Canadian National Committee for SCOR
Comité national canadien pour SCOR

Scientific Committee on Oceanic Research

CANADIAN OCEAN SCIENCE NEWSLETTER
LE BULLETIN CANADIEN DES SCIENCES DE L'OCÉAN

Newsletter Number 98, January 2018
Bulletin numéro 98, janvier 2018

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Taking the Ocean's Pulse - A Vision for the Canadian Biogeochemical Argo Program

Katja Fennel, Blair Greenan and **Participants of the Canadian BGC Argo Workshop**
See Participant list and affiliation at end of article

Fisheries and Oceans Canada

Pêches et Océans Canada

Executive Summary

The international Argo Program, described in the NYTimes[1] as *one of the scientific triumphs of our time,* has fundamentally transformed our ability to measure interior properties of the ocean. Argo is a global array of almost 4,000 autonomous profilers measuring temperature and salinity in the upper 2,000 m. These observations are relayed by satellite and available within hours of collection. While traditional sampling from research vessels is important, it is too infrequent and geographically limited to observe the dynamic and rapidly changing ocean adequately. Satellites provide broad-scale views, but are limited to the surface and in terms of the properties they can observe. Over the past two decades, Argo floats have collected over a million profiles of temperature and salinity, twice the number obtained by research vessels during all of the 20th century. These unprecedented views of the ocean's interior physical properties have enabled quantification of ocean warming due to climate change, and resulted in significant improvements in ocean and weather forecasting.

The ocean's biogeochemical properties are also changing rapidly, with profound impacts on ecosystems and climate, but to date, our ability to observe these changes is limited. The proposed biogeochemical extension of the Argo network (BGC-Argo) would revolutionize our ability to observe the ocean's changing biogeochemical state enabling us to observe seasonal to decadal-scale variability in biological productivity, ocean acidification, and ocean deoxygenation, as well as allowing quantification of the ocean's uptake of CO_2.

In 2016, the Science Plan[2] for BGC-Argo was formulated by an international group of experts. The plan calls for an additional 1,000 biogeochemical floats that would measure pH, oxygen, nitrate, chlorophyll, suspended particles, and light. The biogeochemical extension of Argo has been specifically mentioned by the G7 Science Ministers in their Tsukuba Communiqué in May 2016, which calls for *an enhanced and sustained global observing system that integrates new chemical and biological observations, while sustaining critical ongoing observations*.

In January 2017, a group of scientists from the Canadian federal government and universities gathered to discuss opportunities for Canada that arise from the international BGC-Argo initiative. Their recommendations are summarized in this document. It is clear that Canada is well positioned to play a leadership role in an expanded global ocean measurement program, and that the nation would derive significant scientific and technological benefits from it. In addition to addressing fundamental questions about our

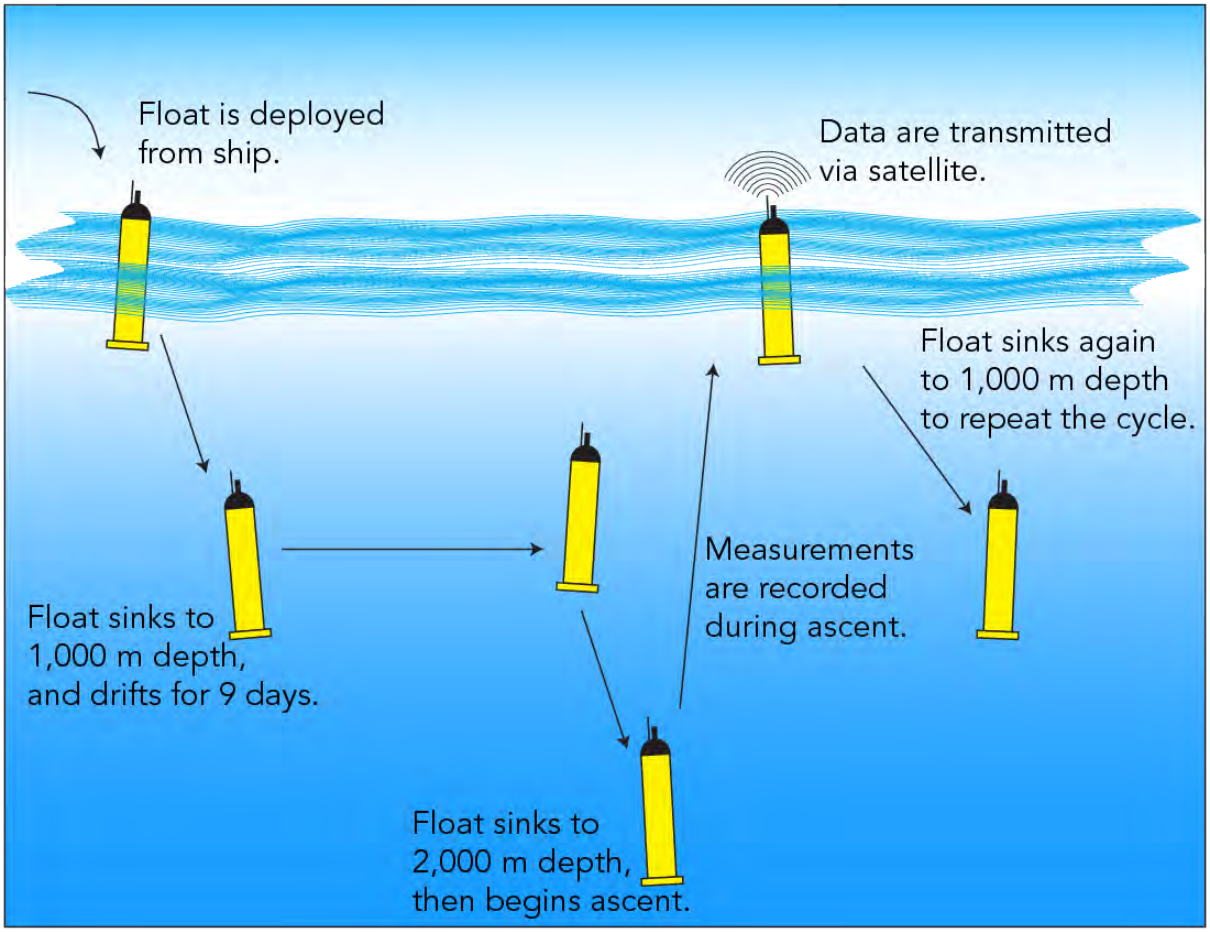
1Gillis, J. (12 August 2014), In the Ocean, Clues to Change, *New York Times*, D3.

