modeling.

In 2002, the GRACE (Gravity Recovery And Climate Experiment Mission) satellite platform was launched to measure, among other things, the gravitational field of the earth. Over its five year life, a pair of orbiting satellites will produce a time series of "mass" changes of the earth-atmosphere system. When integrated over a number of years, this will yield a highly refined picture of the earth's gravity. However, month to month changes in mass is an indicator of the integrated

value of watershed moisture storage. It has been reported by Wahr et al. (2004) that when smoothed over 1000 km that centimeter accuracy can be achieved in monthly storage change.

The goal of this research to compare changes in moisture storage over western Canada using GRACE data with those developed by atmospheric and hydrologic water balances techniques. This work builds on a previous study undertaken as part MAGS and will highlight the recent drought in western Canada as a precursor to the proposed Drought Research Initiative (Canada DRI). Monthly estimates of watershed storage have been developed for the Mackenzie and Saskatchewan River basins.

11:45 AM

4B3.6
Canada's Participation to the Hydros Soil Moisture and Freeze/Thaw Mission
Stéphane Bélair [1] , *Ralph Girard* [2] , *Marie-Josée Bourassa* [2]
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Hydros mission objective is to provide global measurements of soil moistureand freeze/thaw state of the land surface. The mission was selected in December 2003 by the Earth System Science Pathfinder (ESSP) program of the National Aeronautics and Space Administration (NASA)to proceed in Definition Phase for a launch in 2010 followed by two years of operation. Hydros will include a radiometer and a radar operating at 1.2 and 1.4 GHz respectively. The selected frequency is sensitive to moisture in a thin soil layer near the surface (between 2 and 5 cm deep). The satellite will follow a near-circular sun-synchronous orbit approximately 670 km above Earth's surface, with a 6AM/6PM Equator crossing. The swath width will be on the order of 1000 km, providing a revisit time less than 3 days globally (at mid-latitudes, the revisit time will be 1-2 days). The spatial resolution of the measurements will be about 40 km for the radiometer, and 1 to 3 km for the radar. Several algorithms are currently being developed and tested to combine the active and passive measurements in order to obtain a 10-km soil moisture product.

The Canadian participation in Hydros supports Canada’s commitment on climate change and sustainable development. The Canadian Space Agency leads and coordinates the Canadian contribution that consists of the antenna feed sub-system as well as the radar processor and data processing. This contribution allows Canadian scientists to work in collaboration with U.S. partners to construct a land data assimilation system that will combine in an optimal manner land surface modeling results and remote-sensing measurements from Hydros. The scientists will also participate in field campaigns that will be conducted in the next few years, with the objective of validating the several algorithms currently being developed for the retrieval of soil moisture and freeze/thaw state of the surface.

10:30 AM

4B4.1
Development work done at CMC to improve CHRONOS, the operational Canadian numerical Air Quality Model
Richard Moffet , Véronique Bouchet CMC/Environment Canada , Louis-Philippe Crevier CMC/Environment Canada , Mourad Sassi CMC/Environment Canada
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For 2005 and years ahead, CMC is investigating different ways to improve the performance of its air quality model , CHRONOS. Work in the fields of anthropogenic and biogenic emissions will be addressed. Also being evaluated are the possibility of having two runs per day and include assimilation of tropospheric ozone. Examples of case studies including verification will be shown. We will also report in plans to increase horizontal and vertical resolutions of the model.

10:45 AM

4B4.2
Real-time PM2.5 forecasts over Eastern North America during the summer of 2004: An assessment of several models and their ensemble
Stuart McKeen [1] , James Wilczak [6] , Georg Grell [5] , Steven Peckham [5] , Wanmin Gong [4] , Veronique Bouchet [4] , Sylvain Menard [4] , Richard Moffet [4] , Youhua Tang [3] , Gregory Carmichael [3] , Rohit Mathur [2]
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As part of the ICARTT/NEAQS field study (International Consortium for Atmospheric Research on Transport and Transformation/New England Air Quality Study) conducted over Eastern North America during the summer of 2004, real-time forecasts of ozone and PM2.5 were archived from regional air quality models that were operational at five U.S. and Canadian research centers. This presentation focuses on the detailed statistical evaluation of PM2.5 forecasts from six models by comparison with surface data collected in real time through the AIRNow network at 120 monitoring sites throughout the Eastern U.S. and Southeastern Canada. For afternoon eight-hour averages, all forecast models possess a surprising degree of correlation with observed values and predictive skill that equals or surpasses equivalent measures for ozone forecasts. An analysis of mean diurnal cycles for urban, suburban and rural stations illustrates distinct differences between models in terms of the relative influence and timing of emission patterns, planetary boundary layer fumigation, and surface deposition of PM2.5. Ongoing analysis of differences in aerosol composition between the various forecasts is also reported. Additionally, two ensemble forecasts of PM2.5, an arithmetic-mean and a geometric-mean determined with equal weighting of the six model forecasts, are also statistically evaluated. Similar to ensemble forecast results found for ozone, both PM2.5 ensembles have significantly better correlation and more skill in predicting observations than any individual model, with the geometric-mean ensemble yielding the best forecast possible.

11:00 AM

4B4.3
Objective Analysis and Assimilation of Surface Ozone into Air Quality Models
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This study presents results obtained from the application of a statistical interpolation method (known as optimal interpolation) to produce an objective analysis of surface ozone over North America. Objective analysis is the first step in building up an assimilation system. Producing maps of objective analysis (OA) on a regular basis is motivated by many factors such as: 1) to initialize numerical models at regular time interval (usually every 6 or 12 hours) with appropriate fields having overall bias and error variance which are minimum, 2) to provide users with a more accurate picture of the true state of a given variable by using an appropriate optimal blend of model fields together with observations so that it produces the best possible analysis not only in the vicinity of observation points but everywhere in a given domain even where the observation network is sparse, 3) to trace back possible bugs that went undetected either with the numerical model or with the observation system (this is done by identifying regular or systematic patterns appearing on the analysis increment field) and 4) other applications such as producing maps of deposition fluxes, air quality index such as SUM60,

etc. The objective analysis obtained was also fed into a chemistry-transport model (CTM). Combining ozone simulations and surface ozone measurements in a careful way using a special 3D-VAR (three-dimensional variational analysis) formulation is shown to be successful. Validation experiments show that the assimilation system give good results. Various assimilation experiments are performed and show the usefulness of assimilating surface ozone. Finally, application of the objective analysis and assimilation to other areas of environment is also discussed.

11:15 AM

4B4.4
Bias Corrected Ensemble Predictions of Surface Ozone

James Wilczak [1], *S. McKeen* [9], *I. Djalalova* [8], *G. Grell* [7], *S. Peckham* [7], *W. Gong* [6], *V. Bouchet* [6], *R. Moffet* [6], *J. McQueen* [5], *R. Mathur* [4], *J. McHenry* [3], *Y. Tang* [2]
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Real-time forecasts from eight U.S. and Canadian air quality forecast models were used to form a multi-model ensemble forecast system that provided predictions of surface ozone concentration during the summer of 2004. These forecasts are statistically evaluated against observations from the AIRNOW network (Aerometric Information Retrieval NOW) at roughly 340 ozone monitoring stations throughout the eastern U.S. and south-eastern Canada. In addition, bias-corrected forecasts for each of the individual models and the ensemble were made by subtracting the mean bias of each model at each hour of the day over the previous seven day period. This simple ozone bias correction technique is meant to approximate the more complicated Model Output Statistics (MOS) techniques that operational forecast centers routinely apply to model predictions of meteorological variables such as surface temperature and wind speed. The ensemble forecasts are found to provide significantly more skill (higher correlation coefficients, lower root-mean-square error, and lower mean absolute error) than any of the individual models. Bias correcting the individual models greatly improves each of their skill levels. However, the highest skill level is found for the bias-corrected ensemble, which has significantly greater skill than even the best bias-corrected individual model. Rank histograms, receiver operating characteristic (ROC) analysis, and reliability diagrams are used to evaluate the bias-corrected ensemble. Finally, the correlation of the bias-corrected ensemble spread and its mean absolute error indicates that the bias-corrected ensemble has some ability to predict the skill level of the ensemble ozone forecast. The eight air quality models that comprise the ensemble are CHRONOS, AURAMS, WRF1-Chem, WRF2-Chem, Eta-CMAQ, STEM2K, BAMS-15 and BAMS-45.

11:30 AM

4B4.5
Processing the Canadian National Emissions Inventory 2000 with SMOKE

Mourad Sassi [1], *Louis-Phillipe Crevier* [2], *Véronique Bouchet* [2], *Richard Moffet* [2], *Sophie Cousineau* [2], *Sylvain Ménard* [2]
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We processed the 2000 Canadian national emissions inventory with the Sparse Matrix Operator Kernel Emission (SMOKE) modelling system. We prepared anthropogenic and biogenic emissions for the air quality modelling systems AURAMS and CHRONOS using a continental domain. We also generate spatial surrogates at different grid resolutions and projections.
For quality insurance, we compared SMOKE processed inventories against the Canadian Emission Processing System (CEPS) and with data from the AIRNOW network. We performed spatial and temporal analyses of the emissions and the models outputs using SPI, a powerful visualization package.
Impacts on numerical model output for ozone and particulate matter over the Canada and the United States will be presented.

11:45 AM

4B4.6
Real-time Air Quality Forecasting - A State-of-the-Art Approach
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Internationally, many large industries and urban areas are interested in real-time air quality forecasts for control of non-reactive pollutants and reactive pollutants (like ozone and fine particulates). The problems associated with these models are (1) non-linear chemistry and (2) real-time traffic flows. This paper presents an operational forecast model for non-reactive pollutants and its application in Canada and a status report on a developmental stage model for reactive pollutants. In summary, the operational model uses the next generation WRF Weather Model NMM (Non-hydrostatic Mesoscale Model) running on a 4-km grid coupled with a state-of-the-art air quality dispersion modelling system (CALMET/CALPUFF) running on a 100m grid. Some early validation data will also be presented.

10:30 AM

4B5.1
Climatology of Asian Dust Aerosol and its Trans-Pacific Transport - Interannual Variability and Climate Connections

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A 44-year climatology of spring Asian dust aerosol emission, column loading, deposition, trans-Pacific transport routes and budgets during 1960 – 2003 was simulated with NARCM (Northern Aerosol Regional Climate Model). Interannual variability in Asian dust aerosol and transport properties simulated by the model is compared with major climatic indices and records in ground observations. For dust production from most of the source regions, the strongest correlations were with the surface wind speed in the source region, and the area (AIAPV) and intensity (IIAPV) indices of the Asian polar vortex. Dust emission was negatively correlated with precipitation and surface temperatures in spring. The strength of the East Asian Monsoon was not found to be directly related to dust production but rather with the transport of dust from the Asian subcontinent. The interannual variability of dust loading and deposition showed similar relations with various climate indices. The correlation of Asian dust loading and deposition with the Western Pacific (WP) pattern and Atmospheric Circulation Index (ACI) exhibited contrasting meridional and zonal distributions. AIAPV and IIAPV were strongly correlated with the mid-latitude zonal distribution of dust loading and deposition over the Asian subcontinent and North Pacific. The Pacific/North American pattern (PNA) and Southern Oscillation Index (SOI) displayed an opposite correlation pattern of dust loading and deposition in the Eastern Pacific, while SOI correlated significantly with dust loading over Eastern China and Northeast Asia. The Pacific Decadal Oscillation (PDO) was linked to variations of dust aerosol and deposition not only in the area of Eastern North Pacific and North America but also in the Asian dust source regions. The anomalies of transport flux and its divergence as well as dust column loading were also identified for eight typical El Niño and eight La Niña years. A shift of the trans-Pacific transport path to the North was found for El Niño years, which resulted in less dust storm and dust loading in China. El Niño- and La Niña-event had opposite effects on dust transport divergence in the troposphere over East Asia. On the basis of the variability of Asian dust aerosol budgets, the ratio of inflow to North America to the outflow from Asia was found to be correlated negatively with the PNA-index and positively with the WP- index.

10:45 AM

4B5.2
Canadian SOLAS Experiments Simulated in a 1-D Coupled Atmosphere-Ocean-Biogeochemical Model

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Within Canadian SOLAS (Surface Ocean Lower Atmosphere Study), a 1-D coupled atmosphere-ocean-biogeochemical model is developed as a tool to study biogeochemical processes that regulate gas and material exchange across the atmosphere-ocean interface. The atmospheric component is based on the CCCma AGCM (Canadian Centre for Modelling and Analysis Atmospheric General Circulation Model). The ocean component is based on the General Ocean Turbulence Model (GOTM). The ocean model includes a 7-component ecosystem model with embedded inorganic carbon, oxygen and nitrogen cycling. The AGCM includes a comprehensive sulphur cycle and an ocean DMS model is currently implemented. Primary application at this stage is the simulation of CanSOLAS experiments. Presented are simulations of timeseries derived from the Northeast Pacific SOLAS mooring (T, S, O2 versus N2) and a representation of the Subarctic Ecosystem Response to Iron Enrichment Study (SERIES), performed in July 2002. In this experiment a patch of iron depleted surface water in the North Pacific around OSP (Ocean Station Papa, 145W/50N) was fertilized with dissolved iron, stimulating a phytoplankton bloom. Model results show the biological response to the iron enrichment, physical changes in the ocean and gas dispersion in the atmosphere.

11:00 AM

4B5.3

Determination of the relative importance of physical and biological processes on surface ocean DMS pool during SERIES

Yvonnick Le Clainche [1], *Maurice Levasseur Université Laval* [3], *Alain Vézina Fisheries and Ocean Canada* [2]
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During the Subarctic Ecosystem Response to Iron Enrichment Study (SERIES), dimethylsulfide (DMS) concentration outside the iron-fertilized patch varied greatly while inside the patch, a depletion of DMS was observed at the end of the study. Using a DMS budget module embedded in a 1-D turbulent ocean model, we investigated the contributions of the interacting physical, chemical and biological processes to the mixed layer DMS pool both outside and inside the patch. The biological net DMS production rates were reconstructed with an inverse modeling approach. Daily changes in the biological cycling of DMS, as well as the physical changes (effect of turbulent mixing on the vertical distribution of DMS, surface ventilation) due to high frequency wind forcing, are needed to explain the temporal evolution of DMS during SERIES, both outside and inside the patch. We underlined the impact of the temporary shallow mixed layer that developed in mid-study on the creation of a sub-surface DMS maximum and on the subsequent redistribution of the DMS accumulated between the seasonal and temporarily thermoclines over the upper mixed layer. In general, the biological net DMS production was high during the first half of SERIES and later decreased both outside and inside the patch. But the biological DMS dynamic was altered by the iron-fertilization, contributing to a larger DMS accumulation during the first half of the experiment and to the negative DMS anomaly at the end. Globally, the mean DMS flux over the whole sampling period was almost unchanged inside the Fe-patch.

11:15 AM

4B5.4

Comparative analysis of NARCM simulations and measurements taken during CSOLAS-SERIES field campaign

Jean-Pierre Blanchet [1], *Calin Zaganescu* [1], *Maurice Levasseur* [5], *Yvonnick Le Clainche* [5], *Nicole Shantz* [4], *Lisa Phinney* [3], *Ann-Lise Norman* [2]
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Understanding of the conversion of biogenic sulfur compounds to SO_2 and $[SO_4]^{-2}$ (sulphate), their implication through CCN on cloud formation and, ultimately, their effects on climate, is an important issue for current atmospheric research and one of CSOLAS objective. In remote NE Pacific Ocean, far from industrialized regions, oceanic DMS is the leading source of sulphate. In this study, NARCM is used to assess the DMS flux from the ocean to the atmosphere, its transformation to particulate sulphate by basic oxidation paths, as well as the day-to-day evolution of suphur aerosols concentration and size distribution. The simulation performance is compared to the ocean level atmospheric measurements taken during SERIES field experiment (July 2002). The evolution of temperature, winds and moisture agrees well with the field observations, as well as the DMS flux from the ocean and, the DMS and SO_2 surface concentration. In spite of a limited amount of surface data, the lack of vertical data and model limitations, the study indicates that NARCM is able to capture important aspects of the field situation and encourage us to use the model techniques as a complement tool to field experiments diagnostics and assessment of aerosol processes in climate.

11:30 AM

4B5.5

Modelling the Ecosystem Response to Iron Fertilization during SERIES

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We present results from a one-dimensional model designed to explore the planktonic ecosystem and biogeochemical response to the 2002 SERIES iron fertilization experiment in the subarctic NE Pacific. The ecosystem model simulates with the same parameter set both the 'average' annual cycle at OSP and the SERIES experiment. We seek to understand

the role of iron fertilization in changing (i) planktonic ecosystem structure and function, (ii) the macronutrient fields of N and Si, and (iii) the inorganic carbon system (including surface ocean pCO_2). The model captures the initial bloom of small phytoplankton followed by the large bloom of diatoms, accompanied by a strong draw-down of the nutrient silicic acid. However, it took considerable tuning of parameter values to obtain a high enough peak biomass of diatoms before they crashed. Key parameters were the sinking speed of diatoms, the scaling coefficient for aggregation, the relative preference of microzooplankton for diatoms, and the 'normal' or background degree of iron limitation of the diatoms. We discuss the sensitivity of model results to changes in food preference of microzooplankton (from small phytoplankton and detritus to diatoms), to the way aggregation and sinking losses are parameterized, and to the assumed uptake ratio by diatoms of Si and N.

11:45 AM

4B5.6
Identification of water masses in the North West Atlantic during Canada-SOLAS research cruises in 2003 using MODIS data

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In 2003, the Canadian component of SOLAS launched a series of 3 cruises in the North West Atlantic to study air-sea gas exchanges, and related processes. These cruises, as recorded with CTD casts, went through different water masses characterised by their temperature, salinity and other properties. These physical characteristics have an impact on the ecology of the region: for instance, oligotrophic waters with low productivity are found in the warmer and saltier waters of the subtropical gyre. Coupling the physical characteristics of water masses with their physiological traits has lead to the notion of biogeochemical provinces. Identification of the dynamic boundaries of such provinces would find many applications, such as the extrapolation of results obtained at stations within a province. A major challenge in identifying the boundaries of these provinces is the natural variation of their boundaries on various temporal scales. We propose an original method to identify the boundaries of provinces based on sea surface temperature and biomass fields, measured by the MODIS sensors. Composite images of SST and phytoplankton biomass were produced for the periods of the three C-SOLAS cruises. An iterative procedure based on statistical analysis (cluster analysis) was developed to redefine dynamically the static borders of the seven provinces as proposed by Sathyendranath et al. (1995) for the study area. Besides the identification of the water masses along the ship track, interesting features such as the decrease in size of the continental shelf from spring to fall and increase of the polar boreal current during the same period were found.