2http://biogeochemical-argo.org/cloud/document/science-implementation-plan/BGC-Argo_Science_Implementation_Plan.pdf

changing ocean—questions that have significant societal implications—the program holds economic opportunities for Canada's vibrant and thriving ocean economy sector.

Pressing Issues in Canada's Oceans

Anthropogenic perturbations of the global carbon and nitrogen cycles are leading to fundamental changes of physical and chemical ocean properties, including water temperature, density stratification, circulation patterns, nutrient regimes, oxygen levels, carbon storage, and pH. Global warming is primarily ocean warming, in the sense that the ocean has absorbed over 90% of the heat added to the Earth system by man-made greenhouse gases (Rhein et al. 2013). A warmer ocean and increased vertical stratification diminish oxygen supply to the subsurface and deep ocean (Schmidtko et al. 2017). This deoxygenation results in expanding oxygen minimum zones in coastal and open ocean regions with direct negative impacts on ecosystems. Deoxygenation and changes in stratification will likely also reduce the availability of nitrate, the major plant nutrient that limits primary production in the ocean. A reduction in nutrient availability will strongly affect planktonic communities that support the marine food web, and play a major role in regulating the ocean's uptake of carbon and thus in the overall climate system.



In addition to absorbing heat, the ocean absorbs atmospheric CO_2. This mitigates global warming, but decreases ocean pH—a process referred to as ocean acidification. Low pH has direct negative impacts on organisms that form calcium carbonate structures such as oysters, lobsters, and marine snails (pteropods). Ocean acidification may also disrupt feeding relationships with effects cascading through marine feed webs, e.g., by threatening wild Pacific salmon, which rely on pteropods as their primary ocean food source.

Despite the expected effects of anthropogenic carbon and nitrogen cycle perturbations on ocean circulation, climate, the base of the marine food web, and higher trophic levels of the

marine ecosystem (including species of commercial importance or endangered status), our ability to observe ocean biogeochemical changes is limited. Vast areas of the ocean are presently sampled only once per decade or less by research vessels. While this direct sampling provides high-quality reference observations important for calibration of autonomous sensor measurements, the severe undersampling inherent in ship-based observations greatly hampers our ability to observe natural variability and detect anthropogenic changes in the ocean. This limits our capacity to understand, quantify, and predict changes in carbon storage, and its effects on climate and marine ecosystems.

Some of the most rapid changes and globally most important processes are occurring in Canadian ocean waters. Deep convection in the Labrador Sea in late winter produces a cold, relatively fresh, carbon- and oxygen-rich water mass, which together with other deep-water masses formed in the Nordic Seas feeds the deep branch of the global overturning circulation. The overturning circulation supplies the subsurface of the global ocean with oxygen and modulates global climate (Pérez et al. 2013). Deep convection in the Labrador Sea is thus important for ventilating the subsurface ocean, in particular in the North Atlantic (Wolf 2017), and in driving ocean uptake of anthropogenic CO_2, but also exacerbates ocean acidification along Canada's sensitive and commercially important eastern continental margin (Azetsu-Scott et al. 2010). Access by ship to the Labrador Sea during the winter convection period is difficult and expensive. Biogeochemical Argo observations can fill this crucial gap.

In the subsurface North Pacific, which is naturally low in oxygen and pH because it lies at the end of the global overturning circulation, oxygen and pH levels are declining rapidly in mid-depth waters (Whitney et al. 2007, Keeling et al. 2010, Byrne et al. 2010). The resulting hypoxia and acidification are already impacting marine ecosystems along Canada's west coast (Irvine and Crawford 2011, Haigh et al. 2015). Oxygen trends show significant temporal and spatial variability, making them difficult to discern from sparse ship-based measurements (Crawford and Peña 2016). A network of biogeochemical Argo floats would vastly improve our ability to observe and understand these trends.

The Arctic is the most rapidly warming region on Earth and is projected to be free of summer sea-ice by the middle of this century (Wang and Overland 2012). Since most primary production in the Arctic Ocean occurs at the ice edge, the rapid decline in ice cover profoundly affects marine ecosystems, but our understanding of these impacts is limited. Some studies suggest that increased stratification due to ice melt favours small phytoplankton and therefore limits the transfer of energy to higher trophic levels (Li et al. 2009, 2013), while other studies have suggested that expanding open water regions may become more productive due to increased mixing from intensifying Arctic winds (Arrigo et al. 2011, Ardyna et al. 2014). Given the challenges related to fieldwork in the Arctic, autonomous biogeochemical Argo floats represent an unprecedented opportunity for seasonal monitoring of chemical and biological ocean properties.

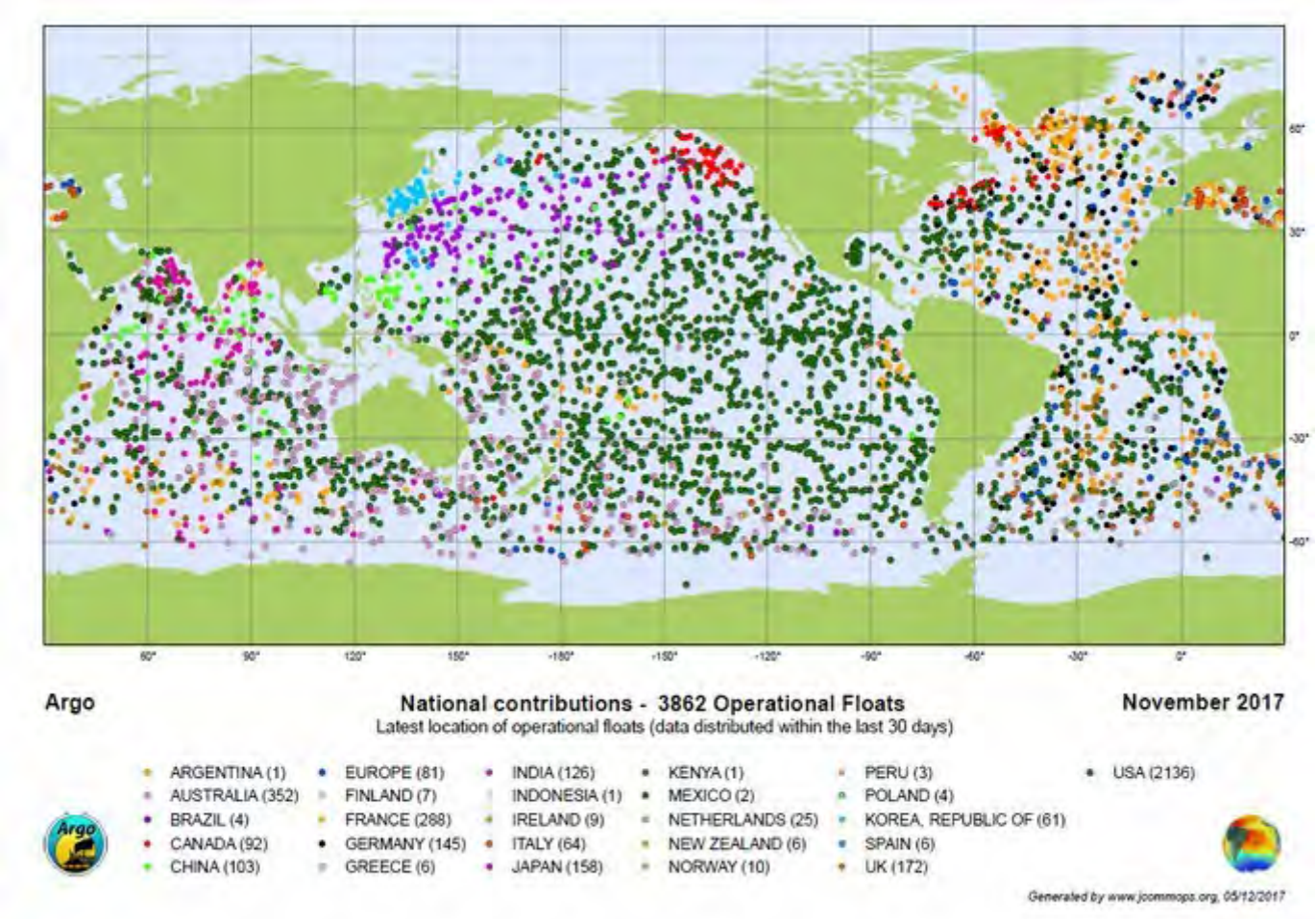
Another key benefit of biogeochemical Argo observations is the ability to detect episodic and unexpected ocean and climate phenomena. A striking example of this was the occurrence of very warm surface waters (>3°C warmer than normal) that developed offshore British Columbia in the winter of 2013-14. This warming phenomenon, which became known as "The Blob," was unprecedented in the historical record (Bond et al. 2015). Temperature and salinity observations from Argo floats were instrumental in detecting this event, demonstrating its magnitude, spatial extent, and duration (Freeland 2014). Fortuitously, some biogeochemical impacts of this event were measured by Argo floats with oxygen and nitrate sensors, which showed that the warm surface layer prevented deep winter mixing and resulted in low nutrient replenishment to the surface waters, suppressing ocean productivity in 2014 (Plant et al. 2016, Whitney 2015).

These examples, along with others that could be listed for all three ocean basins adjoining Canada, make it clear that we need to find a new way to monitor ongoing, and predict

future, changes in Canadian ocean waters. The BGC-Argo program can provide an ideal solution to the undersampling problem. With it, Canadian researchers would be enabled to identify trends in crucial ocean and ecosystem properties and investigate the underlying causes. This would drive a transformative shift in our ability to observe and predict the effects of climate change on ocean productivity, its uptake of CO_2, loss of oxygen, and acidification in Canadian waters. The resulting scientific breakthroughs will enable Canada to address pressing societal questions ranging from accurate accounting of ocean carbon sinks to science-based management of its living marine resources.

An Opportunity to Transform Ocean Observation

The recent maturation of autonomous robotic platforms and miniaturized sensors provides, for the first time, the technological capability to make sustained observations of physical, biological, and chemical ocean properties as they vary globally in three-dimensional space. BGC-Argo is an envisioned extension of the highly regarded and successful international Argo program (Riser et al. 2016), that measures ocean temperature and salinity with ~4,000 autonomous profiling floats distributed throughout the global ocean (see top panel on back cover). Canada has been, and continues to be, a significant contributor to the Argo program.



BGC-Argo will significantly expand the existing Argo capabilities by adding floats equipped with sensors that measure chemical and bio-optical properties.