10:30 AM

4B6.1
A Report on the Status of Argo in general and its status in the N. E. Pacific.
Howard J. Freeland
(Presented by / Présenté par ***Howard Freeland***)
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There are now 20 countries deploying floats in support of Argo internationally and in November 2004 the array achieved 50% of the target number of active floats. This talk will summarise the current status of Argo and the prospects for achieving 100% of the implementation target. The data system is working efficiently with up to 90% of profiles being available for download from the Global Argo Data Centres within 24 hours of the acquisition of the profile. There have been a few problems with the float hardware, these will be outlined. The talk will also review the current status of the array in the NE Pacific and the Gulf of Alaska

(INVITED/INVITÉ) 10:45 AM

4B6.2
Canadian Argo program in the North Atlantic
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At the initial international Argo planning meeting for the Atlantic, Canada accepted responsibility for the Slope Water / Gulf Stream Extension / North Atlantic Current region of the western North Atlantic. This region between 35 N and 50 N, west of the mid Atlantic ridge would require at least 23 profiling floats to achieve the planned density of observations. Since October 2001, Canada has deployed a total of 29 floats; as of 16 February 2005, 22 of these profilers are operating although not all of them are still in the region of Canadian responsibility. The Slope Water / Gulf Stream region is a region of significant circulation variability. Floats have not moved more than 1800 km from their launch positions; some floats achieve such distances during their first 6 months, others remain within 500 km of their launch site after 3 years.

Germany failed to get their anticipated funding level leaving the Labrador Sea sparsely populated with floats. Since spring 2002, 14 Canadian floats have been deployed in the Labrador Sea or near Orphan Knoll northwest of Newfoundland. Nine of these floats are still operating. Several of these floats have spent the winter cooling period in the centre of the traditional deep convection site. By early February, these floats had observed a mixed layer as deep as 1200 metres with a potential density anomaly of 27.72, the density of upper Labrador Sea Water. The paper will report on how convection progresses over the next 6-8 weeks of the cooling season.

The Atlantic Argo Data is being assimilated by the French Coriolis program on the large scale. Several examples will be discussed of how it deals with the intense small scale variability in the western Atlantic

(INVITED/INVITÉ) 11:00 AM

4B6.3
Oxygen measurements on Argo floats
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The Argo fleet of robotic floats provides measurements of temperature, salinity and velocity in the top 2000 m of the ice-free world ocean. The unprecedented spatial coverage of the Argo array offers the opportunity to measure other oceanographic parameters for which reliable sensors with low power requirements can be mounted on the floats. In September 2003, German investigators deployed two APEX floats equipped with Aanderaa's Optode oxygen sensor in the Labrador Sea. Following their lead, Canada deployed four similar APEX/Optode floats in 2004: one in the northwest Atlantic Slope Water (May), one in the Labrador Sea (May), and two in the Gulf of Alaska (June & September). We will report on the first complete annual oxygen cycle of the Labrador Sea float, which remained within less than 305 km of its initial position during the first 9 months. We will also present a T-S-O2 transect across the Gulf Stream collected during the 820 km southward drift of a float from the northwest Atlantic Slope Water region to the subtropical gyre. Comparisons of Argo/Optode oxygen measurements with Winkler titrations for the first profile of a Gulf of Alaska float near station PAPA are very encouraging, with an average absolute difference as small as 6.2 µmol kg^{-1} (within manufacturer's

specifications). Finally, we will compare the Argo/Optode mapping of the oxygen minimum in the North Pacific and the North Atlantic to the World Ocean Atlas 2001 oxygen climatology.

(INVITED/INVITÉ) 11:15 AM

4B6.4
Canada's contributions to Argo in observing the ocean in real-time
Anh Tran , J. R. Keeley
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Prediction of climate variability depends on our ability to observe ocean variability. Argo is an international program where by up to 3000 robotic diving floats will collect temperature (T) and salinity (S) profiles in the world oceans and transmit data in real-time without any restrictions to all users. Some also collect oxygen profiles.

Argo will provide a quantitative description of the evolving state of the upper ocean and the patterns of ocean climate variability. Data provided by Argo and other observation programs will feed in to the Global Ocean Data Assimilation Experiment (GODAE) which will supply the first forecasting tools for the ocean climate. Argo supports the concept of Operational Oceanography.

Deployments for Argo began in 2000. Floats cycle to 2000m depth every 10 days, with a 4-5 year lifetime for individual instruments. As of February 2005, the global Argo network consisted of 1656 active floats deployed by fifteen countries in the Atlantic, Indian and Pacific oceans. Canada made its first deployment on June 9, 2001 and to date has contributed 127 floats to the program with a total of 7441 profiles. Typically, about 90% of the data are distributed within 24 hours of the float surfacing. The current profiling float used in Canada, built by the Webb Research Corporation and METOCEAN, could supply up to 200 profiles over its lifetime.

The objective of our talk is to show Canada's contribution to the Argo program. The Canadian Argo data system will be described showing the various stages that the raw data goes through to become completed T, S and oxygen profiles. Comparisons between data collected from Argo floats and other instruments will be discussed, as well as some products available to users.

11:30 AM

4B6.5
Panel discussion on Argo implementation
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It is the objective of Argo participants to make these new real-time data sets as widely available as is reasonably possible and as useful as possible to the research community. Thus, following presentations concerning the implementation of Argo internationally and within areas of Canadian interest we will open the floor for questions on any aspect of Argo implementation and data access. The purpose of this is for those who are interested in using Argo for research purposes to offer guidance for the future of Argo, suggestions that can be taken to the international Argo committees, and complaints.

1:30 PM

4C1.1
Innovation based estimation of background and obseravtion error statistics in variational data assimilation
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Variational data assimilation system aims at providing an accurate estimation of the current state of the atmosphere by means of minimizing the following the cost function:

$$J(\delta x) = \frac{1}{2}\delta x^T B^{-1}\delta x + \frac{1}{2}\sum_{i=1}^{N}(H\delta x_i - d)^T R^{-1}(H\delta x_i - d)$$
$$= J^b + J^o$$

where the error covariance matrix *B* for background and *R* observation are pre-specified. Usually the matrix *B* and *R* are not very well known. Both of them suffered from some deficiencies. One needs to fine tune these error statistics.
In this study, the method proposed by Desrozier and Ivanov (2001) was used and several experiments on the online tuning based on optimality diagnostic were carried out.
The idea of the method is based on the fact pointed out by Talagrand (1999) that the expectation of J^o and J^b at minimum are

$$E(J^o) = \frac{1}{2}(p - Tr(HK)) \text{ and } E(J^b) = \frac{1}{2}Tr(HK)$$

$$\text{Then } E(J(x^a)) = E(J^o) + E(J^b) = p/2$$

Which implies the mean of the value of the cost function at minimum is proportional to the number of observations. According to these properties, one can adjust the error statistics by multiply coefficients

$s^{b^2} = 2J^b / Tr(HK)$ and $s^{o^2} = 2J^o / (I_p - HK)$ to the background and observational error statistics respectively, so that the total cost function is balanced for the new error statistics.
The method has been used to CMC 3D Var data assimilation system; the results show the improvement of error statistics.

1:45 PM

4C1.2
SST data assimilation
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With a simple 3D Var assimilation algorithm, a new scheme of assimilating sea surface temperature (SST) observations is proposed in this paper. In this new scheme, the linear relation between any two neighboring depths was derived using singular value decomposition (SVD) technique, and then applied to estimate the temperatures at deeper
level using the temperature analyses at shallower level. The estimated temperatures were assimilated into an ocean model, and the procedure run iteratively at each time-step from the surface to a depth of 250m.

The oceanic analyses show that the new scheme can more effectively adjust oceanic thermal and dynamical fields, and lead to a more realistic subsurface thermal structure when compared with the control run and another scheme that is usually used for SST
assimilation. An ensemble of predictions for the Nino3 region SST anomalies (SSTA) was performed to test the new scheme. It was found that the new scheme can improve fairly well ENSO prediction skills at all lead times, in particular for anomalous warm events, and for lead times of 4-7 months.

2:00 PM

4C1.3
Description of a Canadian Land Data Assimilation System (CaLDAS)
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A Canadian Land Data Assimilation System (CaLDAS) has been developed for improving the soil moisture initialization for the Canadian Meteorological Center (CMC) operational Numerical Weather Prediction models. The CaLDAS is built on three modules : a simple land surface scheme ISBA (Noilhan and Planton, 1989), a land surface microwave radiative transfer model (Drusch et al., 2001), and a simplified bi-dimensional variational assimilation technique (Balsamo et al., 2004). This data assimilation system has been designed to allow the inclusion of observations of various origins: near surface meteorological quantities (two-meter temperature and humidity, surface precipitation), satellite radiances in infra-red and micro-wave channels.
This presentation will focus on the methodology defined for a first operational implementation of CaLDAS in the operational assimilation system of the CMC regional model GEM. The advantages of CaLDAS with respect to the current operational soil moisture initialization will be described.

1:30 PM

4C2.1
Simulating Heterogeneous stratospheric Ozone loss in a GCM:Continuing studies using CMAM.
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The calculation of contemporary polar ozone loss with a global climate model with out resorting to "adjustment" or parameterization remains a difficult problem as one must simultaneous simulate appropriate dynamically isolated conditions along with low temperature conditions and adequate moisture. This is particularly difficult since the processing of Cly on PSC is very sensitive to temperature changes of a few degrees. Thus it difficult to know how reliable these models are when attempting to describe future impacts of climate change on ozone loss in polar regions. In this presentation, the continuing development of the CMAM climate GCM will be discussed examining new the issues and challenges of putting together a simulation suitable for WMO intercomparisons. In particular the issue of cloud and aerosol parameterized physics within a climate GCM with a focus on polar regions will be explored.

1:45 PM

4C2.2
Real-Time Collection and Distribution of MSC T&P Climate Data
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The Meteorological Service of Canada is modernizing the reporting infrastructure for its Temperature and Precipitation (T&P) Climate Observer Network, the largest of its monitoring networks. The T&P Network is comprised of stations situated on privately owned land from which volunteer and cooperative observers gather Maximum and Minimum temperature data, as well as rainfall, snowfall, snow-depth data, twice daily. The observer logs the data on a paper form, which is sent at month end to MSC regional offices. It can take up to 18 months for the MSC to receive, manually Quality Control (QC), keyboard, and archive that data to make it available for distribution.

As of late 2004, the Meteorological Service of Canada began asking the volunteer and cooperative observers in the T&P network to convert to an electronic reporting format. The MSC developed a web-based application called COOLTAP to collect climate information from those with access to internet enabled computers. For those who cannot access the internet we maintain a touch-tone reporting system called ONTAP-IVR. All observers received a letter in December 2004, asking that they convert to one of the two electronic reporting systems before April 1st, 2006. The MSC does not expect to have the funding to collect and input hardcopy climate data after that date. As a result, we will see the existing T&P network of 1400 observers evolve in reaction to our requirement for electronic data input. As of February 18, 2005 just over 300 of the 1400 observers have converted to electronic reporting. Some observers have indicated that they will withdraw from the program.

Users of data from this network will be faced with a smaller network of observations, but one that will report the majority of its observations daily. What will be the impacts for those users who monitor climate variability? Weather forecasters? NWP models? What type of network do we get when it evolves in reaction to a technological requirement? We expect to receive responses from all the T&P observers before the CMOS-2005 meeting date.

2:00 PM

4C2.3
Numerical Wind Energy Atlas for Canada
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The surge of the wind energy industry has created a pressing need for surface wind climate at high resolution. This stimulates the development of a Wind Energy Simulation Toolkit (WEST), which can make wind maps accurately and efficiently for an area of about 500 by 500 km^2. WEST is based on a statistical-dynamical downscaling method: a combination of statistical analysis of historical climate data to obtain the basic weather types (or classes) of a region, and dynamic adaptation of large scale air flow of each class to high resolution terrain and surface roughness by using mesoscale and microscale models.

WEST was used to create the Canadian national wind atlas, a first ever digital map for such a large area. To do this, the country was first divided into some 60 overlapping tiles. For each tile, mesoscale simulation at 5 km resolution was carried out for each weather class. The regional wind climate was then established by weighting the individual simulation results with its occurrence frequency. The regional climate from each tile was finally merged into a national map to form the Canadian Wind Energy Atlas. Its first version was released in October 2004 and is publicly available at http://www.windatlas.ca. Among the available statistic parameters, two of them (EU and UHR) are worth to be highlighted. EU is the mean wind speed for the period of climate data available for the classification, and UHR the frequency distribution of mean wind speed by sector and class – a key input for microscale model.

2:15 PM

4C2.4
Rehabilitating the Reference Climate Station Network
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The Reference Climate Station (RCS) network has grown since its first inception in 1992. Many changes have impacted the stations of this network over the last 13 years. The modernization of the network has salvaged several stations at risk over the last 6 years. However, we now need to re-evaluate each station in the network against the RCS standard.

This presentation will provide an update on the status of the modernization of the network, with a focus on the triple configuration of the sensors for critical parameters (precipitation and temperature). Plans for future improvement and/or corrective actions required to insure that all stations in the network meet the standards for this network will also be presented.

2:30 PM

4C2.5
The Role of Soil Moisture in Climate Predictability
Barbara Winter
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Soil moisture has the potential to enhance climate predictability on seasonal time-scales. Like SST, it is a lower boundary forcing for general circulation models of the atmosphere; unlike for SSTs, there are no comprehensive global soil moisture datasets and values fluctuate greatly on very small spatial scales, as well as relating in complex ways to the local hydrology. That is why climate forecasts traditionally rely almost exclusively on SST predictability. Recent studies, however, suggest that the memory inherent in soil states (wet or dry) can contribute to climate predictability, particularly where SST influence is less strong.

We build on the growing body of soil moisture studies by investigating its variability in the newest version of the CCCma atmospheric GCM (AGCM3) and the land surface model CLASS to which it is coupled. Are anomalous values clearly outside the normal range of variability? How well do model-generated values match the available observational data or assimilation results? These questions must be answered before a predictability study can be undertaken, and will be addressed in the talk.

2:45 PM

4C2.6
Changes in temperature and precipitation extremes as simulated in the IPCC multi-model ensemble of global coupled climate model simulations
Viatcheslav Kharin
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Changes in extreme temperatures and precipitation are examined in the IPCC multi-model ensemble of global coupled climate model simulations submitted from about a dozen of climate modelling groups. The projected future changes are estimated for a number of climate change scenarios including the IPCC SRES A1B, B2 and A2 conditions. The extremes are described in terms of return values estimated from the Generalized Extreme Value distribution fitted to samples of annual extremes by the method of L-moments.

This study is still ongoing as more and more model output becomes available for the analysis. The first preliminary results indicate that there is substantial inter-model variability in simulated climate extremes, in particular, precipitation extremes. Changes in temperature extremes on global scale are largely associated with changes in the location of the distribution of annual extremes and are comparable to changes in mean temperature. Cold extremes are warming up faster than the warm extremes. Changes in precipitation extremes generally exceed the corresponding changes in the annual mean precipitation.

1:30 PM

4C3.1
Improved measurements of wind profilers
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Wind profiler radars are being deployed increasingly world-wide, furnishing critical information on changing wind fields. These instruments continuously monitor wind fields above with a high temporal / spatial resolution. The measurements do not depend on the presence of precipitation.

The quality of available data has improved significantly over the past few years. Because of advances in hardware / software, measurements below 100 m are common. In addition to mean wind profiles, wind profiler radars also furnish in real time wind variability, atmospheric turbulence, wind shear information, rainfall rates, boundary layer height. We present examples of various information available from wind profiler radar data.

1:45 PM

4C3.2
Radar Meteorology at VHF band
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Traditionally, Radar meteorology applied to the study of precipitation has been done mainly using the microwave band (wavelengths between 1m and 1mm). However, VHF-band radars (wavelengths between 1 and 10m) present some advantages since they measure backscatter from both clear air and precipitation. (Both signals produce independent contributions in VHF Doppler power spectra.) This research explores the scientific use of Very-High-Frequency (VHF) radar measurements in precipitation. Operational observations from the McGill VHF radar are used to generate profiles of horizontal and vertical winds. Research applications, however, require the calibration of the radar received power. This calibration is performed using the cosmic VHF emissions as reference. After the calibration, distributions of radar scatterers as a function of vertical velocities (Doppler spectra) are analyzed for snow and rain events.

2:00 PM

4C3.3
Identification of microphysical processes with polarimetric radar
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Since 1999, McGill University's S-band radar has polarisation capability and in the last two years data quality has improved significantly.

Polarimetric radar variables defined as radar reflectivity Z, differential reflectivity Zdr, cross-correlation coefficient, are sensitive to the hydrometeors' size, shape, orientation, thermodynamic phase, number density and diversity of meteorological targets. This information is already used to classify the different types of hydrometeors.
Radar rainfall estimation uses a relationship between the reflectivity Z and the estimated rainfall R. Improving the rainfall estimation is possible with a better understanding of the microphysical processes of precipitation.

We have examined the variability of the vertical profiles of polarimetric radar variables and the POSS measured variability of DSD. We have attempted to identify microphysical processes through the morphology of radar echoes and the evolution of DSD.

In this presentation, we describe the results of two years of observations. Cases of stratiform precipitation with a well-defined bright band are considered. Ways of identifying microphysical processes in clouds using the polarimetric radar are discussed.

2:15 PM

4C3.4
Effect of the spatial variability of precipitation on the differential phase shift
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Avec les radar à polarisation, nous pouvons acquérir des informations supplémentaires permettant de mesurer le taux de précipitation et d'identifier le type de particules sondées. Le radar émet dans l'atmosphère des impulsions d'énergie électromagnétique interagissant avec la précipitation (composée de particules non sphériques) d'une telle façon qu'une partie de l'énergie est diffusée vers le radar (rétrodiffusion). Les particules non sphériques composant la précipitation dépolarise le signal lors de la rétrodiffusion. La propagation dans ce même milieu affaiblit et déphase les ondes lorsqu'elles se déplacent. Le déphasage différentiel est obtenu avec le signal rétrodiffusé par la précipitation parvenant au radar. Il représente la différence de phase entre les composantes verticales et horizontales du signal radar.

Le but de ce projet est d'étudier la propagation d'un faisceau radar dans la précipitation non uniforme présentant de la variabilité dans la direction de propagation et dans le plan transverse. Nous verrons l'impact de cette non uniformité sur le déphasage différentiel.

La présentation portera sur la façon de traiter la propagation d'une onde dans un milieu non uniforme, donc sur la méthodologie retenue. Des résultats préliminaires seront également présentés.

2:30 PM

4C3.5
Hydrological Model Validation of Surface precipitation from Volumetric Doppler Radar Data
Erika S. Klyszejko [1] , N. Kouwen [1] , R. Juneja [1] , A. Bellon [2] , I. Zawadzki [2]
(Presented by / Présenté par ***Erika Klyszejko***)
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The University of Waterloo Hydrology Lab currently receives four (4) different radar precipitation products from McGill University's J.S. Marshall Radar Observatory in Montreal. The radar domain includes parts of Eastern Ontario, Southwestern Quebec and Northern New York and Vermont.

In order to determine which product most accurately estimates precipitation over time and space, separate runs of the WATFLOOD Hydrological model are performed using each of the radar products. The model is also run using distributed rain gauge data. Computed streamflow hydrographs using the radar products and rain gauge data are compared to observed streamflows at various locations within the radar domain.