Argo floats are free-drifting, battery-powered devices that park at 1,000 m for 5 to 10 days, then profile the water column by first descending to 2,000 m depth before rising to the surface and collecting measurements at prescribed depth intervals (see cover image). At

the surface, float location is determined by GPS, its position and ocean measurements are communicated to receiving stations via satellite, and made publicly available within 24 hours. Each float measures 150 to 300 profiles over the course of its battery life depending on its sensor load.

Currently available biogeochemical sensors measure dissolved oxygen, chlorophyll fluorescence, particle backscatter, light, nitrate, and pH. The maturity of these chemical and bio-optical sensors for deployment on profiling floats has been demonstrated in numerous research studies, and their accuracy and stability for climate-quality observations is proven (see footnote 2 [page 2 above] and references therein). Initial biogeochemical float studies used single or a small number of floats, but resulted in important new insights. Currently ongoing biogeochemical float studies are focussing on regional to basin scale processes (e.g. the Southern Ocean, the North Atlantic, the Mediterranean Sea, the Kuroshio region and the Indian Ocean; see bottom panel on back cover). The chemical and bio-optical sensors enable measurement of several variables that have been identified by the Intergovernmental Oceanographic Commission (IOC) of UNESCO and the World Meteorological Organization (WMO) as Essential Ocean Variables (EOVs), ecosystem EOVs (eEOVs) and essential climate variables (ECVs)[3]. This means that measurements of these variables are required to shed light on the biogeochemical cycles of carbon, oxygen, and nitrogen and are fundamental for addressing the scientific and societal issues related to global change.

In January 2016, a planning meeting for a global biogeochemical Argo program was held in Villefranche-sur-Mer, France, with attendees from 8 nations currently deploying Argo floats, including Canada. Following the meeting, a Science and Implementation Plan was formulated (see footnote 2) that calls for the addition of 1,000 biogeochemical profiling floats, uniformly distributed throughout the global ocean. In addition to the routinely measured physical properties, these floats would measure pH, oxygen, nitrate, chlorophyll, suspended particles, and light. Given an endurance of four years, maintaining an array of 1,000 floats will require the deployment of 250 floats per year.

With a clear need and defined plan, the BGC-Argo program has already received attention from the highest levels of governments of G7 countries. The program was discussed at the Science and Technology Ministers' Meeting in Tsukuba, Japan in May 2016, and the joint communiqué specifically calls for *Increasing the capability of the global Argo network to include more biological and biogeochemical observation and observation of the deep sea* (see Recommendation 1 in Attachment 2 of the Tsukuba Communiqué).

Case for Canadian Leadership

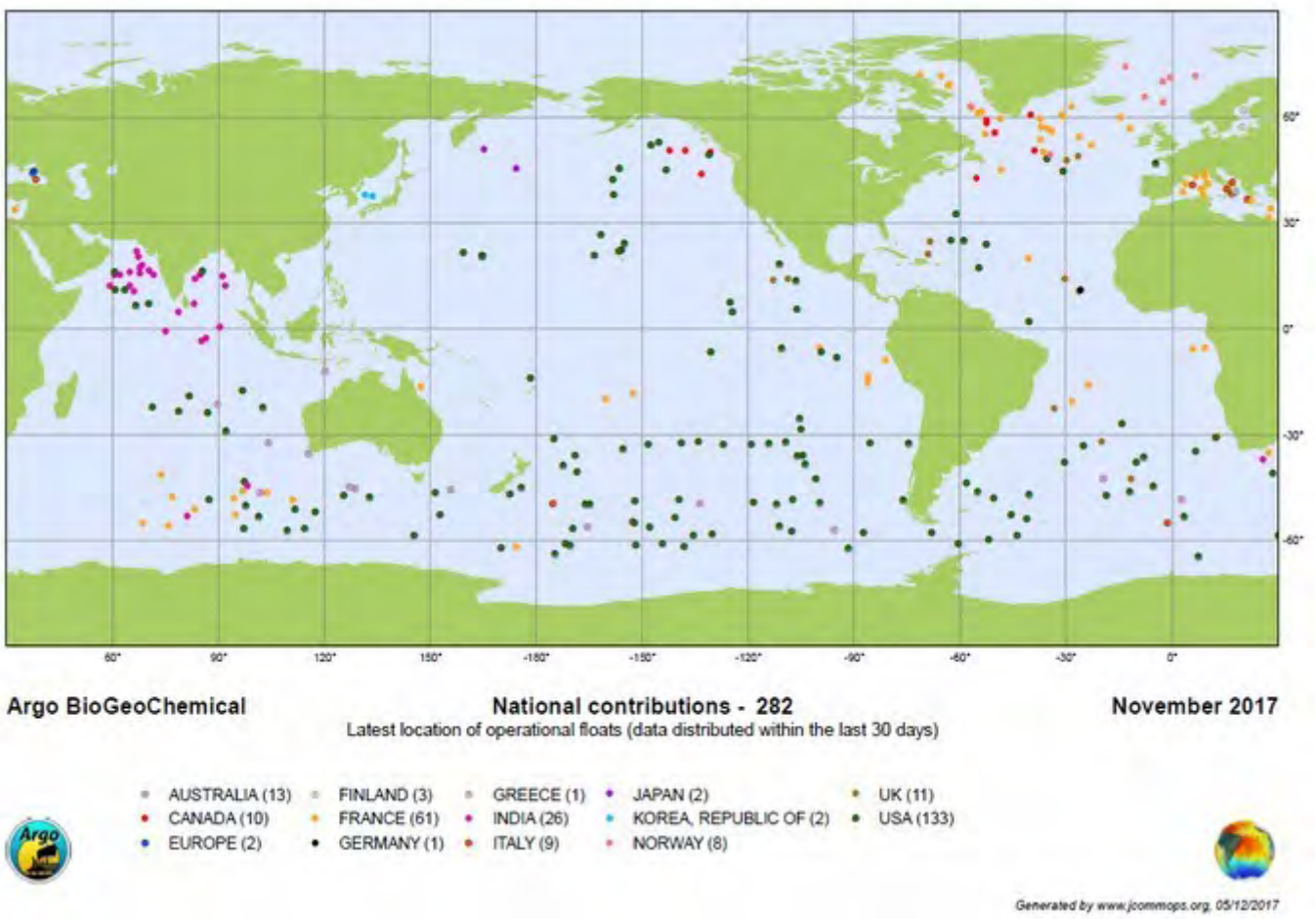
Canada was instrumental in helping to launch the first array of Argo floats, and is poised to take a leadership role in implementing the BGC-Argo program by supporting the core program in Canadian ocean spaces and by expanding the program's scope. This would be a natural step, since Canada is already a leading contributor to the existing Argo program, with Canadian scientists being well networked and represented on the international Argo steering committees. Another key factor is that Canadian companies have developed several of the chemical and bio-optical sensors that are used on today's biogeochemical floats and are working towards expanding the suite of observable parameters through new sensor development.