It will be shown that where overlapping coverage of radar and rain gauge network exists, the hydrographs computed using the radar product with the highest level of correction best match those derived from gauge rainfall alone. Individual streamflow events will be further analyzed to determine if the type of synoptic condition associated with the event impacts the accuracy of radar-estimated precipitation measurements.

The study shows that where radar has an unobstructed view of the atmosphere within the Doppler range, the new corrective schemes have improved estimates of precipitation (over time and space) to the point of making them useful for hydrology. Some problems with the model remain (i.e. timing) but in general, the model performs well because some hydrograph sequences exhibit very low error and most problems can be explained.

1:30 PM

4C4.1
Simulations of Anthropogenic Heat: Meteorological and Air Quality Implications
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Comparisons of air-quality model results to observations collected during a measurement intensive in August of 2001 showed significant overpredictions of many chemicals in urban regions. An analysis of the model processes suggests that the cause of these overpredictions lies in the forecast atmospheric stability, with insufficiently strong vertical diffusion relative to the ambient atmosphere. A simple anthropogenic heat emissions parameterization, incorporated into the operational regional GEM forecast model, suggests that urban heat islands may account for the reduced stability over urban regions. The results also suggest that incorporation of urban heating effects may substantially improve forecasts of air quality and air temperature in urban centres, particularly at night. Comparisons of simulations using A Unified Regional Air-quality Modelling System (AURAMS) with original and modified GEM forecasts as input will be used to show the impact of the altered meteorology on the air-quality simulations.

1:45 PM

4C4.2
Fuzzy Logic Modeling of Surface Ozone Concentrations
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Fuzzy logic is a methodology based on the principle that relationships are often imprecise or uncertain. For this reason, fuzzy logic provides effective solutions for nonlinear and partially unknown systems. Due to the complex relationships and the necessity for forecasts in atmospheric studies, air pollution modeling is a task for which fuzzy logic methods are amicably suited. This research investigates the ability to predict surface ozone concentration with the use of an automated fuzzy logic method, termed Modified Learning from Examples (MLFE).

An MLFE ozone model is developed using meteorological inputs for the city of Edmonton. Hourly ozone concentrations during summer months in Edmonton are predicted with the MLFE model and the results are compared to the CHRONOS and CANFIS models used by Environment Canada. The MLFE model captures the trends in ozone concentration, and based on the statistical comparisons, the MLFE consistently shows good agreement with the observed ozone data.

2:00 PM

4C4.3
A simulation of aerosol dispersion and wet deposition using a Lagrangian stochastic dispersion model and precipitation fields from radar estimations and GEM
Jian Feng
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Aerosols in the atmosphere are subject to being transported with winds and deposited to the ground. Wet and dry deposition are two important mechanisms to remove the aerosols from the atmosphere onto the ground. Wet deposition refers to the removal of particles from the atmosphere by precipitation while dry deposition is the deposition of particles in the absence of precipitation. The relative importance of these two mechanisms depends on the properties of particles, the amount and type of precipitation, the boundary level turbulence and the surface properties. In this study, we simulate the atmospheric dispersion of aerosols with a Lagrangian stochastic dispersion model with mean wind fields from the Global Multiscale Environmental Multiscale (GEM) model. Wet deposition is parameterized in terms of precipitation rate using a 3-mode method, which takes into account the fact that wet scavenging efficiency depends strongly on aerosol size. Precipitation fields are taken from the near real-time radar mosaics, which are produced and archived at the Canadian Meteorological Centre (CMC), and from the GEM model output. The aerosol deposition pattern and magnitude at the ground will be compared between different simulation scenarios.

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2:15 PM

4C4.4
A new numerical scheme for sub-grid scale convective transport of chemical tracers
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It is widely accepted that large convective storms have a major impact on the chemical composition of the troposphere. In particular deep convection has an important impact on the distribution of chemical tracers which subsequently have an effect on cloud properties and climate. The current project is focused on the numerical modeling of sub-grid scale transport of tracers by deep convection in a regional chemical and transport model.

The newly developed numerical scheme for sub-grid scale convective transport of tracers is a modified version of the Kain-Fritsch (1990) sub-grid scale convective scheme. The Kain-Fritsch scheme is currently operationally in use in the regional configuration of the Global Environmental Multiscale (GEM) model at Environment Canada. The new scheme has been implemented in the A Unified Regional Air-quality Modelling System (AURAMS) model from Environment Canada. AURAMS is an Eulerian, size-resolved, composition-resolved, regional-scale, particulate-matter, air quality model. The measurements from two different campaigns are compared to the new model output for transport of CO. The two campaigns looked specifically at the vertical redistribution of CO and other trace gases by convective storms. We have chosen carbon monoxide as it is an inert gas with little chemical interaction and would hence give us a better comparison of the effects of vertical transport on the vertical distribution than other available tracers. The preliminary results of the evaluation of this new scheme in AURAMS will be presented.

2:30 PM

4C4.5
The CMC Trajectory Model
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The CMC Trajectory Model is a useful tool to predict the path followed by an air parcel released at different time interval, location and elevation. This model can compute forward and backward trajectories for historical and forecast cases by using meteorological data with different resolutions, from models (GEM, GEM regional, HIMAP) and analysis (NCEP).

A web site has been developed to allow users to compute trajectories with this model. It is possible to request trajectories for multiple sites for a period of time. Model outputs can be in ASCII format and/or images. The images can be customized by choosing the map projection, the colors of levels, and many other options.

The web site also offers a database of back-trajectories computed on a daily basis for over 80 cities throughout Canada.

1:30 PM

4C5.1
Phytoplankton Production and Export during the Decline of a Northwest Atlantic Spring Bloom
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Despite its importance to the understanding of the fate of photosynthetic carbon, the declining phase of a bloom has been poorly studied. As part of the Canadian-SOLAS program, phytoplankton production and particulate organic carbon (POC) export rates were measured over two periods of the decline of a Northwest Atlantic (NWA) spring bloom. Over a 7-day Lagrangian study, nutrients were in low concentration in the surface waters and large phytoplankton cells (>5 µm) dominated the phytoplankton community, representing >75% of the total chlorophyll *a* biomass and >50% of the production. Phytoplankton biomass and total production decreased from 361 to 136 mg/m^2 and from 2550 to 340 mg C/m^2/d, respectively. The phytoplankton community, initially dominated by centric diatoms, became progressively dominated by small (2-5 µm) flagellates. The downward sinking flux of POC at 50 m decreased from 674 to 281 mg C/m^2/d. However, the percentage of the daily phytoplankton production exported out of the euphotic zone through sinking increased from 23 to 91%. Twelve days later, phytoplankton production increased to 1000 mgC/m^2/d while chlorophyll *a* concentration decreased to 100 mg/m^2. In contrast to the first study period, small phytoplankton cells (0.7-5 µm), mainly prymnesiophyceae and unidentified flagellates, dominated the biomass and production. POC sinking rate decreased to 141 mg C/m^2/d, and only 14% of the phytoplankton production was exported out of the euphotic zone. This study represents a unique survey of phytoplankton production and export rates of organic matter during the decline of the natural NWA spring bloom.

1:45 PM

4C5.2
Uptake of CO2 in the Northwest Atlantic Ocean
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The objective of the study is to understand the effects of primary production and its export on the CO_2 uptake of the upper water column in different biogeochemical provinces of the Northwest Atlantic Ocean. CO_2 uptakes vary among different provinces and seasons. Subtropical provinces (Sargasso Sea and Gulf Stream) were observed to be CO_2 source in spring, summer and fall. Northwest Atlantic shelf was observed to be sink of CO_2 in spring and summer, but source in fall. North Atlantic drift was a sink for CO_2 in spring, but source in summer and fall. Subarctic stations were observed to be a sink of CO_2 in all seasons, except for stations > 50ºN (station T7 in the Greenland Current was not sampled in spring), where they were a source of CO_2 in spring due to low primary production. In addition to primary production, decrease in solubility of CO_2 in the water column due to increase in temperature and decrease in salinity and total alkalinity from spring to summer and fall played an opposite role of the biological effects in CO_2 uptake. There were significant relationships between organic carbon export (E_{PC}) and CO_2 uptake (ΔTCO_2) during spring to summer ($\Delta TCO_2 = -1.07\ E_{PC} + 19.45$, $r = -0.79$, $n = 8$, $p < 0.01$) and summer to fall ($\Delta TCO_2 = -0.80\ E_{PC} + 36.98$, $r = -0.81$, $n = 6$, $p < 0.05$). These results suggest that most of CO_2 uptake was driven by export of organic carbon.

2:00 PM

4C5.3
Seasonal and Spatial Patterns of Bacterial Community Structure in the Northwest Atlantic
Kimberley Keats [1], *M. Robin Anderson* [2], *Heather Bussey* [1], *Michelle S. Hale* [1], *William K. W. Li* [2], *Paul L. Matthews* [1], *Richard B. Rivkin* [1]
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Heterotrophic bacteria are ubiquitous and abundant in the world's oceans, often dominating the biomass of planktonic food webs and thus having a central role in mediating water column biogeochemical processes. Until recently, marine bacteria have been considered as a single group with unknown diversity and variation. However, it is now recognized that the abundance and activity of specific phylogenetic groups within the bacterial assemblage and their role in the cycling and transformation of dissolved organic matter and the remineralization of biogenic carbon may vary both spatially and temporally. We characterized the phylogenetic diversity of the bacterial community in six biogeochemical provinces of the Northwest Atlantic, using Fluorescence *In Situ* Hybridization (FISH), and related this to a number of concurrently measured ecological and climate-related parameters. The results of this study show significant differences in bacterial community structure between biogeochemical provinces of the Northwest Atlantic, as well as seasonally within each biogeochemical province. The phylogenetic diversity coupled with indicators of the metabolic activity of the bacterial assemblages provide new insight into the influence of bacterial metabolism on larger scale biogeochemical and ecosystem processes.

2:15 PM

4C5.4
Springtime DMS production during a Lagrangian study of the North Atlantic diatom bloom

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Marine emissions of DMS may have important implications for climate regulation by increasing the scattering of solar radiations and the albedo of clouds. The production of DMS stems mostly from the bacterial cleavage of DMSP, a molecule synthesized by phytoplankton with specific variability among phytoplankton taxa. Diatoms are considered to biosynthesize only a small quantity of DMSP. The objective of this study was to determine whether large vernal efflorescences of diatoms may contribute to the production and sea-air fluxes of DMS. We hypothesized that peaks in DMS concentration should coincide with the collapse of the diatom bloom, following a release of DMSP in the environment and its degradation by bacteria. The senescent phase of the spring diatom bloom in the NW Atlantic was captured during a 7-day Lagrangian experiment conducted in April and May 2003. As the bloom aged, surface waters became depleted in particulate and dissolved DMSP and a modest increase of DMS was observed despite a twofold increase of heterotrophic bacterial cells. Biological production of DMS was variable and fairly low throughout the study period (maximum rate of 0.08 nmol l^{-1} h^{-1}). Low biological production rates of DMS suggest that the DMSP released in the water column was predominantly utilized by bacteria as a source of sulfur, a pathway that precludes the production of DMS.

2:30 PM

4C5.5
Dynamics of DMSP consumption and DMS production by attached and free bacteria during the declining phase of a diatom spring bloom

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The climate-active gas dimethylsulfide (DMS) is produced in the ocean from the degradation of algal dimethylsulfoniopropionate (DMSP), a process mainly mediated by marine bacteria. Understanding bacterial DMSP metabolism is crucial since generally less than 10% of the DMSP consumed by bacteria is converted into DMS. Bacterial DMSP consumption and the fate of the DMSP consumed were determined during a 7-day Lagrangian study of the declining phase of the spring bloom in the Northwest Atlantic. Unfiltered (whole bacterial community) and 1 μm-filtered (only free-living bacteria) seawater samples from the surface mixed layer were amended with ^{35}S-$DMSP_d$ and the products of bacterial DMSP metabolism were measured during 3-h incubations. Diatom abundances gradually decreased during the course of the study, marking the decline and sedimentation of the diatom bloom. During the first 2 days, $DMSP_d$ consumption by the whole bacterial community (0.91-1.27 nM h^{-1}) was significantly higher than consumption by free-living bacteria (0.17-0.26 nM h^{-1}), suggesting that bacteria attached to particles or cells were responsible for most of the $DMSP_d$ consumption. $DMSP_d$ consumption by the whole community decreased to 0.18-0.35 nM h^{-1} between days 3 and 7, and was similar to consumption by free-living bacteria (0.09-0.17 nM h^{-1}), suggesting that $DMSP_d$ consumption was mostly mediated by free-living bacteria. DMS production was also maximum (>0.06 nM h^{-1}) and mostly mediated by

attached bacteria during the first 2 days. DMS production then declined to <0.02 nM h^{-1} and became mainly mediated by free-living bacteria. These results suggest that the sedimentation of the diatoms during the decline of the spring bloom led to a decrease in bacterial $DMSP_d$ consumption and DMS production, possibly due to the removal of attached bacteria, which strongly dominated these processes.

2:45 PM

4C5.6
Source Apportionment of Sulphate Aerosols and Gaseous Sulphur Dioxide over the NW Atlantic using Stable Sulphur Isotopes.

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Sulphate aerosols have the potential to alter climate, reducing the effect of increasing greenhouse gas emissions by scattering incident solar radiation back to space. Dimethylsulphide (DMS) is emitted from the surface ocean, and oxidized into methanesulphonic acid (MSA), or gaseous SO_2 in the atmosphere. SO_2 is oxidized forming new sulphate aerosols. Sulphate aerosols, MSA and SO_2 were collected on a diurnal basis during the 2003 Spring C-SOLAS cruise of the NW Atlantic using hi-volume samplers and size segregated impactors. The cruise consisted of a track ranging from 36ºN to 54ºN. Aerosol and SO_2 samples were characterized isotopically and for their chemical composition.

Anthropogenic sulphate was concentrated in the smaller size fractions on the impactor filters and corresponds to lower isotopic signatures. Sea-salt-sulphate and other ocean constituents dominated the larger size fractions. The daytime sample collected over the Gulf Stream had 96% sea salt in the largest size fraction (>7.2µm), and an isotopic signature of +20‰. In the <0.49µm size fraction the isotopic signature was +9‰, with 11.5% sea salt. NO_3 oxidizes DMS and the highest concentration of NO_3 (2175ng/m^3) was found off the coast of Halifax corresponding with a $\delta^{34}S$ signature of +6.8‰, indicative of anthropogenic emissions. $\delta^{34}S$ and $\delta^{34}SO_2$ were both statistically significant latitudinally ($p<0.001$ and $p=0.011$) and also diurnally ($p=0.024$ and $p=0.031$). The biogenic fraction showed latitudinal significance ($p=0.003$), with higher concentrations at northerly latitudes. $\delta^{34}SO_2$ values were higher during night-time sampling, indicating a potential increase in DMS oxidation to SO_2 during the night.

1:30 PM

4C6.1

Towards Operational Assimilation of ARGO Data

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The Meteorological Service of Canada (MSC), the Department of Fisheries and Oceans (DFO), and the Department of National Defence (DND) all need the products and modelling capabilities that can be provided by an operational global coupled atmosphere-ocean-ice data assimilation and prediction system. Of particular relevance, the ARGO float program, to which Canada is a major contributor, is expected to have about 3000 floats deployed in the global oceans by the end of 2005. Together with other data sets (e.g., altimeter, remotely sensed SST, and tropical moored arrays) there is tremendous potential for the development of ocean data assimilation systems. An inter-departmental advisory panel (comprised of the authors listed above) has developed recommendations for an operational Canadian coupled atmosphere-ocean-ice data assimilation and modelling capability. In the past year there have been presentations to senior EC, DFO and DND management. Resources are being sought for the establishment of a "fast-track" operational system based on an imported capability, and for a parallel "slow-track" research and development network to develop a system tailored to Canadian needs in the longer term. This talk will provide an overview of the proposed system and its applications, and will summarize progress to date and plans for the future.

1:45 PM

4C6.2

Estimation of the circulation in an ocean basin using Argo.

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(Presented by / Présenté par ***Howard Freeland***)
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Methods will be outlined that allow the estimation of the time-varying ocean circulation on the scale of an ocean basin. The first step is the computation of the geostrophic circulation fields relative to a reference level of no motion. However, Argo floats also supply information on the deep velocity field which offers the possibility of direct estimates of velocity relative to a level of *known* motion. Examples will be shown based on analyses of circulation in the N. E. Pacific and in the Indian Ocean. The fields estimated all have associated error fields and these error fields are not random, rather areas of large expected error appear to be associated with intense eddies. This offers the possibility that the error field can be coupled with sea level fields to insert eddies into the mapping process. Examples of this will be shown.

2:00 PM

4C6.3

Recent Ocean Temperature Anomalies in the Gulf of Alaska

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Argo profilers now provide real-time observations of ocean anomalies in the Gulf of Alaska, and offer insights into the origins of these anomalies. Over the past few years the surface waters of the eastern gulf warmed significantly, reaching highest-ever temperatures in the summer of 2004, whereas waters below the surface mixed layer were close to normal temperatures. These deeper waters had also warmed over the previous two years, but were much colder than normal at the start of this warming in 2002. We will investigate the set-up of these temperature anomalies by winds over the gulf, and investigate their impact on coastal waters and life in coastal waters of North America.

2:15 PM

4C6.4
Can seal based observations complement Argo observations for ocean forecasting in eastern Canadian Waters?
Fraser Davidson , Gary Stenson [2] , MIke Hammill [1]
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In 2004, nearly 100 satellite based temperature depth tags were placed on seals and belugas in eastern Canada. These animals collected in 10 months roughly 30,000 temperature profiles from the Gulf of St. Laurence to Greenland and beyond. As part of the development of an east coast forecasting system, we investigate the coverage of the sea mammal based observations with respect to data collected by the Argo array. We then compare this data set for 2004 with traditional oceanographic observations. We discuss assimilation methods considered for application in a Newfoundland Shelf Forecasting system and the importance of combining in-situ with remotely sensed observations. Field work comparing a new generation of Temperature and Salinity measuring tag with a Seabird 911+ are also presented. We conclude this presentation with planned work for imbedding in-situ observations with an ocean forecasting system for the Newfoundland Shelf and adjacent deep waters.

3:30 PM

4E5.1
Development of coupling strategy NODEM-NARCM through GOTM
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CLAW hypothesis suggests that the phytoplankton can control climate through the emission of dimethylsulfide gas (DMS). Recent advances have shown that the major source of cloud condensation nuclei over oceans is the volatile DMS. In fact, this gas increases the cloud albedo and their life time, thus decreasing the solar radiation budget at the surface. In order to verify this hypothesis, we are building a coupled model between the dimethylsulfide (DMS) production model NODEM and the Aerosol Regional Climate Model NARCM through the General Ocean Turbulence Model GOTM. The coupling strategy starts with a 1D link between GOTM and the single column version of NARCM (LCM). Then, we replace GOTM by the already coupled modules NODEM-GOTM. Finally, this coupling will be carried to the full 3-D version of NARCM. The approach is similar to that used at CCMA for coupling biochemical modules to the AGCM. This will permit comparisons between global and regional single column versions.