BGC-Argo will allow Canada to address pressing national issues related to all three of its adjacent ocean basins. These include issues related to the sustainability of aquaculture,

3 http://www.geowow.eu/downloads/GEOWOW-WP6-DEL-D6.2.pdf; https://www.wmo.int/pages/prog/gcos/index.php?name=EssentialClimateVariables

quantification of Canada's ocean carbon sinks, questions about the variability of anthropogenic carbon sequestration and ventilation of the global ocean through air-sea exchanges, and questions surrounding the dramatic changes in the Arctic Ocean. The latter is an area in which Canada is at the leading edge. Canadian scientists and engineers are actively pursuing innovations in under-ice sensing and navigation, which will enable the routine deployment of BGC-Argo floats in the Arctic Ocean

It must also be noted that Canada is well positioned to take advantage of the data streams that will result from the BGC-Argo array, given its cutting-edge capabilities in marine modelling and prediction. Canadian researchers in academia, at the Department of Fisheries and Oceans, and at Environment and Climate Change Canada are leaders in ocean modeling and prediction. With enhanced investment in this area, they will be able to spearhead methods for transforming the new observation streams into the data products and environmental forecasts that are needed by a broad base of end users, including those engaged in fisheries and aquaculture, tourism, alternative energy industries as well as efforts related to marine planning, policy, and conservation.



Benefits to Canada

Full participation in the international BGC-Argo initiative would have significant benefits to Canada across academic, government, and private sectors. In addition to the resulting scientific breakthroughs, BGC-Argo will enable significant innovations in marine prediction and the management of living marine resources, will provide opportunities for Canadian technology developments and will contribute to enhancing Canadian national security and asserting sovereignty in the Arctic.

Interannual fluctuations of fish stocks linked to variations in ocean temperature and primary production are a major challenge to fisheries management and can have significant economic impacts. BGC-Argo will enable improved observations and modelling, facilitating innovations in fisheries management.

Ocean deoxygenation and acidification are threatening ecosystems and jeopardizing aquaculture operations. BGC-Argo will allow the provision of real-time observations along with the detection of long-term trends, enabling the monitoring of ecosystem health indicators for regulation of aquaculture and implementation of conservation efforts.

Through leveraging Canada's expertise in satellite remote sensing of ocean color, BGC-Argo will advance the quantification of primary production in Canada's oceans. Canadian researchers are recognized as world leaders in this field and incorporation of BGC-Argo observations will further advance this international standing.

Participation in BGC-Argo will provide exceptional training opportunities to science and engineering students. The program will also provide early career scientists and engineers with opportunities to mount impactful research programs in this important new field.

BGC-Argo will expose expanding global markets to biogeochemical sensor development by Canadian enterprises. Several Canadian companies are already at the forefront of this technology sector.

Recommendations for Canada

1. Actively strive to maintain and enhance our position as an international leader in ocean observation through strong participation in the global BGC-Argo program.

2. Enhance Canadian scientific capacity in biogeochemical modelling and prediction, in order to capitalize fully on the potential of BGC-Argo.

3. For Canada to reap maximum scientific and societal benefit from BGC-Argo, ample training opportunities for young scientists should be provided, which would also help to ensure that "eyes are on the data" at all times.

4. Ensure free and near real-time access to the emerging data streams through properly resourcing data management.

5. Form a national BGC-Argo steering committee to facilitate communication within the Canadian user community.

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This report is a contribution to the international biogeochemical Argo (BGC Argo) program.

Workshop funding from the Department of Fisheries and Oceans and the MEOPAR Network of Centres of Excellence is gratefully acknowledged.

To be cited as:

Katja Fennel, Blair Greenan, and participants of the Canadian BGC Argo workshop, (2017), Taking the Ocean's Pulse: A vision for the Canadian Biogeochemical Argo program, doi:10.13155/52451.

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This section of your newsletter provides an opportunity to highlight your research programs to the Ocean Science Community. *Your are invited to send contributions to David Greenberg,* *david.greenberg@dfo-mpo.gc.ca*	*Mettez en valeur vos programmes de recherche en publiant un article dans cette première section de votre bulletin.* *Faites parvenir vos contributions à David Greenberg,* *david.greenberg@dfo-mpo.gc.ca*

CNC-SCOR West to East Tour Speaker Schedule

The 2017-18 Eastern annual CNC-SCOR tour speaker is Dr. Karen Kohfeld from Simon Fraser University. Her talk will be titled: ***The Ocean's Role in Atmospheric Carbon Dioxide Changes During Ice Age Cycles***.

Abstract: Ever since scientists discovered from polar ice cores that carbon dioxide levels were about 33% lower during ice ages compared to warm climate periods, they have been proposing theories to understand why. Since the ocean holds approximately 50 times more carbon than the atmosphere, oceanic processes are thought to be responsible. A range of physical and biological oceanic processes have been put forth to explain these fluctuations, and many can explain at least part of the total glacial-interglacial signal. However, Earth system models have yet to simulate carbon dioxide changes over a full ice-age cycle. This presentation will show how the fossil record can be used to infer long-term changes in marine productivity, ocean temperatures, ocean circulation, westerly winds, and sea-ice cover, and how these data can be pieced together to understand the sequential timing of processes affecting atmospheric CO2 concentrations during the last full glacial cycle (130,000 years).

The confirmed dates and venues are:

Jan 29 Rimouski **Location**: Institut des sciences de la mer de Rimouski, Salle Mohammed El-Sabh (P-210)
Time: 11:00 am
Contact: - Sophie_Banville@uqar.ca

Jan 30 Québec **Location**: Université Laval Vachon Building, room 3068 1045 avenue de la Médecine
Time: 11:00 am
Contact: - Brigitte.Robineau@qo.ulaval.ca

Jan 31 Ottawa, **Location**: Rideau Canal, Junior Officers Mess, 4 Queen Elizabeth Drive
Time: lunch at noon, presentation at 12h30.
Contact: - Martin.Gauthier@rwdi.co

Feb 1 St. John's **Location**: DFO NAFC White Hills Auditorium, 80 East Whitehills Rd.
Time: 2:30 pm
Contact: - Fraser.Davidson@dfo-mpo.gc.ca

Feb 2 Halifax **Location**: Location: Needler Boardroom, VS427 Bedford Institute of Oceanography
Time: 10:00 am
Contact: - Zeliang.Wang@dfo-mpo.gc.ca

https://www.sfu.ca/rem/people/profiles/kohfeld.html

http://meopar.ca/research/project/i-cap

https://www.sfu.ca/fenv/news/dr-karen-kohfeld-research-group-win-awards.html

CNC-SCOR East to West Tour Speaker

Cédric Chavanne, from l'Institut des sciences de la mer at Rimouski Quebec will be the CNC-SCOR tour speaker from eastern Canada talking at venues in western Canada. He is a physical oceanographer whose research interests focus on mesoscale (tens to hundreds of kilometers) and submesoscale (hundreds of meters to tens of kilometers) oceanic motions. He uses observations and theoretical models to investigate the ocean dynamics at these scales and their effects on biological processes. One of his observational tools are high-frequency radars, which hourly map ocean surface currents with a resolution of a few kilometers over areas of thousands of square kilometers. He received his PhD from the University of Hawaii in the USA in 2007 where he studied the impact of mesoscale currents on the propagation of internal tides generated at the Kauai ridge. He then held a post-doctoral position at the University of East Anglia in the UK where he investigated the dynamics of the slope front in the southeastern Weddell Sea in Antarctica. Since 2011 he has been a Professor in physical oceanography at UQAR-ISMER, Rimouski, Canada.

http://www.ismer.ca/Chavanne-Cedric

Cédric's talk will be ***Peering into the ocean interior from the surface***.

Abstract: Mesoscale (~100 km) and submesoscale (~1-10 km) processes in the upper ocean play a fundamental role in the vertical transport of tracers, exchanging heat and gases with the atmosphere, and supplying nutrients from the ocean interior into the euphotic zone. However, estimating the vertical velocities responsible for this transport from in-situ observations would require to sample the ocean vertically at a prohibitive horizontal resolution. A new method to diagnose vertical velocities using only surface observations, while taking into account the key physical processes of the mixed layer (ML), has been developed and tested against numerical simulations and in-situ observations. Its skill varies regionally and seasonally, performing in particular quite well for deep winter MLs, with correlations between simulated and diagnosed vertical velocities reaching 0.8 in the ML. This good performance for deep winter MLs is important since the properties of waters downwelled from the ML into the permanent thermocline are set when the ML is deepest in late winter. This method will open new perspectives to fully exploit the high-resolution data from the Surface Water Ocean Topography (SWOT) satellite altimeter that will become available in 2021. Expected outcomes are global observational estimates of upper ocean turbulent tracer fluxes in the range of 10-100 km. These observational estimates will in turn provide valuable benchmarks to tune and refine parameterizations of unresolved processes in global ocean circulation models used to predict climate change.

The tour is scheduled for March 12-15 and he will be visiting UVic, IOS, UBC, UAlberta and UManitoba. The details are still being finalize; we will try to put out a special bulletin when dates and venues are known.

Monday March 12 - UVic Contact: Jody Klymak jklymak@uvic.ca
- IOS Contact: Michelle.Bigg@dfo-mpo.gc.ca, Bill.Williams@dfo-mpo.gc.ca
Tuesday March 13 - UBC Contact: Susan Allen sallen@eos.ubc.ca
Wednesday March 14 - UAlberta: Contact: Paul Myers pmyers@ualberta.ca
Thursday March 15 - UManitoba: Contact: CJ.Mundy@umanitoba.ca

MEETINGS

3rd Open Science Symposium WPOC

Qingdao, China, May 8-10, 2018
Western Pacific Ocean Circulation and Climate (3rd OSS-2018)

The 3rd Open Science Symposium on Western Pacific Ocean Circulation and Climate (3rd OSS-2018) will be held on May 8-10, 2018 in Qingdao, China. This will provide a forum for oceanographers, meteorologists and climate scientists to exchange recent progresses in their study of the WPO circulation and climate and its generality/difference with other oceans, marine biogeochemistry and ecosystem, their variability, changes and impacts, to explore opportunities for international scientific collaboration, and to promote inter-disciplinary study in the WPO. It will be an excellent opportunity for early career scientists and students to show-case their research and gain international exposure. Visas are required.