3:45 PM

4E5.2
Algal Production of Dimethylsulphoxide (DMSO) in Seawater
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Dimethylsulphide (DMS) is the major oceanic source of reduced sulphur to the atmosphere, and it has been hypothesised that marine DMS emissions are involved in the biological regulation of global climate. However, in order to understand the link between the marine biota and climate, we must also understand the processes that control DMS concentrations in seawater. Among these are the transformations that potentially exist between DMS and DMSO, an oxidised form of DMS.

In this presentation, we will provide evidence from laboratory studies for the direct biosynthesis of DMSO in marine phytoplankton. Following its release from cells and subsequent bacterial reduction to DMS, the algal-derived DMSO may serve as a novel source of DMS in seawater. However, it is known that DMS can also be derived from extracellular dimethylsulphoniopropionate (DMSP), which is released from cells through processes that disrupt cell structure, such as viral- and auto-lysis and micro-zooplankton grazing. The purpose of this study was to investigate whether intracellular DMSO can also be released to the dissolved phase in a similar way to DMSPp. Results from laboratory experiments using axenic cultures of the marine haptophyte, *Emiliania huxleyi* demonstrated that viral lysis, autolysis and micro-zooplankton grazing all led to elevated concentrations of DMSOd. These findings may suggest that all three microbial processes could contribute to the levels of DMSOd in the natural environment, where DMSO may potentially play an important role in the marine cycle of DMS.

4:00 PM

4E5.3
Spatial and temporal patterns of microbial dynamics in the Northwest Atlantic: Potential role in cycling of climate active gases
Richard Rivkin [1] , *Michelle S. Hale* [4] , *Paul Matthews* [4] , *Heather Bussey* [4] , *Kim Keats* [4] , *M. Robin Anderson* [3] , *William K. W. Li* [2]
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Processes occurring within the microbial food web influence the remineralization of biogenic carbon, air-sea CO2 flux and carbon export. Despite their potential importance in biogenic carbon cycling, comprehensive analyses of

microheterotrophic processes in the World Oceans are quite incomplete. As part of the Canadian Surface Ocean Lower Atmosphere Study, we measured the seasonal and spatial patterns in the abundance, distribution and rates of growth and loss of heterotrophic bacteria in six biogeochemical provinces of the Northwest Atlantic. These data are combined with a meta-analysis of similar variables for the North Atlantic and are used to test critical hypothesis about the regulation of microbial processes and microbial mediation of biogenic carbon cycling in the upper ocean. We find strong seasonal signals in all parameters and divergent trends in bacterial biomass, growth and respiration with respect to latitude and temperature. These patterns have a important implications for understanding the response of the upper ocean biogeochemical cycles to climate forcings.

4:15 PM

4E5.4
Seasonal and spatial variability of ocean-atmosphere fluxes of methyl halides in the N. Atlantic: what do they reveal of the sources?
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The ocean is the predominant source of gas phase iodine to the atmosphere with methyl iodide being the main carrier. The ocean is also one of several sources of methyl chloride and bromide. Quantifying the fluxes of these gases requires knowledge of the spatial and seasonal distributions of their concentrations in surface waters and, ideally, a knowledge of their sources within the ocean. We will present results obtained during 3 CSOLAS cruises in the N. Atlantic that reveal major seasonal and spatial variation. An objective of the study is to identify the production mechanisms the ocean, with biological and photochemical production being two main possibilities. The relationship between surface concentrations of the methyl halides and algal pigments and light will be examined.

4:30 PM

4E5.5
High concentrations of DMSP and DMS during a Northwest Atlantic seasonal cycle
Michael Scarratt [1] , *Sonia Michaud* [3] , *Maurice Levasseur* [2] , *Martine Lizotte* [2] , *Anissa Merzouk* [2]
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DMSP and DMS profiles were measured at 8 stations in the NW Atlantic in April-May, July and October 2003 ranging in latitude from 36.8 °N to 59.6 °N. Three distinct seasons were sampled, including the spring bloom. This is the first reported seasonal cycle of DMSP and DMS measurements in the Northwest Atlantic. Particulate DMSP (DMSPp) concentrations ranged widely, with maximum values of 120 nM in subarctic and Greenland Current waters in summer. Dissolved DMSP (DMSPd) concentrations were typically an order of magnitude lower than the correponding DMSPp values, with a maximum of 11.75 nM at Greenland in summer. DMS concentrations at all stations were highest in summer, with a maximum value of 13.5 nM in subarctic waters. This is high for the open ocean and compares with values routinely found in the NE Pacific, a region known for DMS productivity. DMSP and DMS were lowest in the fall at all stations. DMSP and DMS profiles at all stations were characterized by a subsurface maximum (<50 m) declining to zero by 200 m. The region of highest DMSP and DMS concentrations shifted from South to North as the seasons progressed, following the seasonal succession of species. DMSP distributions were correlated with the presence of known DMSP-producing species (dinoflagellates, chrysophytes, coccolithophorids and other prymnesiophytes) with stronger correlations in the spring and fall. DMSPd and DMS showed little or no relationship to phytoplankton abundances. The spring diatom bloom contributed little to DMSP and DMS concentrations, with consistently low values in diatom-dominated waters.

4:45 PM

4E5.6
Seasonal Variations in Atmospheric Dimethylsulphide Over the North Atlantic during SABINA
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Dimethylsulphide or DMS, a gas released from the surface ocean in response to biotic productivity and decline as well as wave action, is thought to be an important precursor in the formation of fine aerosol sulphate. Newly formed particulate matter from the oxidation of DMS is expected to have a negative impact on global warming as it scatters incident solar radiation back to space and alters the presence, lifetime and radiative properties of clouds. Atmospheric concentrations of DMS were made hourly aboard the spring, summer and fall SABINA cruises during transit to and along a North-South transect along 45ºW between 36ºN and 59ºN. In contrast to the very unusual results over the Pacific Ocean during SERIES, where DMS concentrations reached 8 ppb, DMS concentrations over the Atlantic were found to be in a similar range to measurements reported elsewhere in the literature (typically < 1ppb). DMS concentrations displayed no diurnal variations in spring and fall but were slightly higher at night than during the day in summer. Average atmospheric DMS concentrations in spring were 104 ppt, in summer 163 ppt, and in fall 70 ppt. Higher DMS concentrations were observed at different latitudes for each cruise. In spring and fall, DMS was present in higher concentrations at lower latitudes. In summer, DMS concentrations were greatest at high latitudes. An examination of the factors influencing atmospheric DMS concentrations during different times of the year will be presented.

3:00 PM

1D10.1
Reactive uptake of O3 on Oleic Acid - Alkanoic Acid Mixtures
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In the atmosphere gas-phase species react on or in organic particles and potentially modify the particle composition and morphology. These reactions, often referred to as heterogeneous reactions, may change the hygroscopic and the optical properties of the aerosol particles and have a direct influence on air quality and health issues. The heterogeneous reaction of O_3 with pure liquid oleic acid has been studied extensively. In the atmosphere, however, oleic acid is most likely found in mixtures with other species, and these other species may influence the reaction rates, reaction mechanisms, and lifetimes of oleic acid. The heterogeneous reactions of O_3 on oleic acid/alkanoic acid mixtures, which provide a proxy for meat cooking aerosol particles, are studied as a function of composition and physical state employing a rotating wall flow tube reactor coupled to a chemical ionization mass spectrometer. The heterogeneous uptake coefficient of O_3 for the binary mixtures is measured at 298K as a function of saturated acid concentration. The addition of small amounts of saturated fatty acids decreases the uptake coefficient significantly. The uptake coefficient of O_3 is an order of magnitude lower for solid-liquid mixtures, yielding longer atmospheric lifetimes. The experiments show that the uptake reaction is affected by both the phase and the morphology of the mixture. These observations are closer to estimates of OA atmospheric lifetimes compared with previous measurements on pure OA.

3:00 PM

1D10.2
Global/Regional Atmospheric Mercury Chemistry: A Modeling Study
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Mercury is one of the highly bioaccumulative and toxic trace metals in the environment. Despite continued efforts to regulate anthropogenic mercury emissions and their resulting reductions in last decade, the mercury concentrations in water and air have remained unaltered. Atmospheric transport and deposition is the main pathway for the introduction of mercury in the ecosystem. Unlike other heavy metals, significant form of mercury exists in elemental gaseous form, which is believed to react slowly in the atmosphere, has low solubility in water and is volatilized at the earth's surface making it a long-range pollutant. Ambient measurements of mercury reveal a vast global pool of mercury in the atmosphere up to the tropopause and yet at the same time, atmospheric measurements of mercury in polar regions have shown that elemental mercury can be rapidly oxidized to more hygroscopic forms and deposited in the presence of halogens. Although aqueous phase chemistry of mercury is reasonably well known, few kinetic studies of gaseous phase reactions of elemental mercury exist in the literature. In addition, there are large uncertainties in the existing data due to the difficulties related to its low atmospheric concentrations and strong effects of the surface chemistry on the reactor walls. The purpose of this study is to examine the current state of atmospheric mercury chemical mechanism and its implications on atmospheric mercury cycling by using an atmospheric mercury model and atmospheric measurements of mercury as constraints in the model.

At Meteorological Service of Canada (MSC), we have developed a high resolution Global/Regional Atmospheric Heavy Metals Model (GRAHM). GRAHM is an Eulerian Multiscale model and at present it is being used to investigate atmospheric mercury at global and regional scales. The model solves dynamic equations for all meteorological processes and physio-chemical processes for mercury species. Gas and aqueous-phase chemistry, multiple-resistance based dry deposition, vertical planetary boundary layer diffusion, cloud-chemical interactions using detailed cloud schemes and wet deposition form the set of mercury processes included in the model. Sensitivity studies are performed to examine the impact of different mercury chemical mechanism on atmospheric burden of mercury, global and regional depositions and life-time of mercury in the atmosphere. Results from this study will be presented at the conference.

3:00 PM

1D10.3
Ground-level ozone events in South Ontario and its related source region
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Air quality in southern Ontario can be affected by long range transported ozone precursors as well as local emissions. To further investigate source impact, three scenario runs was conducted by using Canadian Hemispheric and Regional Ozone and NOx System (CHRONOS). In the model base case, the emission inventory consist of anthropogenic and biogenic sources in the Canadian and US inventories. Additional model runs was conducted by using base case emission inventory but excluding anthropogenic emission from Ontario and third runs excluding anthropogenic emissions from the United States. Model simulation for summer 2002 and 2003 were analyzed and the results indicate high ozone events in southern Ontario were associated with US emissions and could occurred without any contribution from Ontario sources.

3:00 PM

1D10.4

7Be as a Tracer of Stratospheric Contribution to Ground Level Ozone at Harlech, Alberta

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As a step to understanding the stratospheric contribution to ground level ozone in the Alberta foothills, monitoring was conducted at Harlech, Alberta, from July 2003 to June 2004 using a TECO 49 for continuous ozone observation and a hi-volume sampler for subsequent analysis for beryllium-7. In addition, relative humidity, temperature, and wind direction and speed were collected. A high ozone event, a low ozone event, and an average ozone period are analyzed to estimate the likelihood and magnitude of stratospheric contribution to ambient ground level ozone.
Beryllium-7 (^{7}Be) is a cosmogenic gamma emitting radionuclide with a radioactive decay half-life of 53.3 days. ^{7}Be is formed through spallation reactions leading to the fragmentation of light atmospheric nuclei such as ^{12}C, ^{14}N, and ^{16}O, and is primarily produced in the stratosphere and to a lesser extent in the upper troposphere. ^{7}Be atoms rapidly attach to ambient aerosols and therefore depend on the removal and transport of these aerosols. ^{7}Be is considered a tracer of stratospheric air which typically has attendant high ozone levels and low relative humidity.
A high case was considered for values of ozone and ^{7}Be of 2σ greater than monthly mean values; a low case for values 1σ below monthly means and average values within that range. The meteorological conditions during and preceding the observations are also examined for dynamic influences.

3:00 PM

1D10.5

Tropospheric NO2 column distributions over North Eastern America: Comparison of Regional Model Simulations with Satellite Measurements

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Tropospheric NO2 columns derived from the measurements of the Global Ozone Monitoring Experiment (GOME) have been compared with the simulations from a regional chemical transport model for May to September 1998 over North Eastern America. The model calculation was done using the *MM5/MCIP/SMOKE/CMAQ* modeling system. The main objective of this work was to evaluate the accuracy of the NO_2 emission data currently available and also to detect anomalies in the performance of the model. The results show that the model can reproduce the distribution and the monthly changes in the NO_2 column over the modeled domain very well. While the modeled NO_2 column trends are in good general agreement with the GOME measurements, they are slightly smaller than the measurements in some places. In this presentation, we will discuss the causes of these differences and propose some improvements that might reduce their effects.

3:00 PM

1D10.6
Preliminary Testing and Validation of the CanX-2 GPS Radio Occultation Experiment
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CanX-2 is a Low-Earth Orbiting (LEO) satellite being constructed by the Space Flight Laboratory of the University of Toronto Institute for Aerospace Studies. It will have onboard a GPS radio occultation experiment designed by the Department of Geomatics Engineering at the University of Calgary. The purpose of this experiment is to extract vertical profiles of refractivity in the troposphere. In radio occultation, signals from GPS satellites are observed by the LEO as they graze the Earth, passing through the atmosphere. The extent to which the atmosphere bends the signal can be computed, and from this the refractivity can be obtained. As the GPS satellite sets with respect to the LEO, the line of sight moves vertically and a profile of refractivity is obtained. The GPS receiver carried by the satellite will be an OEM4-G2L provided by NovAtel Inc. In preparation for the expected launch of the mission in late 2005, preliminary testing and analysis has been done by the University of Calgary.

The CanX-2 radio occultation experiment differs from large-scale (and high budget) microsatellite missions such as CHAMP. For example, the very small size (~3kg) of the satellite places significant power restrictions on the occultation experiment. Only a few occultation events per day can be observed, and the receiver can only be powered long enough to observe one event. Simulation software has been developed to predict occultation events, and to calculate the tangent point of the occultation and the geometry of the remaining GPS satellites. Occultations to be observed are selected from those predicted, with preference given to occultations occurring over Canada and with strong geometry of the remaining GPS satellites for positioning purposes. To test the ability of the GPS receiver to acquire and track satellites under LEO dynamics, testing has been done on a hardware GPS simulator. Testing shows that under LEO dynamics the default acquisition scheme does not acquire satellites quickly enough for the requirements of the mission. Manually assigning all channels proves to be a faster and more reliable means of acquisition. Once satellites are acquired, the receiver is able to track all satellites, even under L1 Doppler frequency values as high as 45kHz.

Routines to extract refractivity profiles from the occultation measurements have also been developed, and have been tested using raw data available from a current radio occultation mission (CHAMP). Validation of the routines is performed by comparison against profiles extracted by other institutions. The future potential for low-cost radio occultation missions, using off-the-shelf GPS hardware and a picosatellite platform, is explored for meteorology and climatology applications.

3:00 PM

1D10.8
Application of the GEM-LAM for wind studies at Arctic weather forecasting sites
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In 2003 the Minister of the Environment announced the establishment of 5 National Laboratories across Canada, each focusing upon an aspect of weather that is of concern to operational forecasters. Within Prairie and Northern Region resides the Hydrometeorology and Arctic Laboratory (HAL).

A forecasting challenge of particular importance over northern Canada is the understanding and forecasting of winds within complex topographical regions. The resultant winds at many Arctic locations are due to the interaction between steep / complex topography and the synoptic flow, which can cause winds to vary in speed by tens of knots within minutes. Due to the paucity of observing sites in the north, these interactions are not well understood.

A major initiative within the HAL, then, is to perform a series of case-studies at specific Arctic forecasting sites using GEM-LAM run at a high resolution of 2.5km. These case studies cover synoptic flow patterns which are known to result in surface winds that are highly variable, or stronger than their expected geostrophic value. As part of testing of the GEM-LAM, initial work on case-studies has already begun. Preliminary results from these case-studies will be presented.

3:00 PM

1D10.9
A general convolution filter for variable-resolution models
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The modern approach of a variable resolution in the global numerical models for weather forecast or climate simulation can be used to adequately represent the regional scales over the area of interest with acceptable computational costs, avoiding the nesting problems of the limited-area models. In order to address some problems associated with the stretching and anisotropy of the computational grid, a general two-dimensional convolution filter operator is developed, based on an axisymmetric weighting function. Applied in the stretching area adjacent to the uniform fine-resolution zone, it renders the resolution effectively isotropic. The main feature of this filter is to remove all the wavelengths shorter than a user-prescribed length scale, which may be chosen as the maximum distance between two grid points in the areas where the resolution changes. This operator can be used not only to remove anisotropy, but also for the pole problem arising from the convergence of the meridians, and to control short-scale oscillations arising in all numerical models. The details of the construction and the applications of this operator are presented.

As a feasibility study prior to introduce the filter into a complex variable-resolution model, the filter has been tested with a simple wave on a variable grid in one dimension, and later applied for two-dimensional fields. The results show that the filter is able to remove selected noise outside the high-resolution zone of interest. Its application can be a pragmatic compromise between the response of the filter and the related implementation costs.

3:00 PM

1D10.7
Evaluating GEM and MC2 forecasts for Sea Fog identification at Lunenburg Bay
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Climatological studies in Canada suggest that there is an overall decrease in fog occurrences, which is consistent with the trends observed in the United States. Despite these trends and improved vehicle safety, annual averages of fatal highway accidents involving fog are 54 for Canada and 700 for the United States. Fog also has serious economic impacts. For example, it is estimated that inaccurate fog forecasts would cost US aviation up to $875 million in additional operational costs annually.

In Atlantic Canada advection of sea fog accounts for most fog observations at inland stations where the more common of two major types of sea fog forms when warm moist air moves over colder water. A case study spanning 4 days from 29 June to 02 July 2004 was selected, where GOES images indicated fog banks unobscured by higher level clouds and the synoptic patterns were typical for sea fog formation off Nova Scotia.

Preliminary results suggest that moisture parameters in CMC objective analyses can deviate significantly from measurements, which have implications when these analyses are used to initiate mesoscale model simulations to forecast sea fog. Work is in progress to diagnose the causes of these deviations amongst measurements, objective analyses and mesoscale model forecasts. Although CMC objective analyses do not deviate substantially from radiosonde observations in the lower atmosphere, there are areas off the coast of Nova Scotia where the analyses do not seem to reflect the presence of fog or low clouds that are seen in satellite images. Refinements of the NWP forecasts for fog are expected to result from inputting near surface moisture information at initial time and also by increasing model resolution to better define the sea surface temperature and modeled details of the coastline. GEM and MC2 configuration studies for 15km, 9km, 3km and 1km horizontal resolutions are underway.