Symposium website

Abstract submission and early registration are now open.

Abstract deadline: 15 February 2018
Early registration deadline: 15 March 2018

52nd CMOS Congress

Halifax, June 10-14, 2018
Marine and Environmental Risks and Impacts

The preparations for the next CMOS congress are well underway. Scientific and plenary sessions of the Congress will take place from Monday, June 11 to Thursday June14. In addition, time and venue space have been set aside on Sunday, June 10th for related workshops, business meetings, courses and other Congress-related events, as well as an icebreaker reception to be held that evening. **Abstract Deadline: ~February 28.**

Congress website

Ocean Related Gordon Research Conferences

Gordon Research Conferences (GRSs) are a group of prestigious international scientific conferences organized by a non-profit organization of the same name. The conference topics cover frontier research in the biological, chemical, and physical sciences, and their related technologies. The conferences have been held since 1931, and have expanded to almost 200 conferences per year. Conference locations are chosen partly for their scenic and often isolated nature, to encourage an informal community atmosphere. Contributions are "off-record" to encourage free discussion, often of unpublished research.

There are several 2018 GRSs centered on ocean research. Some examples are:

Ocean Global Change Biology Waterville Valley, Waterville Valley, NH July 15 - 20, 2018

Ocean Mixing Proctor Academy, Andover, NH June 3 - 8, 2018

Ocean Biogeochemistry The Hong Kong University of Science and Technology, Hong Kong, China July 8 - 13, 2018

Marine Microbes Renaissance Tuscany Il Ciocco, Lucca (Barga), Italy July 1 - 6, 2018

Talks are all invited. Posters are welcome. Travel and registration subsidies are available to many contributors. Registration is by application which often closes within a month of the conference start. See the FAQ.

Please send meeting announcements to David Greenberg, david.greenberg@dfo-mpo.gc.ca	*SVP faites parvenir vos annonces de réunion à David Greenberg, david.greenberg@dfo-mpo.gc.ca*

POSITIONS AVAILABLE

Tenure track or Tenured Position in Geological Oceanography

University of California, Santa Cruz

The Ocean Sciences Department (https://oceansci.ucsc.edu/) at the University of California, Santa Cruz (UCSC) invites applications for an early to mid-career (tenure track or tenured) professorial position in Geological Oceanography. We seek applicants whose research and teaching focuses on geological processes that are an integral part of the ocean environment. Preferred areas of interest include leading-edge research directions in paleoceanography, such as new approaches to reconstructing sea level rise, the relationships between biogeochemical cycles and climate, regional impacts of global climate change, or novel paleoproxy development in marine sediments or other paleoarchives. The preferred candidate will be expected to develop and maintain a vigorous research program that complements existing departmental strengths in paleoceanography and biological, chemical and physical oceanography. We seek scholars who are seriously committed to teaching undergraduate courses in general oceanography and Marine Geology, a graduate level course in Marine Geology, and speciality courses in their field of expertise. The successful candidate will have an opportunity to develop course materials for a new Environmental Sciences undergraduate major (expected to start in Fall 2018) for both upper division and capstone/senior thesis requirements. These teaching responsibilities will require this individual to have considerable breadth in Geological Oceanography. The successful candidate should also contribute significantly to undergraduate and graduate education and to the mentoring of graduate students.

Full Announcement

Review of applications will begin on January 29, 2018. The position will remain open until filled.

Postdoctoral Fellowship: Linked Ocean and Ecosystem Models - Lake Erie

University of Michigan in Ann Arbor

A postdoctoral fellowship is available for a highly qualified individual to join the Cooperative Institute for Great Lakes Research (CIGLR, https://ciglr.seas.umich.edu/) in the area of biophysical modeling. The position is funded for an initial period of 18 months, with opportunity for extension on the basis of satisfactory performance and availability of funds.

The successful candidate will join a multidisciplinary team working on development of models and scientific products to improve understanding and management of the Laurentian Great Lakes. The recently updated Lake Erie Operational Forecasting System (LEOFS) provides a high-resolution nowcast and forecast of temperature and currents in Lake Erie. Physical fields from the FVCOM-based LEOFS are used to provide ecological forecasts, including the Lake Erie HAB-Tracker and an experimental hypoxia forecast. The successful candidate will build upon these efforts by developing a biophysical model linked to LEOFS that simulates

the processes of biogeochemistry and plankton dynamics that lead to HABs and hypoxia in Lake Erie.

Applications will be accepted until the position is filled.

Oceanography faculty positions

University of Alaska Fairbanks

The College of Fisheries and Ocean Sciences (CFOS) at the University of Alaska Fairbanks (UAF) seeks applications from exceptional candidates for at least two tenure-track faculty positions to complement CFOS's breadth of expertise in fisheries and ocean sciences. We invite applicants with seagoing programs in chemical, geological, physical, biological, or fisheries oceanography, whose research plans include use of the ice-capable, Global Class R/V *Sikuliaq*, and who will further the mission and strengths of the College. These faculty appointments are intended to be at the rank of Assistant Professor, although outstanding candidates at a higher rank will be considered. These positions begin a broader campaign to hire up to five faculty to enhance research, teaching, and service in the College of Fisheries and Ocean Sciences.