3:00 PM

1D10.10
A hybrid neural network/analog model for multivariate and multi-site climate downscaling
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Previous studies have shown that combined multiple linear regression/analog models and canonical correlation analysis/analog models can perform better than the individual constituent models when applied to spatial downscaling tasks. In this study, a novel neural network architecture with output nodes based on an analog model will be used as the basis for statistical downscaling. Unlike previous combinations of linear models with analog models, this approach embeds the analog model inside a nonlinear neural network model. Building on recent developments in nonlinear multivariate statistical modelling, the neural network is responsible for mapping the input variables to a new set of variables. These new variables are used to find the optimum analogs from the historical database. Results suggest that the new approach performs better than traditional analog methods when applied to a climate downscaling task.

3:00 PM

1D10.11
Lag of Maximum Correlation as an Ocean Climate Model Diagnostic
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Lagged correlations are often interpreted as establishing causality: if the correlation (positive or negative) between time series A and time series B peaks when B is subject to a time lag L, then it is logical to suppose that A at time t is influencing B at time t+L. In theory, one can can go a step further and map L as a function of position to establish propagation of causal influence. The usefulness of such an approach using observational data is limited due the the relatively short time series available, whereas coupled climate models can provide time series of 1000 years or longer. This poster explores the utility of this diagnostic, which we denote "lag of maximum correlation", or LOMC, using a 1000 year control run of the CGCM2 coupled model. Three phenomena are considered: ENSO-like variability originating in the tropical Pacific, advection ofthermal anomalies in a subtropical gyre, and propagation of influences arising from buoyancy forcing in the Labrador Sea.

3:00 PM

1D10.12
Influence of waves and sea spray on midlatitude storm structure and intensity
William Allan Perrie [1], *Zhang Weiqing* [3], *Li Weibiao* [2]
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A coupled atmosphere –wave – sea spray model system is used to evaluate the combined impacts of spray evaporation and wave drag on midlatitude storms. Our focus is on the role of air-sea fluxes on storm intensity and development, and related impacts on the structure of the atmospheric boundary layer. The composite model system consists of the Canadian Mesoscale Compressible Community (MC2) atmospheric model coupled to the operational wave model WaveWatchIII (WW3), and a recent bulk parameterization for heat fluxes due to sea spray. Case studies are extratropical hurricane Earl (1998) and two intense winter storms from 2000 and 2002, hereafter denoted Super-bomb and Bomb, respectively. Results show that sea spray tends to intensify storms, whereas wave-related drag tends to de-intensify. The mechanisms by which spray and wave-related drag can influence storm intensity are quite different. When wind speeds are high and sea surface temperatures (SSTs) warm, spray can significantly increase the surface heat fluxes. By comparison, momentum fluxes related to wave-drag are important over regions of the storm where young, newly generated waves are prevalent, for example during the rapid-development phase of the storm, and decreases in areas where the storm waves reach maturity. We show that the collective influence of spray and waves on storm intensity depends on their occurrence in the early stages of a storm's rapid intensification phase, and spatially, in the near neighborhood of the storm center.

3:00 PM

1D10.13
Simulating the response of stratospheric ozone to specified increases in greenhouse gas concentrations between 1979 and 2060

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While chlorine loadings in the atmosphere are expected to decrease towards pre-ozone hole levels by 2060, the greenhouse gases (GHGs) burden is rising continuously and may in turn modify significantly the stratospheric ozone layer.
In this study, the response of stratospheric ozone to increases in greenhouse gas concentrations between 1979 and 2060 is investigated using the new interactively coupled chemistry - general circulation model IGCM-FASTOC. The IGCM (Intermediate General Circulation Model) is a relatively fast general circulation model (GCM) with parameterizations of an intermediate level of complexity, and the new chemistry scheme FASTOC (Fast STratospheric Ozone Chemistry) is an efficient input-output model composed of precomputed non-linear functions.

Multiple time-slice simulations are performed to allow for the quantification of individual processes involved in the response of stratospheric ozone. In the talk, emphasis will be placed upon the sensitivity to increases in methane and water vapour concentrations.

3:00 PM

1D10.14
Surface Energy and Water Budgets as Simulated by two Generations of the Canadian regional Climate Model (CRCM) over the Mississipi and Columbia River Basins

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This study aims to compare and evaluate the operational and developmental versions of the CRCM surface energy and water budgets with re-analyses and available observations. The two versions of the model differ by their physical parameterization packages: the operational and developmental versions of the CRCM employ the physical parameterization packages of CGCM-II and III, respectively, as developed for the Canadian General Circulation Model (CGCM) at the Canadian Centre for Climate Modelling and Analysis (CCCma). Among the improvements to the physics of CGCM-III is the land-surface scheme CLASS, a three-layer soil model with explicit treatment of snow and canopy layers. It replaces the so-called bucket hydrological scheme and one-layer force-restore surface energy budget in the operational version. The configuration of CRCM for these comparison is taken from the PIRCS-1c experiment for 1987 to 1994 over the continental USA. The analysis focuses over two major river basins with strong differences in atmospheric forcing, vegetation and topography: the Mississippi and the Columbia river basins. Observed data used in this study are monthly mean screen temperature, precipitation, snow cover and river discharge; surface energy fluxes are compared with both NCEP/NCAR and ECMWF ERA40 re-analyses. Results show that the developmental version of the CRCM constitutes an improvement over the operational version, particularly for precipitation, evaporation and diurnal temperature range. A persistent cold bias in screen temperature, however, is associated with an excessive snow amount in winter followed by an excessive runoff peak in spring.

3:00 PM

1D10.15
Ocean Observatory Technologies: Some VENUS Solutions
Richard K. Dewey , *Paul Macoun*
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Cabled ocean observatories will offer both continuous power and high-bandwidth communications to instruments moored on the ocean bottom and profiling systems. The Victoria Experimental Network Under the Sea (VENUS) in a mid-depth (up to 350m) observatory consisting of three arrays, one each in: Saanich inlet, Strait of Georgia, and Juan de Fuca Strait. This paper will present the latest design and engineering plans, including instrument platforms, specifications for connecting to the fibre optic backbone, power and communication protocols, command and control interfaces, and an overview of the data management and archive system (DMAS).

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1D10.16
Climate-induced shifts in the soil thermal regime for a high-latitude location
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Observed soil temperatures at Salluit, a high-latitude town in Northern Québec, suggest a deepening of the active layer associated with the recent climate warming. This increase of the active layer thickness (ALT) and associated permafrost degradation can have adverse effects on the socio-economic and eco-environmental systems. The soil thermal regime for this location is simulated using a one-dimensional heat conduction model (Goodrich, 1976) for current (1979-2003) and future (2041-2070) climates.

Soil temperatures and ALT are simulated for current climate with the model using NCEP reanalyses ground temperature and snow-cover as input. Analysis of the NCEP data shows a small negative trend for the thawing index and statistically significant positive trend of freezing index for the period 1979-1991. The following 1992-2003 period on the other hand exhibits the statistically significant negative (positive) trend for the thawing (freezing) index. A positive trend is reproduced as well in the model-simulated ALT, with ALT increasing by about 1m during the period 1992-2003. Model-simulated upper soil temperatures show an increase by several degrees, in good agreement with in-situ observations.

The ground temperature and snow cover from the transient climate-change simulations with the Canadian Regional Climate Model (CRCM) for the period 2041-2070 are used to drive the model to simulate the future soil thermal regime for Salluit. The soil thermal regime shows a further increase in the ALT by 1m over the period, reaching 5m by the end of 2070, which is roughly 4m deeper than the current active layer thickness. This is in agreement with the significant positive (negative) trend obtained from the analysis of the thawing (freezing) index simulated by the CRCM and reduced snow cover duration for Salluit for that period.

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1D10.17
Algal entrapment in newly formed sea ice in the Canadian Beaufort Sea
Magdalena M.R. Rozanska , Michel Poulin Canadian Museum de la Nature , Michel Gosselin Universite du Quebec a Rimouski
(Presented by / Présenté par ***Magdalena Rozanska***)
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During the Canadian Arctic Shelf Exchange Study (CASES) expedition in the Western Beaufort Sea, microalgal samples were collected in October 2003 in newly formed sea ice (e.g. slush, nilas and pancake) and the underlying surface water. This study aimed to test the hypothesis that there was no difference in the algal taxonomic composition between the two habitats. Preliminary results based on the comparison of 3 paired samples (2 from the end of September, 1 from the end of October) indicate that both habitats were dominated by small flagellates belonging to Chlorophyceae, Cryptophyceae, Prasinophyceae, and Prymnesiophyceae, and thecate and naked Dinophyceae. However, they were more abundant in newly formed sea ice than in surface water. Diatoms were also present but in lower abundance than flagellates. Diatom species like *Attheya* spp. and *Melosira arctica* were only abundant in the sea ice, while *Cylindrotheca closterium, Pseudo-nitzschia seriata, Thalassiosira/Porosira* group and *Chaetoceros* spp. were numerous in both habitats. Higher numbers of diatoms and spores of *Chaetoceros* spp. and *Melosira arctica* were observed mostly in the surface water sample collected in October. These higher numbers of diatoms can probably be explained by the desalination of the ice sheet when it forms, therefore, releasing the algal cells outside the ice. The occurrence of a high abundance of diatom spores in the surface water coincides with the fall season in which case the diatom cells enter into a dormant phase with the production of spores before the period of total darkness in the Canadian Arctic.

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1D10.18
Characteristics of Vertical Migration of Zooplankton in Coastal Newfoundland
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Zooplankton populations from three areas around Newfoundland - Trinity Bay, Placentia Bay, and Funk Island Bank - were observed using 300 kHz acoustic Doppler current profilers (ADCPs) from 1999 to 2004. The acoustic backscatter data show a clear diel vertical migration of zooplankton toward the surface during evening twilight hours, and away from the surface during morning twilight hours. Vertical velocities registered by the ADCPs during these migrations are dominated by zooplankton velocities, which can be distinguished from water velocities by correlating appropriate backscatter levels with high velocity values. Analysis of long time series (approximately 100 days at each of 11 moorings) allows for assessment of this method of measuring zooplankton velocity. Day-to-day variations in migration patterns, timing, and character are then correlated with changing physical conditions to determine what environmental factors influence this diel migration.

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1D10.19
On the Climate Change at Antarctica Peninsula Region
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The most pronounced lower tropospheric warming in South Hemisphere is found for the region of the Antarctic Peninsula in the second half of XX century with one of the most intensive rates about +0.055±0.04°C/year at Vernadsky, Ukrainian Antarctic base (65°14'S, 64°15'W, formerly known as Faraday, UK). Significant reduction of regional glaciation including ice-shelves and small islands' glaciers as well as some changes in Antarctic ecosystems can be considered as main aftereffects of warming.
The warming at Antarctic Peninsula is in line with global changes, namely with growth of near-surface temperatures in polar and mid-latitudes' regions of the Northern Hemisphere, as Arctic, Alaska, Central Siberia. However if warming in the Northern Hemisphere took place at the background of changes in tropospheric circulation, the reasons of warming at Antarctic Peninsula region remain still not enough understood.
Warming in this region is hypothesized to be explained by intensification of circumpolar westerlies, along with some decrease in atmospheric pressure in lower pressure belt and domination of cyclones which responsible for the advection of warm and wet air. Both frequent coldest spells and winter seasons at Antarctic Peninsula in 1950s -1970s were caused by south or south-east advection in stable like-blocking anticyclonic processes centered poleward of 60°S, which were unusual for last decades. Alternatively, last years were characterized by northward shift of blocking, which brings in much warmer air to Antarctic Peninsula.
El-Nino Southern Oscillation defines weather anomalies throughout the world; the influence of ENSO on regional circulation and climate at the Antarctic Peninsula region is displayed in the best way on time scales from monthly to half-an-year after ENSO mature phase by means of circulation shifts between alternative synoptic patterns such as stable (blocking) anticyclones and cyclogenesis.

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1D10.20
Atmospheric Monitoring Operating Process
Ted Sawchuk
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Due to organizational changes over the last several years, the quality of standards, operational procedures and documentation has deteriorated resulting in inconsistent methods, duplication of effort and obsolete documentation.
AMOP was developed in response to several concerns:

- out-dated manuals, for example, instrument manuals and bulletins, program manuals (wind, etc.),Land Inspection Manual
- new equipment/networks with insufficient documentation
- requirement to harmonize inspection procedures nationally
- inability to easily obtain/determine an up-to-date picture of a particular monitoring network
- incomplete information for the LCM process
- changes in headquarters organization – workloads prohibit reviews and updating
- experienced staff retiring/leaving MSC (losing corporate wisdom)
- integrity of the data being produced by the national networks

To address these issues Atmospheric Monitoring Operational Process (AMOP) is being implemented. AMOP combines national and regional resources to systematically assess processes, standards and documentation for the eight major atmospheric monitoring networks to develop effective and efficient solutions. The basic components/tenets of the process include:

- regular technical review of maintenance procedures for approved systems
- national/regional participation at all levels of the process
- analysis and action on cross-cutting issues affecting all networks
- analysis and action on review of the process itself
- support to the Network Managers (including CMB process)
- support to the LCM process
- national coordination of technical reviews

Benefits:

- shared responsibility and participation results in efficiently and effectively maintained networks
- nationally consistent data
- supported documentation
- experience (wisdom) is recorded)and not lost
- provision of information to ‘management’ as they deal with workloads and resources
- assists the CMB process
- consistent with quality system principles

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2D10.1
Analytic flux formulation for the Unstable Surface Layer
Kenzu Abdella , Dawit Assafa
(Presented by / Présenté par ***Dawit Assafa***)
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This study presents a semi-analytic non-iterative solution for the Monin-Obukhov similarity equations under unstable surface conditions. The solution is represented in terms of the nondimensional Monin-Obukhov stability parameter $\frac{z}{L}$. This parameter is given as a function of the bulk Richardson number and other surface parameters including the heat and momentum roughness lengths which are generally assumed to be different in this formulation. The proposed formulations give results that are both quantitatively and qualitatively consistent with the fully iterated numerical solution for a wide range of surface parameters.

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2D10.2
Surface Energy Balance Closure by the Eddy Covariance Method Above Three Boreal Forest Stands and Implication for the Measurement of the CO2 Flux
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Closure of the surface energy balance provides an objective criterion for evaluating eddy-covariance (EC) flux measurements. This study analyses five years of EC carbon dioxide, sensible heat, and latent heat flux measurements from three mature boreal forest stands in central Saskatchewan, Canada.

At all three sites, the EC sensible and latent heat fluxes underestimate the surface available energy (net radiation minus storage) by ~ 15%. All three sites show a similar dependence of the energy-closure fraction (CF) on the friction velocity u_* and time of day. At night, CF increases from minimum of ~0.4 at very low u_* to an asymptotic maximum of ~0.9 at u_* above 0.35 m s^{-1}. During unstable-daytime periods, CF increases linearly from a minimum of ~0.7 at low u_* to a maximum of ~1.0 at high u_*. The CF versus u_* analysis provides an objective method to evaluate the EC measurements of H and λE.

EC measurements of net ecosystem exchange (NEE) have no objective, diagnostic parameter that is equivalent to CF. To evaluate the measurement of NEE, we developed an analogous parameter to CF, normalizing measured NEE against an empirical NEE model that was calibrated using high-u_* data only. The normalized NEE - u_* analysis shows remarkable similarity to the CF - u_* analysis, both day and night. The analysis supports the common practice of rejecting EC NEE measurements during low-u_* periods at night. It also provides an objective justification for the less accepted practice of applying energy-closure adjustments to EC measurements of NEE.

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2D10.3
Long-term Changes for Incoming Solar Radiation on the Canadian Prairie
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Variability in the sun's activity is one potential cause of natural climate change. The output of energy from the sun has been increasing since about 1850. About half of the warming of the earth's surface over the past century and a third of the warming since 1970 may be due to increased solar energy output. However, many regions of the earth have experienced a steady decline in solar radiation since the late 1950's. We analyzed long-term (1960 to 1997) meteorological records from six locations across the Canadian Prairies for evidence of annual and seasonal trends in incoming solar energy (MJ m^{-2} day^{-1}). Averaging across the six locations, the annual and seasonal (January through April, May through August) average daily

incoming solar energy have decreased linearly between 1960 and 1997. Over the same period, the average daily incoming solar energy for September through December has tended to decrease (but not significantly).

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2D10.4

Measuring N2O emissions associated with liquid and solid dairy manure application in private producer fields

Elizabeth Pattey [1] , Christophe Forget Agriculture and Agri-Food Canada [1] , Lynda G. Blackburn [2] , Ian B. Strachan [2] , Dave W. Dow [1]
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As part of Model Farm/Mitigation Program initiatives, a roving GHG flux measuring system was developed to monitor GHG emissions from diffuses sources in fields of private producers. The roving measurement system was made of flux-gradient towers for measuring N_2O gradients, which were analyzed sequentially using a tunable diode laser trace gas analyzer (TGA100, Campbell Scientific, Logan, UT, USA) and of an eddy flux tower equipped with a 3D ultrasonic anemometer (R3-HS Solent, Gill Instruments, Lymington, UK) and a fast-response infrared CO_2 H_2O analyzer (LI6262, LI-COR, Lincoln, NE, USA). In 2003, the roving GHG flux system was installed at Coteaux-du-Lac in a pea field (QC, west of Montreal), which received solid dairy manure after harvest. The measuring system was moved to Richmond (ON, South of Ottawa) in an alfalfa and grass mixture field, in the spring of 2004. At Richmond the liquid dairy manure was applied in the spring prior to forage growth and after the two cuts. Continuous measurements of N_2O fluxes, made during and after solid dairy manure applied on the harvested pea field, showed huge N_2O emissions, which lasted almost 10 days. They totalled more than 2 kg N_2O-N ha^{-1}. The cumulative N_2O emissions measured during the following soil thawing period in Coteaux-du-Lac were 0.8 kg N_2O-N ha^{-1}. At Richmond, N_2O emissions were measured after each liquid dairy manure application following each cut and during winter and spring thaw. In this case N_2O emissions were much lower being in the range of 0.2-0.3 kg N_2O-N ha^{-1}.

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2D10.5
VisualTAF: Graphical Forecast Verification - A First Step to Improving Forecast Quality
Heather Antoniuk [1], *E de Groot* [2]
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Aerodrome Forecasts (TAFs) are issued by the Meteorological Service of Canada (MSC) for NAV CANADA, the corporation that owns and operates Canada's civil air navigation service. These forecasts are used for weather briefings, flight planning, and pre- and in-flight briefings. VisualTAF provides forecasters with an enhanced tool to help them uphold a performance standard when writing and maintaining their TAFs.

VisualTAF is a graphical output of a selected forecast, either current or historical. The graphs allow forecasters to immediately compare their TAF to the observed ceilings, visibilities, and weather. The TAF ceilings and visibilities are plotted in conjunction with the observations made at the selected airport site. The graph can be used to show the trend in the forecast and whether it is in agreement with the observations. A forecaster may also compare their forecast to previous TAFs, or later ones, depending on the time chosen. The purpose of VisualTAF is to provide forecasters with a quick visual way to evaluate and verify past or current forecasts. The end product will be accessed via a website and will be available in real time so forecasters may immediately see their results while working an operational shift. This will provide the opportunity for self identification of the areas which need improvement.

The features of the graph will be presented in detail.

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2D10.6
Initial results on the forecasting of snowfall to snow water equivalent ratio by a new model
Jessica Cox [1], *R. Stewart* [4], *C. Lin* [4], *V. Turcotte* [3], *B. Kochtubajda* [2]
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The sophistication of QPF forecasting by numerical models has increased substantially in recent years. However, in the cold season, the 10:1 rule of thumb conversion of forecast liquid precipitation to forecast snowfall is still widely used operationally even though it is well-known to introduce error in the forecasts since the density of snow is highly variable. In 2003 Ivan Dube of the Quebec region developed a decision tree to find the snow water equivalent ratio (SWE). Using this decision tree the Severe Weather Lab of MSC Quebec region has built an algorithm to calculate a more realistic snow forecast amount using numerical model outputs which has been made available to the operational forecasters. The objective of this presentation is to examine the first results from an attempt to validate the success of this technique in forecasting snow to snow water equivalent ratio across all regions of Canada using the model output and data from Environment Canada's National Climate Archive.

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2D10.7
An educational tool to better understand how air is used locally
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Humans need about 9700 litres of air per day to live. Other urban processes also need air to operate. It is very interesting to compare human needs for air with similar needs from various other processes. A method is presented to easily compare and visualize volumes of air impacted by a number of processes in an urban setting. Vegetative processes contribute air to the airshed. It will be shown how an average tree contributes about 10,000 litres of air per "growing day". Combustion processes require a steady intake of air in order to function. A baseline 1 litre combustion cylinder, operating at 2000 rpm for 1 hour uses about 6 times the volume of air required by 1 average human per day. The above baseline processes can then be used to calculate total air volumes impacted from a much greater variety and number of processes typical of an

urban setting. Results of these total volumes of air are presented graphically. This method is particularly insightful for stagnant meteorological cases by providing quantitative estimates of how local air consumption patterns impact on air quality. Data from real time environmental monitoring systems (cameras, photos, GIS, etc) may allow this simple model to be used as first guess inputs to air quality models that presently rely on often outdated databases of emissions inventories. Ground-truthing such results could help to more objectively grade urban activities in a manner that better reflects their impact on local air quality. This in turn, could help establish behaviour changing incentives, for example, a clean air trading system similar to existing greenhouse gases trading systems. This prototype is easily adaptable to an Internet format which could allow users to input local number of units and processes and gain a greater practical appreciation of how the air in their neighborhoods is used.

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2D10.8
Observational Error Statistics for Radar Data Assimilation
Yongmei Zhou [1] , *Roland Stull* [1] , *Robert Nissen* [2]
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Optimal assimilation of weather radar data into numerical models requires knowledge of the observational error statistics, i.e., the error variance magnitude at each data point and its correlation to adjacent data points. For simplicity, these errors are frequently modeled as independent and identically distributed, whereas in reality the errors may be vastly different. In this study, a qualified velocity-azimuth processing (QVAP) technique is applied to derive the horizontal wind components (u and v) from single-Doppler radar observations. The resultant QVAP-retrievals are used to model observational error covariance matrices for the Bratseth scheme. The positive impact of the implementation of this model is illustrated by simulated and real data.

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2D10.9
Economic impacts of wildfire smoke on human health in Canada
Robert Field , *Vic Adamowicz*
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To the best of our knowledge, the impacts of smoke on public health do not rank as high a priority for forest fire management in Canada. We develop economic estimates, however, that indicate that these impacts are significant and in some cases may be at least as large as losses of infrastructure or timber loss.

We draw upon research in forest fire management, atmospheric dispersion modeling and health economics to model these impacts. We conduct simulations of smoke transport from the 2001 Chisholm fire in Alberta, which produced an acute fumigation episode in Edmonton. Model predictions of particulate concentrations are coupled with concentration-response models to estimate the economic impacts of forest fire and compare these to costs of fire suppression and timber loss.

Health-related economic impacts are expected to become an even greater issue in the context of:
- demographic change in Canadian society
- the expansion of the wildland-urban interface
- establishment of Canada Wide Standards for air quality
- climate change
- and further development of transboundary environmental agreements.

We argue that the effects of forest fire smoke on human health should be made a priority when assessing the values at risk from forest fires. Mitigation programs should be developed, with an emphasis on early warning to the general public of expected smoke episodes and air quality effects being a component of fire suppression preparedness . Extensive tools are available from the public health, air quality management and fire management communities to assist in developing such programs.

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2D10.10
A Multi-centre Approach to Investigating the Health Impacts of Extreme Heat and Cold Events due to Climate Change and Climate Variation in Canada
Wendy Thompson [1] , *Yang Mao* [1] , *Chad Cheng* [2]
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Relatively small changes in the average climate conditions could produce large changes in the frequency and magnitude of weather factors and events. In order to asses the effects of climate change and climate variation on the health of a population, it is necessary to understand the relationship between health and climate under current and past conditions. It is important to identify and quantify the health effects associate with climate and how these effects may vary by region or by population. The purpose of this project is to assess the prevalence of illness, injury and death as a result of extreme heat and cold events through the collection and evaluation of administrative health data in the form of mortality, hospital separations, and emergency department records from selected urban cities across Canada.

The synoptic classification system by Environment Canada, will assign each day in terms of the various weather variables into a particular synoptic category based primarily on air mass differentiation. Linking the regional/area health data to synoptic weather classifications of extreme heat and cols events over an approximate 10 year period (1990-2002) will provide new knowledge regarding the vulnerability of certain populations and/or regions and establish the need for a surveillance system to monitor associated health impacts of climate variability. These results can provide more accurate assessments of the health effects of climate change in Canada, a base measure for health service utilization during these extreme weather events and a scientific basis for preventive and adaptation measures needed to policy and decision-makers. This is a joint project between Health Canada, Environment Canada, participating hospitals and universities across Canada, partially funded by the Climate Change Adaptation Initiative, Natural Resources Canada.

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2D10.11
The solubility pump in the McGill Paleoclimate Model
Andres Antico [1] , Lawrence A. Mysak [3] , Zhaomin Wang [3] , Olivier Marchal [2]
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A modified version of the solubility pump (i.e., an inorganic ocean carbon cycle) model that is used in the second phase of the Ocean Carbon Model Intercompasion Project (OCMIP-2) is incorporated into the McGill Paleoclimate Model-2 (MPM-2). The effect of fresh water fluxes on the dissolved inorganic carbon (DIC) concentration is formulated explicitly, and the sea-air CO_2 flux is taken to be a function of wind speed, sea-ice concentration, sea surface temperature and sea surface salinity.
The simulations of the pre-industrial equilibrium state of sea-air CO_2 flux and latitude-depth distribution of DIC from the MPM-2 are compared with the results from ten 3-D inorganic ocean carbon models that participated in OCMIP-2. It is shown that the MPM-2 results compare favourably with those from 3-D models.

3:15 PM

2D10.12
Interfacial waves in a laboratory exchange flow
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Flows in the aquatic environment often consist of well defined layers of different densities. The different densities are a result of either different salt concentrations (e.g. in an estuary) or different temperatures (e.g. warmer surface layer in a lake or ocean). Previous studies have shown a variety of wavelike features occur at the interface between the layers. These interfacial waves or instabilities grow until breaking when large parcels of fluid are exchanged vertically between layers. Although considerable study has focused on these instabilities their affect on mixing in real flows remains largely unknown.

As a preliminary step to quantifying mixing the characteristics of these waves are investigated. The density interface is established in a uniform rectangular channel with a steady exchange flow of salt and fresh water. Large fresh and saline reservoirs connected by a relatively long uniform channel allow disturbances to develop more regular characteristics than previous studies. Flow details (velocity and density) are captured by digital imaging of particles and fluorescent dye.

Observed disturbances had cusp-like wave crests resembling Holmboe instabilities. As expected from the two-layer hydraulic theory the disturbances propagate in both directions in the subcritical region within the channel and only outwards in the supercritical regions at each end. Disturbances occurring within the channel are therefore only a result of instability within the channel, ie. wave energy does not appear to enter the channel from the reservoirs.

Leftward and rightward propagating disturbances show little evidence of interaction indicating a Holmboe instability mechanism rather than a Kelvin-Helmholtz mechanism. The wave spectra of the observed disturbances compare well with the predictions from the two-layer hydraulic theory and linear stability analyses. These comparisons are however complicated by asymmetry in the velocity and density profiles.

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2D10.13
Two climatic states and feedbacks on thermohaline circulation in an Earth system Model of Intermediate Complexity
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The McGill Paleoclimate Model-2 (MPM-2) is employed to study climate-thermohaline circulation (THC) interactions in a pre-industrial climate, with a special focus on the feedbacks on the THC from other climate system components. The MPM-2, a new version of the MPM, has an extended model domain from 90S to 90N, active winds and no oceanic heat and freshwater flux adjustments. In the MPM-2, there are mainly two stable modes for the Atlantic Meridional Overturning Circulation (MOC) under the ``present-day'' forcing (present-day solar forcing and the pre-industrial atmospheric CO2 level of 280 ppm). The 'on' mode has an active North Atlantic deep water formation, while the 'off' mode has no such deep water formation. By comparing the 'off' mode climate state with its 'on' mode analogue, we find that there exist many large differences between the two climate states, which originate rom large changes in the oceanic meridional heat transports. By suppressing or isolating each process associated with a continental ice sheet over North America, sea ice, the atmospheric hydrological cycle and vegetation, feedbacks from these components on the Atlantic MOC are investigated. Sensitivity studies investigating the role of varying continental ice growth and sea ice meridional transport in the resumption of the Atlantic MOC are also carried out. The results show that a fast ice sheet growth and an enhanced southward sea ice transport significantly favor the resumption of the Atlantic MOC in the MPM-2. In contrast to this, the feedback from the atmospheric hydrological cycle is a weak positive one. The vegetation-albedo feedback could enhance continental ice sheet growth and thus could also favor the resumption of the Atlantic MOC. However, before the shut-down of the Atlantic MOC, feedbacks from these components on the Atlantic MOC are very weak.

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2D10.14
The Canadian CloudSat Calipso Validation Project (C3VP)
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The expected date of launch for NASA's CloudSat satellite is July 2005. It, along with the Calipso satellite, will join the so-called A-train satellite constellation and begin routine data transmission and processing this fall. CloudSat carries the first cloud-profiling radar into space, Calipso houses a lidar, and NASA's AQUA satellite carries a suite of conventional passive radiometers. Together, data from these satellites should improve our comprehension of global distributions of the vertical and horizontal structure of clouds. This information should help assess and improve representations of clouds in large-scale atmospheric models.

Beginning in January 2006, the MSC, with financial support from the Canadian Space Agency, in conjunction with researchers from several universities, will perform a 4-month CloudSat/Calipso validation campaign. The primary purpose of the campaign is to assess the ability of CloudSat to sense, and its associated retrieval algorithms to infer, properties of cold-season clouds and precipitation. This campaign includes several flights by the NRC's Convair-580 aircraft which is equipped with several dozen MSC cloud monitoring instruments. In addition, MSC's CARE facility at Egbert, ON will be instrumented to the point of resembling a 'mini-ARM site'. Most flights will attempt to under-fly CloudSat as it traverses northward across the Great Lakes Basin during the early afternoon. Some night flights are planned too. Moreover, most flights will occur during 'routine' and 'exceptional' cloud events, though there are several clear-sky flights planned as well. The following winter (Nov 2005 - Apr 2006) will see essentially a repeat aircraft and surface data collection schedule.

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2D10.15
Improvement of cirrus clouds and the ice sedimentation scheme in ECHAM5 GCM
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A microphysical scheme of cirrus cloud formation has been implemented in the ECHAM4 general circulation model (GCM) (Lohmann and Kärcher, 2002, Lohmann et al., 2004). In the meanwhile a new version of ECHAM (ECHAM5) has become available whose major improvement is an improved aerosol microphysics scheme (Stier et al., 2004). While homogeneous freezing depends only weakly on the number concentration of supercooled aerosol particles, an accurate representation of aerosols is important for heterogeneous freezing. Heterogeneous freezing is generally limited by the number of freezing nuclei. Ice crystals formed by heterogeneous freezing nucleate typically at lower supersaturations than required for homogeneous freezing. Thus, these crystals will grow larger and sediment more readily. Until now, sedimentation of ice crystals has not been accounted for realistically. Because large ice crystals sediment faster than small ones, the vertical distribution of ice water content, ice crystals number in cirrus clouds have their typical structure: the cloud top contains small ice crystals in large numbers, while the bottom of cloud consists of a few large crystals. Without considering the ice crystal fall velocity in the ECHAM5 GCM correctly, the vertical distribution of cloud ice is not accurate. For example, the original ECHAM5 results show that the simulated ice water content is 100 times smaller than the observations and large ice water mass occurs at the cloud top during the ARM IOP period in March 2000.

In order to improve the cloud ice parameterization in the ECHAM5 model, a new sedimentation scheme (Gierens and Spichtinger, pers. Comm.., 2005) together with the cirrus scheme will be implemented in ECHAM5. This method could improve the cirrus microphysics and radiation properties. The new sedimentation scheme will be evaluated by the newly retrieved cloud radar dataset for ARM IOP experiment (J. Mace et al., pers. comm., 2005).

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2D10.16
Interactions Between Clouds and Radiation in the Multiscale Modelling Framework
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The Multiscale Modelling Framework (MMF) uses 2D Cloud System Resolving Models (CSRM) to represent subgrid-scale cloud processes in Global Climate Models (GCMs). Four numerical experiments were performed to examine the sensitivity of the MMF to the inclusion of CSRM-scale versus domain-mean radiative heating rates as well as the sensitivity of the MMF to the GCM component receiving unbiased radiative heating rates and fluxes. Due to the computational expense of the MMF, the simulations were limited to a single season (December/January/February). However, statistical significance of differences between each of the experiments was computed by using the results of performing MMF simulations over the same season in four different years. We found that clouds simulated in the MMF are sensitive to the inclusion of CSRM-scale radiative heating rates.

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2D10.17
Using singular vectors and Markov chains in a limited-area ensemble prediction system
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A limited-area ensemble prediction system with resolution between 15 and 30 km is being developped at the Meteorological Service of Canada. The methodology for producing the ensemble members is as follows: 1) A set of singular vectors (optimised over 24 hours) with an initial global total energy norm and a final limited-area total energy norm is calculated 2) An ensemble of pilot runs are generated using these singular vectors as perturbations for the initial and boundary conditions 3) Moreover, stochastic perturbations to the physics tendencies and to some physics parameters by simple Markov chains are performed on the limited-area model. Results from this newly developped EPS will be presented, in particular the skill of this system for probabilistic precipitation forecasts will be evaluated.

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3D10.1
The relationship between elevation and monthly precipitation accumulations in the Alberta foothills
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As part of the Foothills Orographic Precipitation Experiment (FOPEX), six meteorological stations were installed in a 45 km east-west transect between Caroline and Limestone Mountain in west-central Alberta. One of the objectives of FOPEX is to examine the relationship between precipitation and elevation in the foothills region east of the Rocky Mountain front-range. This region represents a gap in the observational network and is also a significant source region for early spring runoff into both prairie and northern river basins. The FOPEX sites, located at elevations between 1070 and 2120 metres (above sea level), have measured accumulated precipitation as well as other climate variables since August of 2001. Strong linear correlations exist between monthly precipitation and elevation when precipitation is greater than 60% of normal but this relationship breaks down when monthly precipitation is below 60% of normal. For months with greater than 60% of normal precipitation, the slope of the precipitation-elevation relationships shows a linear increase with increasing monthly precipitation. Further, the precipitation-elevation relationship at a site can be determined using monthly precipitation observations at any of the other sites in the transect. Using these regression models, a technique has been developed to calculate precipitation anywhere in the transect using monthly precipitation from other locations in the transect.

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3D10.2
A Review of the Problems Associated with the Measurement of Snowfall and Snow on the Ground
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Accurate measurement of solid precipitation is one of the more difficult tasks facing cold-region climate and hydrological scientists. Environment Canada employs two types of measurements for two aspects of solid precipitation. The first, for total snowfall or precipitation, is the all-weather accumulating precipitation gauge (which measures the water equivalent of snow as it falls), and the second, for snow on the ground, is either a manual snow course or an automated acoustic sensor. Systematic errors (wind bias being the most significant) in measuring solid precipitation using an accumulating gauge are well recognized and an adjustment can usually be made if the measurement is made properly. The significance of this adjustment is revisited and preliminary results from a new precipitation gauge intercomparison project focusing on the Geonor all-weather gauge are discussed. When the snow on the ground is measured using either a manual snow course or a single point acoustic sensor, certain assumptions are made regarding how representative this measurement is of the surrounding landscape. Results show that representativeness is highly dependent on landscape characteristics, and that the measurement location and situation must be carefully considered.

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3D10.3
Non-methane hydrocarbons over the far North Atlantic and their Relationships to Marine Dissolved Organic Matter
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Light non-methane hydrocarbons (NMHCs) are present at trace concentrations throughout the marine troposphere. Over remote areas of the oceans, they have long been postulated to originate from the degradation of dissolved organic matter (DOM) in surface ocean waters. Our strategy for understanding the processes by which volatile organic compounds such as NMHCs may originate from marine DOM involves simultaneously sampling whole air, DOC in surface waters, and organic aerosols. Such sampling was conducted over the North, Greenland and Norwegian seas during the summer of 2004. In this paper, we present and discuss initial results of NMHC measurements in the whole air samples, taken just above the sea surface and analyzed using a cryogenic preconcentration-gas chromatography apparatus constructed in-house. We relate these to the long-term goal of elucidating links between volatile organic compounds and marine DOM.

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3D10.4
The Seasonality and Biogeochemical Cycle of Marine Methyl Chloride
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Methyl chloride is the largest natural source of organic chlorine to the troposphere. The global budget is unbalanced with total known consumption processes outweighing known production estimates by about 1Tg/y. While the net marine source of methyl chloride to the troposphere is small, about 0.3Tg/y, the oceans play a significant role in the biogeochemical cycle of this compound. The seasonality of methyl chloride was studied in three cruises in the North West Atlantic in 2003. Regions north of 45^{o}N were found to be undersaturated with respect to atmospheric equilibrium in all seasons and the Sargasso Sea was the only region studied that was supersaturated in all seasons. The dissolved concentration in excess of the atmospheric equilibrium value was found to be correlated with sea surface temperature. Fluxes to the Deep Ocean and *in situ* consumption of the gas will be discussed.

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3D10.5
Exploratory models of CH3I in the surface mixed layer in the NW Atlantic
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Based on field data collected during the C-SOLAS Atlantic cruises in 2003, simple models of CH3I concentration in the surface mixed layer as a function of physical, chemical and biological parameters (e.g. temperature, mixed layer depth, wind speed, solar irradiance and phytoplankton pigments) were developed. The models were evaluated for their ability to predict the seasonal and spatial variations of CH3I in the NW Atlantic. Model results showed that a linear model of CH3I concentration as a function of solar irradiance and water temperature (r2 = 0.44) could largely explain the variation of CH3I concentration in the surface mixed layer in this investigation. By observing the sum of the squares of the model residuals, we found that the fit of the simple linear model was better than that of a non-linear model based on a mass-balance equation of CH3I in the surface mixed layer.

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3D10.6
Bubbles and air-sea exchange of gases under storm conditions
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Starting from September 2002, two years of data from Canadian SOLAS (C-SLOAS) Northeast Pacific mooring deployed at station P (50°N, 145°W) have been recovered. The instrumentation includes a vertical array of dissolved gas sensors (pCO_2, O_2, N_2), an upward looking echo-sounder for bubble measurements, an ambient sound recorder for wind and precipitation, and a variety of other sounders. This allows for studies of air-sea gas exchange processes in the open ocean, especially for periods with high winds and sea states, which are quite rare, as reviewed above.

In an analysis of time-series measurements of dissolved CO_2 measurements during Hurricane Gustav in the NW Atlantic, Perrie et al., (2004) showed that the storm – induced CO_2 flux can vary by a factor of two, comparing recent three gas-exchange formulations, which are (1) direct transfer of the gas through a surface boundary layer (Wanninkhof and McGillis, 1999, GRL) enhancement of the gas flux due to wave breaking and bubbles (Zhao et al. 2003, Tellus), and (3) enhancement of the gas flux taking into account turbulent and radiative fluxes, winds, waves, currents, white-capping and thermal structure (Fairall et al., 2000, BLM). But the lack of any vertical resolution in the measurements meant that they could not rule out water advection and entrainment, rather than bubble-mediated air injection, as the cause of the increased flux.

A 7-day long storm case with wind speeds (10 m reference height) greater than 15 m s^{-1}, lasting about 2 days during 2003 September to 2004 June mooring period is studied. As suggested by Woolf (1997), given a time series of gas concentrations, wave breaking and bubble cloud statistics and other environment measurements, there is a good possibility of establishing the dependence of direct, bubble-mediated gas transfer velocities, and fractional supersaturation, induced by bubbles on environment factors. As a preliminary step in better understanding the gas exchange under high wind speeds, with the contributions from bubbles included, the bubble distribution and the possible dependence of bubble-induced gas transfer velocity on wave breaking and other environmental factors are studied by simulations co-located with in situ observations.

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3D10.7
Chemical Weather Forecast at MSC

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Many of the pressing questions about climate change and global air quality look to the development of an integrated atmospheric data assimilation system of meteorological and chemical observations that should be capable of delivering real time prediction as well as long term analyses.

Chemical weather id the term given to a complete, global description of the chemistry of the atmosphere at a particular time. It focuses on the same temporal and spatial scale as meteorological weather – that is, from a fraction of an hour to several weeks, and from a few kilometers to the entire globe.

We will give an overview of the current effort worldwide in developing chemical weather and also give an overview of the canadian effort. Recently the MSC in collaboration with York University and the Belgium Institute for Space Aeronomy we are determining the most cost effective way to achieve this objective and examine the role of meteorological-chemical coupling in data assimilation. An outline of the project will be presented, the main difficulties of its implementation will be discussed, as well as its potential impact.

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3D10.8
An examination of mixed layer variability in the Gulf of Alaska from Argo and ship-based data

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Mixed layer depth (MLD) is computed in the Gulf of Alaska. Forty-six years of historical measurements along Line P are used, as well as measurements from Argo floats covering 2001-2004. Monthly estimates, both climatological, as well as for two periods (pre and post 1976) are examined. A phase shift of the deepest winter mixed layers to April is seen but no clear sign of the mid-70s regime shift is observed. A pentadal analysis at Station P confirms the previous results, as well as highlighting significant seasonal variability. For the 2001-2004 period, mixed layers from Argo floats are projected onto Line P (where they compare well with ship based measurements during the same period), as well as mapped (monthly) throughout the rest of the Gulf of Alaska. Significant spatial and temporal variability is seen, including very shallow mixed layers during the winter of 2002-03.

The projected data from the Argo program will then be used to force a model to examine mixed layer variability at Station P between 2001 and 2005. The data will be analyzed using the General Ocean Turbulence Model. Different atmospheric and oceanographic parameters will be manipulated to determine which processes had the greatest influence on the mixed layer depth during this time span.

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3D10.9
Climate Change Impact Assessment on Transportation Infrastructure in Manitoba.
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This study has been carried out as a part of regional climate change impact assessment for transportation infrastructure in Manitoba. Global Circulation Models (GCM) have been used to assess the impacts of greenhouse gases on climate change study for the last three decades. While useful, many studies have highlighted considerable uncertainties due to its coarse spatial resolution over global grids. There are also large precipitation errors which lead to significant problems for local impact studies. The objective of this study is to identify local climate impacts on elements of transportation infrastructure in Manitoba. To do this, we must translate atmospheric conditions into 'loadings' on infrastructure elements such as highway embankments, bridge structures and pavement materials. These require higher spatial and temporal resolution data which is not readily available from GCM summaries. A number of studies suggest that climate downscaling using a nested dynamic model will provide further refinement of coarse scale GCM output simulate these local impacts. Here we consider the dynamic downscaling of climate data using the Pennsylvania State University / National Center for Atmospheric Research (PSU/NCAR) mesoscale model, known as MM5. This model allows choices of cumulus parameterization, boundary layer schemes and convection schemes. The model domain consists of a mother domain centered at 54^{o} N and 98^{o} W which covers a large portion of the Canadian prairies with two inner domains at successive downscaled resolutions to 10 Km. To date, National Centers for Environmental Prediction (NCEP) reanalysis data has been used for initial and boundary conditions to setup the model and run multiyear simulations. The model results are compared with ground observation station data and impacts on transportation infrastructure. Future runs will implement GCM forcing data.

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3D10.10
Thunderstorm and Sea Breeze Correlation on Mainland Nova Scotia
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Days with thunderstorms reported at Greenwood Airport and Halifax International Airport, both on mainland Nova Scotia, were categorized as being associated with synoptic frontal passages or not. Cases not associated with frontal passages were compared with dates found to have favourable conditions for sea breeze development. Conditions favourable for sea breeze development were determined by searching archived climatological data for available reporting sites for diurnal onshore wind shifts. Once identified, synoptic patterns for these cases were investigated and favourable conditions for sea breeze development were determined. Of particular interest for this investigation were simultaneous occurrences of sea breezes on both the Atlantic and Bay of Fundy coasts. Matches of these dates with occurrences of thunderstorms not associated with frontal passages suggest that sea breeze convergence promotes thunderstorm development. Testing of these results during the upcoming summer months will determine their usefulness as a forecasting tool.

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3D10.11
Suspended Particles in the Martian atmosphere; simplified scenarios for lidar measurements from the surface of Mars during the Phoenix mission

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Simple eddy diffusion models are used to investigate possible scenarios for the vertical distribution of dust in the atmosphere of Mars. Both steady state and diurnal cycle scenarios are considered. The dust can be assumed to originate locally, or to have been advected from a distant source. Published interpretations of the vertically integrated size distribution as a gamma function, and observations of optical properties, are used in conjunction with our model to infer height variations in concentration and size distribution corresponding to specified optical depths. These results are intended for use in evaluating the capabilities of a surface based lidar to be included as a part of the NASA/CSA Phoenix scout Mars lander.

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3D10.12
A 1-D ocean mixing model of the Strait of Georgia: Toward understanding ecological responses to physical forcing
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The Strait of Georgia estuary in southern British Columbia has experienced rapid oceanic and atmospheric environmental change over the past decade coinciding with population growth in surrounding urban regions. To understand how these changes are affecting the ecosystem, a numerical model linking the biological and physical dynamics of the Strait is being created as part of the STRATOGEM project. The one dimensional vertical mixing model uses a K Profile Parameterization of the boundary layer and is forced by monthly field data and hourly meteorological data. The physical model parameterizations are adjusted for optimal performance using this data. Standard physical parameterizations are adjusted and changed using local data to model the Strait of Georgia. Field irradiance measurements allow for the calculation of a new representative albedo, and in conjunction with fluoresence, mixed layer depth, and Fraser River flow data, standard light attenuation equations are adapted for the location being modeled. Daily Fraser River flow data is used to parameterize horizontal advection and entrainment; this flow and the inclusion of a smaller non-glacial river effectively forces the surface salinity. Profiles of key physical properties agree well with field data; model results also correspond to data obtained from the STRATOGEM ferry sampling program. The model responds appropriately to storm forcing and other various environmental testing. The physical model is now being coupled with a biological model to predict the timing of the spring phytoplankton bloom, and then to further investigate links between physical forcing, particularly the Fraser River spring freshet, and biological responses.

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3D10.13
Estimating the Energy Flux from the Wind to Ocean Inertial Motions: The Sensitivity to Surface Wind Fields
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The energy flux from the wind to ocean inertial motions is estimated using three wind products in addition to the benchmark NCEP wind. A correction to the NCEP wind, based on satellite scatterometer measurements (Large and Yeager, 2004), increases the energy flux by 50% globally and by 30% at mid-latitudes. The use of the blended QSCAT/NCEP winds doubles the energy flux at mid-latitudes, and leads to much larger increases at high latitudes and near the equator. In the North Atlantic Ocean the enhancement of the NCEP wind, through a kinematic reanalysis procedure (Swail and Cox, 2000), increases the energy flux by 30%. We conclude that the estimate of energy fluxes is sensitive to even modest enhancement of wind speed. Previous studies based on the NCEP wind only provide a lower bound of the estimates of wind energy into ocean inertial motions.

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3D10.14
Co-variability of the Strait of Georgia and the northeast Pacific Ocean on climatic time scales
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A 35 year record of biweekly vertical temperature profiles from the central Strait of Georgia is examined. A decomposition of the variability into empirical orthogonal modes shows that the dominant mode, accounting for over 70% of the variance, has its maximum amplitude at mid-depth in the water column. Amplitudes decrease towards the bottom, and more markedly towards the surface. The principal component (PC1), or time series, associated with this mode is dominated by long period fluctuations on interannual to decadal time scales. PC1 also clearly reflects the recent cool episode of 1999-2002 and the subsequent warming of 2003.

These results from the Strait of Georgia are compared with subsurface observations from Line P in the northeast Pacific. This shows that there is a close correspondence between nearly all the major warming and cooling episodes occurring offshore with those observed in the Strait of Georgia. The main exception is the remarkable cooling episode of 1979 which is not reflected in the Line P data and appears to be locally forced. Apart from this, the comparison indicates that conditions

in the Strait co-vary with those from over the northeast Pacific on interannual to decadal time scales. We suggest that the response to wind forcing over the ocean interior is an important mechanism driving this variability.

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3D10.15
The Canadian Wildland Fire Information System (CWFIS): Its Role within NRCan's National Carbon Accounting and Sustainable Development Framework

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Wildland fires have burned an average of 1-2 M ha of forest every year in Canada during the last two decades. There is large inter-annual variability in the amount of area burned, and a wide range in forest fuel types burned. The burning conditions under which fires occur are also wide ranging. All of these factors have a strong influence on the total amount of carbon emissions released from wildland fires each year. In support of a national forest carbon accounting system, a fire and carbon emissions project was initiated to provide an annual estimate of national carbon emissions in a timely and consistent manner across the entire country. The Project is housed within the Canadian Wildland Fire Information System (CWFIS) which integrates multi-source data for national-level products. Burned area mapping is done using fine resolution satellite data. Spatially and temporally explicit burning conditions for each fire are determined using fire weather data from CWFIS, and by monitoring fire spread with coarse resolution satellite data. Detailed fuel type and pre-fire fuel load data are provided by the Carbon Budget Model for the Canadian Forest Sector (CBM-CFS) based on national and/or provincial forest inventory data. CWFIS calculates fuel consumption for 8 different biomass pools in each burned cell based on fuel type, fuel load, burning conditions, and fire behaviour using a fire effects model. CWFIS also performs the post-fire transfer of biomass between pools as necessary, and returns the post-fire results to CBM-CFS. Fuel consumption is summarized and reported as carbon emissions for all fires. This Project is supported through the Canadian Space Agency, and through the assistance of fire management agencies in Saskatchewan, Manitoba, and Ontario to implement pilot studies in the boreal region.

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3D10.16
Climate Hardcopy Archives in Downsview (CHAD)Content and Access

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Climate Hardcopy Archives in Downsview (CHAD) is a depository of Environment Canada original meteorological forms and documents, climate data logs, pictures, maps and climate related publications. The collection dates back to the middle of XIX century and it contributes to a national treasure.

Climate Hardcopy Archives in Downsview is going through modernization effort to allow for computerized operation and more friendly access to its content.

Organization, content and different ways of accessing historical meteorological data and metadata will be presented during the talk. There will be live demonstrations of existing tools and Web searches available.

4:30 PM

3D10.17
Estimating the effect of errors in lateral boundary conditions nesting data on the simulated fields of nested RCM with the Big-Brother experimental protocol

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Regional Climate Models (RCM) are powerful tools for studying climate and making climate-change projections at regional scale, because of their high horizontal resolution. However, a RCM is a model nested by atmospheric data

simulated by lower resolution Global Climate Models (GCM) and therefore its simulations are affected by errors in GCM simulations.

In this study, we investigate the response of an RCM to errors in atmospheric lateral boundary conditions (LBC). The method used consists in a series of experiments using a perfect-model framework nick-named the "Big-Brother Experiment" (BBE). A first integration is made by performing a large-domain high-resolution RCM simulation: this simulation called the Perfect Big-Brother serves as reference virtual-reality climate, to which other RCM runs will be compared. The errors in the driver-model can be introduced in several ways, including performing simulations with increasingly lower horizontal resolution; such simulations are called the Imperfect Big-Brother. The difference between the climate statistics of the Imperfect and the Perfect Big-Brother represent the errors of the LBC. The Imperfect Big-Brother can be further degraded by removing short scales to achieve low-resolution typical of today's GCM. The resulting fields are used as nesting data to drive a second series of simulations called the Little Brother identical to the Perfect Big-Brother, but integrated over a smaller domain located in the centre of the larger domain. The climate statistics of the Little-Brother are compared to those of the Perfect Big-Brother in order to estimate the errors resulting from nesting with imperfect LBC.

4:30 PM

3D10.18
A prototype interactive GIS delivery system for disseminating statistically downscaled climate change scenarios, variability and extremes in Canada
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Over the past several years, Environment Canada has been developing expertise in the use of on-line internet based mapping applications for the delivery of environmental data to the impacts and adaptation community. These applications provide both spatial and temporal analysis tools, including GIS functionality, access to downloadable stored data, interpreted products, on-the-fly generation/analysis, real time charting, client based data entry forms, statistical analysis and a range of security features. Data currently housed in Excel or other spreadsheet-based systems can be ported to fully relational databases, resulting in improved data acquisition speed, accessibility and functionality. The system includes several on-line query options through the use of drop-down menus and is designed to aide both expert and non-expert users in assessing the impact of climate change scenarios on their site-specific region of interest.

The heart of the interactive system is the Autodesk Mapguide software, which allows for flexible user-friendly spatial querying. The system is built on a series of four nested scale National and Regional base maps (1:20 Million, 1:7.5 Million, 1:2 Million and 1:1 Million). As users zoom into local areas of interest the base map scale will change automatically to display a reasonable level of detail. Available themes for the basemaps include drainage features (coastlines, rivers, lakes), boundaries, roads, transmission lines, major population centres and national parks. These layers can be turned on or off and can provide users with the ability to navigate to a particular area of interest using recognizable landmarks. Displayed data can be printed at any time.

The climate change component of Mapguide will be populated with both historical (1961-90) and projected (2011-40, 2041-2070, 2071-2100) data for the basic meteorological parameters Tmax, Tmin, and Pcpn, from 14 sites in Atlantic Canada. This suite of data has been generated by downscaling using a Statistical Downscaling Model (SDSM) and output from the Canadian Global Coupled Model (CGCM1) running the GHG+A1 experiment. All data can be accessed and displayed through several mechanisms: downscaled data (including 20 ensembles of projected results) can be downloaded in FTP Zip format; interpreted products, such as climate variability graphs, analyzed extreme climate indices (generated using STARDEX software) and Extreme Value Analyses using Gumbel statistics can be displayed or downloaded as tables, histograms, or maps contoured over eastern Canada. Contour maps of modular data were generated using the Spline-Tension (W=0.1) contouring algorithm within the GIS analytical software and can be overlaid with any other thematic layer.

Current plans are to increase the number of downscaled sites from 14 to 26, and to use two more world class GCM driving models, namely the CGCM2, and the HADCM3, in order to create a range of future climates scenarios readily available through this GIS interface.

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3D10.19
Evaluation of Canadian Regional Climate Model (CRCM) Water Cycle over the Missisipi River Basin
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Regional climate models can be powerful tools in quantitative water cycle studies. Inadequate understanding of many complex interactions involved in water cycle and our limited ability to model them will contribute to model errors. Model evaluation and validation are therefore necessaries.
In this study the hydrological cycle simulated by CRCM-II over the Mississippi River basin in the period of 1988-1999 is evaluated and validated. Because observations of some of the water cycle components are not available a corresponding validation methodology is developed. Namely, an integrative approach linking both the atmospheric and terrestrial branches of the hydrological cycle is applied over the large area (Mississippi River basin). Firstly the annual means analysis for the whole Mississippi River basin is performed. Then the annual cycles of all water cycle components are analyzed and compared with the observations or quasi-observations. Because the monthly tendencies of atmospheric and terrestrial water storage cannot be neglected, the annual cycle analysis is more complex and involves more uncertainties. The results of the analysis show that the major problem of MRCC-II is in its single layer « bucket » surface scheme resulting in too large evapotranspiration which is mainly related to the model's very high soil water holding capacity. Consequently the annual mean CRCM-II precipitation is overestimated while the runoff and atmospheric moisture convergence are underestimated. The implementation of the multi-layer surface scheme CLASS into the CRCM is in progress.

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3D10.20
Relationship between Pacific Climate Patterns and Stream Low-Flows in British Columbia and Yukon, Canada
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(Presented by / Présenté par ***Jon Wang***)
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Contact:jon.wang@ec.gc.ca

This study investigated the hydrological response of rivers in British Columbia (BC) and Yukon of Canada to the Pacific Decadal Oscillation (PDO) and the El Niño/Southern Oscillation (ENSO). Using stream discharge data from four hydrometric stations in each of four regions of BC (Southern Coast, Southern Interior, Northern Coast, and Northern Interior) and in Southern Yukon, coherent responses of stream low-flows to PDO and ENSO were identified and examined. Stream low-flows were defined as flows less than the 10^{th} percentile on a given day compared to the historical streamflow series for that day. It was found that PDO and ENSO both influenced stream low-flows in all study regions except Southern Yukon. The PDO signal influenced magnitudes of low-flows more significantly and consistently than the ENSO signal. However, the PDO signal was modulated by ENSO, either strengthening or weakening low-flows depending on geographic location. ENSO may also cause low-flow anomalies, adding an additional level of variation to low-flow magnitudes. Correlation analysis showed that, at the 95% confidence level, all four rivers in Southern Interior of BC and three of four rivers in each of Southern Coast, Northern Coast, and Northern Interior of BC had significant associations between PDO index and low-flow magnitudes. None of the rivers in Yukon showed a significant correlation with PDO. Significant correlations between low-flow magnitudes and ENSO events were only found in the coastal regions (Southern Coast and Northern Coast) of BC.

4:30 PM

3D10.21
Regional climate simulations produced by the GEM and CRCM models
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The GEM model has been used operationally by the Canadian Metorological Centre to produce the short- and medium-range forecasts requested by the various clients of the Meteorological Service of Canada (MSC). More recently, the GEM model began to be applied in seasonal forecasts, after a series of validation tests and climate simulations.

Here we present the design of an intercomparison study of regional climate simulations. This study will be conducted with two limited-area models, the GEM-LAM of MSC and the CRCM model of the Ouranos consortium. The domain will include the North American continent and the boundary conditions will be provided by the ERA40 reanalyses. This project represents one of the steps in the development of a new system for regional climate scenarios at the MSC, in collaboration with the climate modelling groups of the Ouranos consortium and Université du Québec à Montréal.

3D10.22

The Relationship Between Cyclone Characteristics and Trajectories and Annual Hydrological Resources

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Cyclones represent a significant component of the climate because they are responsible for most of the day-to-day variation in weather. They are also the origin of many extreme events. Variations of cyclone tracks have been related to large scale circulation variability such as NAO and ENSO. In this presentation we will present the link between cyclone characteristics (trajectories and intensity) and the annual hydrological resources for several basins in Quebec during the 1960-1999 period. The following cyclone track statistics were calculated using software adapted from Murray and Simmonds (1991) and Sinclair (1997): cyclone density, cyclone track density, density of the strong cyclones, the cyclone circulation, the direction and average the speed of motion. It was found that the wettest years when compared to the driest years were associated with almost doubling in the number of late fall and spring cyclones which were somewhat more intense and predominantly moved into the basins from a southerly direction. There were no significant difference in the number and characteristics of cyclones during the winter months of December, January and February. These result suggest that changes in water resources in the context of climate change will be related to changes in the characteristics of cyclone activity and that future scenarios could be developed by using analyses of cyclones simulated by reliable climate models.

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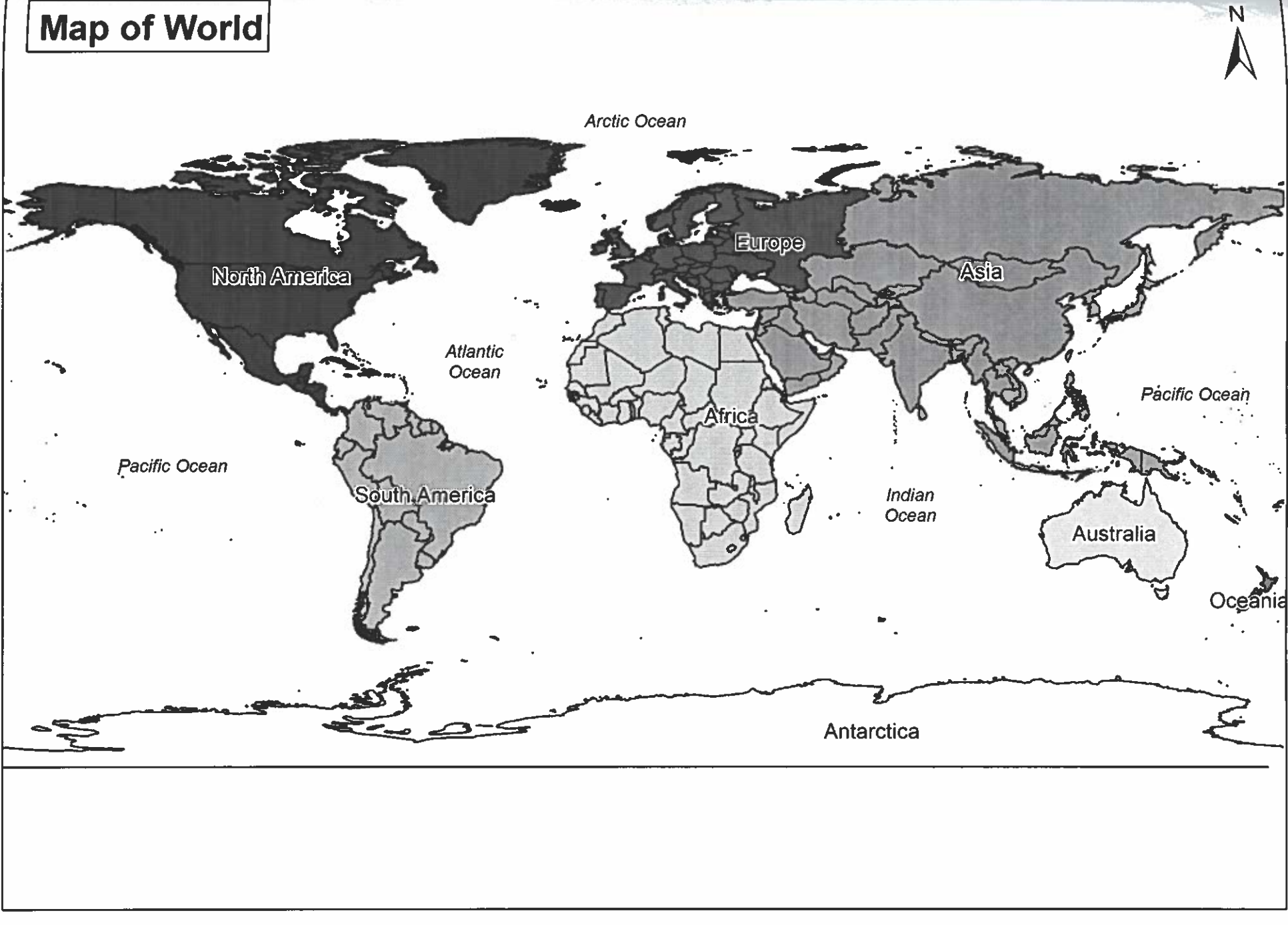
Map of World



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Map of North America

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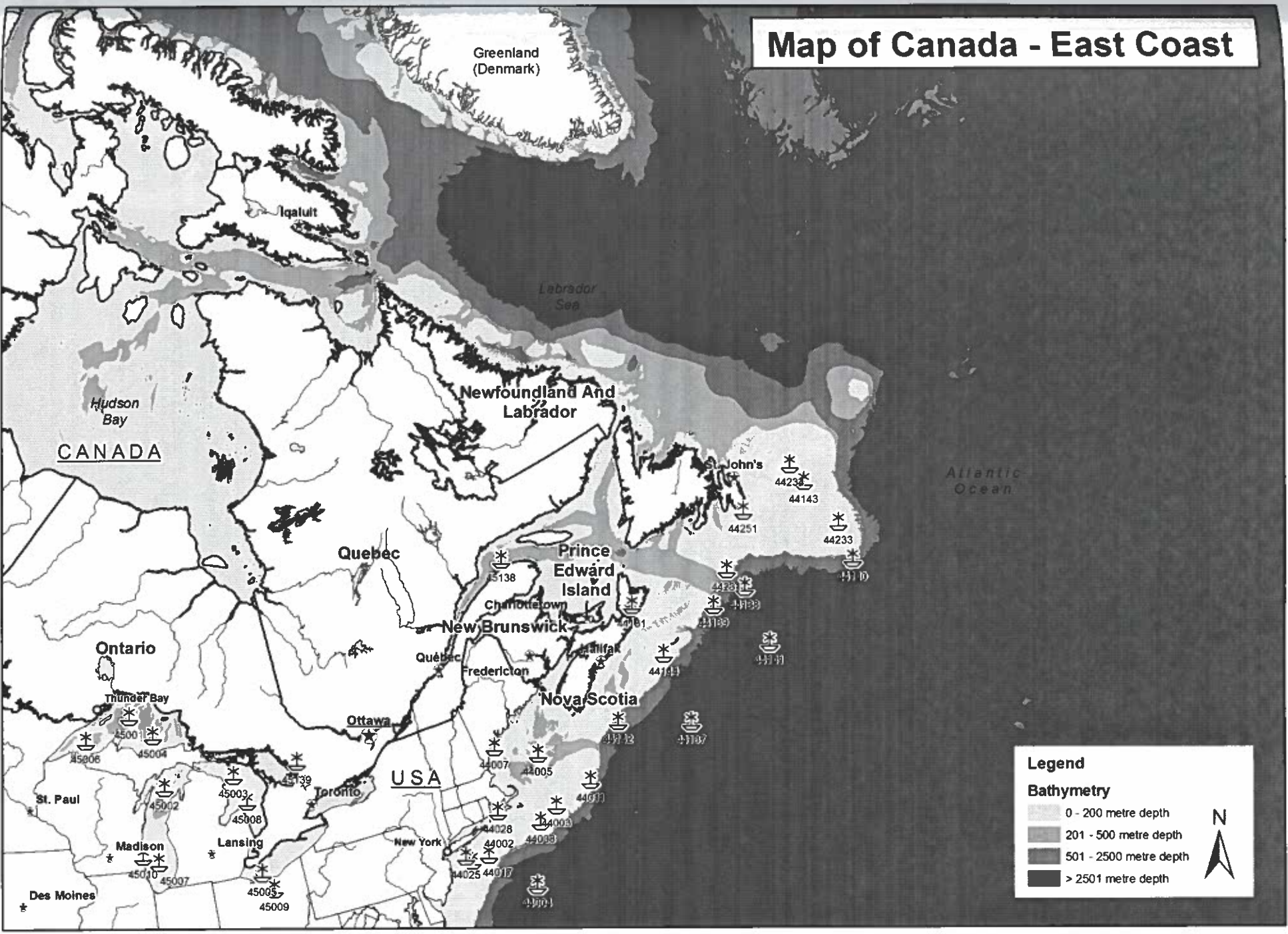

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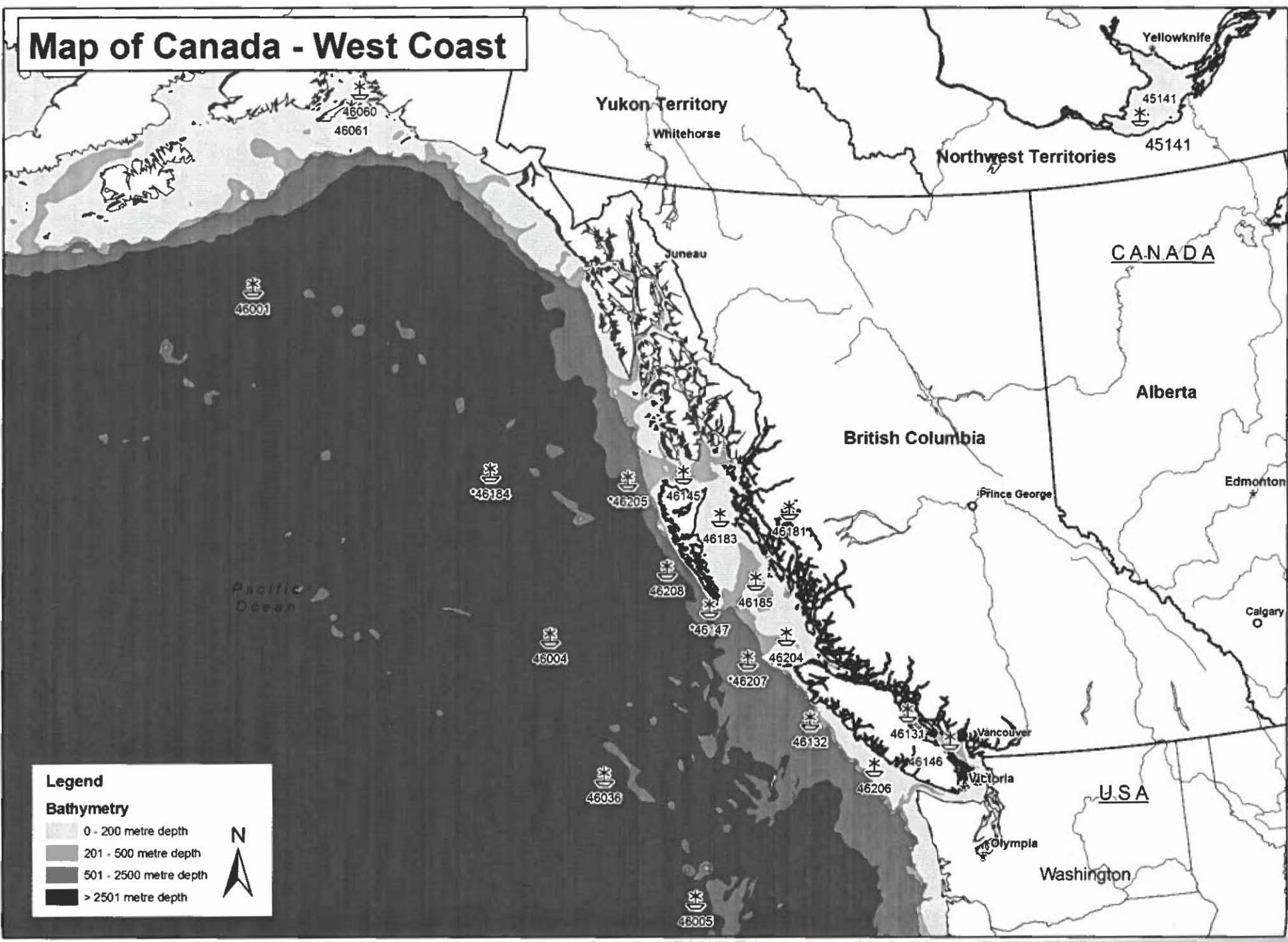

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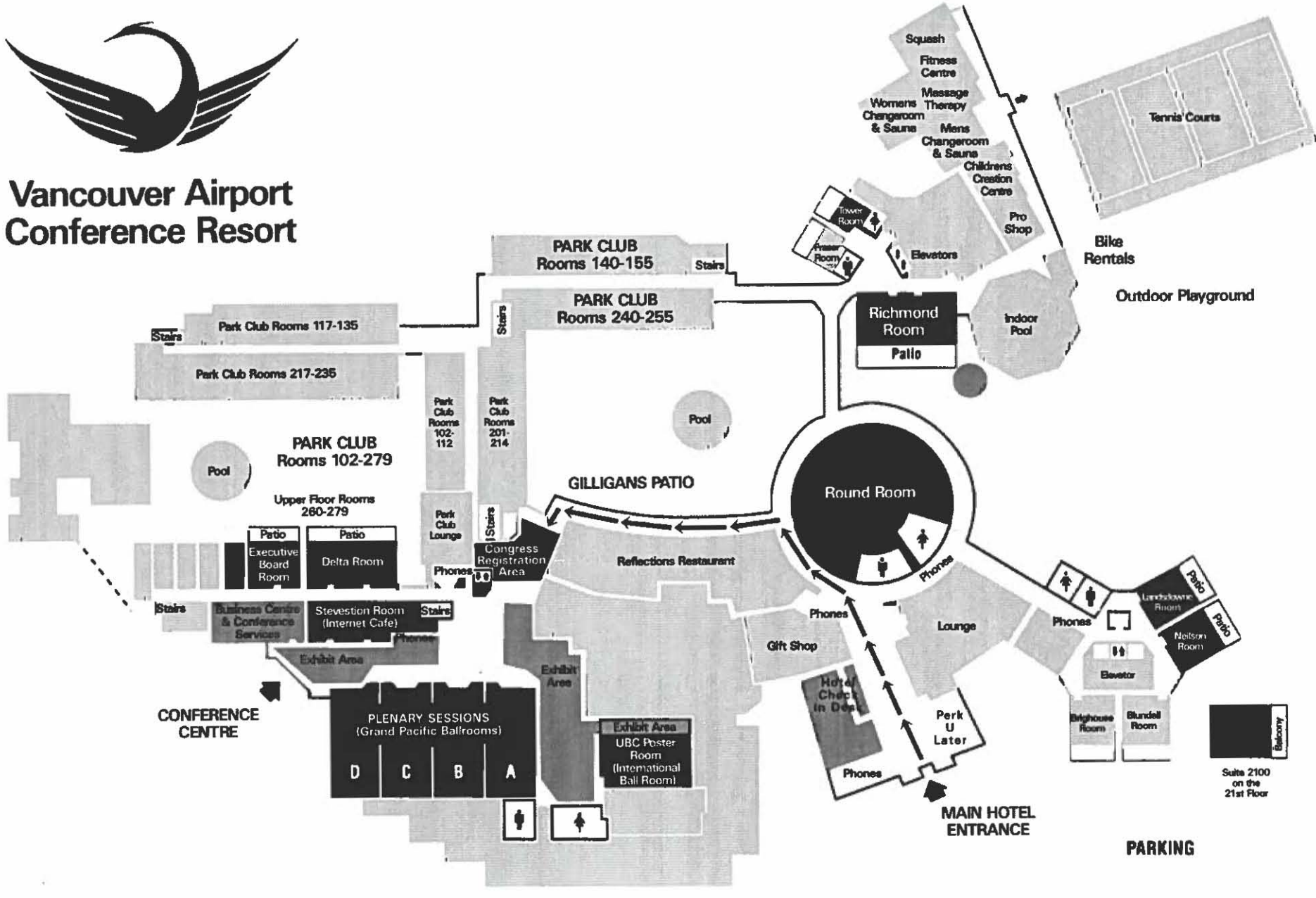
Vancouver Airport
Conference Resort
Squash
Fitness Centre
Massage Therapy
Womens Changeroom & Sauna
Mens Changeroom & Sauna
Childrens Creation Centre
Pro Shop
Tennis Courts
Bike Rentals
Outdoor Playground
Tower Room
Fraser Room
Elevators
PARK CLUB Rooms 140-155
Stairs
PARK CLUB Rooms 240-255
Park Club Rooms 117-135
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GILLIGANS PATIO
Round Room
Park Club Lounge
Patio
Executive Board Room
Patio
Delta Room
Congress Registration Area
Reflections Restaurant
Phones
Stairs
Business Centre & Conference Services
Stevestion Room (Internet Cafe)
Exhibit Area
Gift Shop
Lounge
Landsdowne Room
Patio
Nelson Room
Elevator
Brighouse Room
Blundell Room
Balcony
Suite 2100 on the 21st Floor
CONFERENCE CENTRE
PLENARY SESSIONS (Grand Pacific Ballrooms)
D
C
B
A
Exhibit Area
UBC Poster Room (International Ball Room)
Hotel Check in Desk
Perk U Later
MAIN HOTEL ENTRANCE
PARKING