Full Announcement

Deadline: February 28, 2018

Looking for work? Try the CMOS site (click).	*Vous recherchez un emploi? Visitez le site SCMO (click).*

CNC-SCOR Early Career Ocean Scientist Award

The Early Career Ocean Scientist Award is presented to an early career oceanographer/marine scientist for an outstanding contribution to marine sciences (in the broadest sense) within Canada. The award can be based on a single work/paper that provides a seminal contribution to the field, or ongoing work at a sufficiently high level of excellence that provides an outstanding overall contribution.

The Award: The award winner will receive a plaque with the award, as well as funds, from CNC-SCOR, to travel to the upcoming CMOS congress to receive the award and present a paper. Additionally, the award winner will be invited to sit on the CNC-SCOR committee for 1 year beginning with the CMOS Congress associated with their award.

Obligations of winner: The winner will acknowledge CNC-SCOR on their presentation at the CMOS-Congress, and will be asked to provide a 1 to 2 page article on their research for the Canadian Ocean Sciences Newsletter.

History of the Award: The award was presented for the first time in 2016. It is open to candidates (Canadians, working in Canada or overseas, or permanent residents) who are within 10 years of completion of their Ph.D. (note that periods of leave (e.g., parental, health) during this period do not count against the 10 year duration, provided appropriate documentation is provided). The candidate can work in any area of marine sciences, including academia, government, industry, NGO's, etc.

Award Nomination Instructions: Nominations are to be received no later than **15 February 2017**, by email to the CNC–SCOR secretary: David.Greenberg@dfo-mpo.gc.ca to be considered by the selection Committee. Receipt of submissions will be provided if requested.

Nominations will be adjudicated by the CNC-SCOR committee and will require a nomination letter highlighting the nominee's merits (maximum 2 pages), plus 2-4 supporting letters as well as an up to date CV of nominee. Nominations not selected for the award in previous years will be maintained active for three subsequent years (although they can be updated) or until the 10-year deadline has passed.

Teacher Professional Development - The Maury Project

Do you know a dynamic precollege teacher who could lead the way in oceanographic education? The Maury Project is a two-week teacher professional development workshop designed for precollege teachers and supervisors of science who teach, or supervise the teaching of, units with significant oceanography content. The workshop is fully paid for by the American Meteorological Society (AMS) and the US Naval Academy of the United States. Travel expenses are covered by CNC-SCOR and CMOS. Presentations at the workshop are made by some of the most respected American scientists in the field of oceanographic sciences. Participants have returned with material, resources and teaching modules readily adaptable to classroom presentations. It is to be noted that the successful candidate must agree to give two presentations to in-service teachers or other community groups in the following school year and to also provide CMOS with a short report on his/her experience at the workshop and a short report on the two presentations carried out during the school year. The application form must arrive by mail or email no later than **March 15 2017** at:

CMOS Project Maury Workshop
P. O. Box 3211 Station D Ottawa ON
K1P 6H7
or:
awards-coord@cmos.ca .

Call for Nominations to the SOOS Scientific Steering Committee

The Scientific Committee on Oceanic Research (SCOR) and the Scientific Committee on Antarctic Research (SCAR) invite nominations of qualified individuals to serve on the Scientific Steering Committee of the Southern Ocean Observing System (SOOS).

SOOS is an international initiative of the Scientific Committee on Antarctic Research (SCAR) and the Scientific Committee on Oceanic Research (SCOR). Developed over many years, SOOS was officially launched at the end of 2011 with the opening of the International Project Office, hosted by the Institute for Marine and Antarctic Studies (IMAS), and the Australian Research Council's Antarctic Gateway Partnership at the University of Tasmania, Australia. Since then, SOOS has built a network of stakeholders and contributors, all working together to achieve the community-defined mission and objectives.

SOOS activities are overseen by the international SOOS Scientific Steering Committee (SSC). The SSC meets annually and provides scientific direction for the SOOS towards achieving its mission. The SSC comprises 4 organisational levels: The Executive Committee (Co-Chairs, Vice Chairs and Executive Officer), Scientific Members, Data Committee Co-Chairs, and Ex-officio representatives.

For further information on this call, please visit http://soos.aq/about-us/ssc/nominations

Deadline: 1 February 2018

Developments in the Science and History of Tides

A special issue of Copernicus journals called “Developments in the Science and History of Tides” has been announced. The issue is open to any aspect of the subject including the present accuracy of coastal, regional and global tide models, tidal dissipation and its role in geophysics, internal tides and their role in mixing the ocean and in the global ocean circulation, secular changes in tides, and new techniques for measuring tides and analysing the data. The issue also welcomes new findings on earth and atmospheric tides, the role of tides in the origin of life on earth, palaeotides, lake and planetary tides and many other aspects of tides.

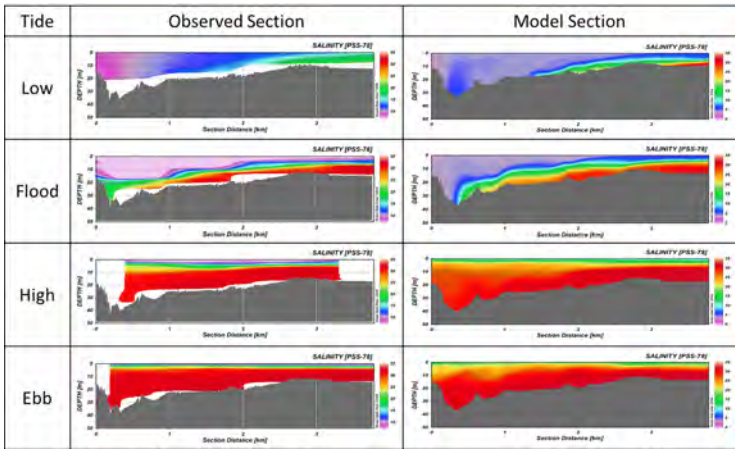
The special issue will span five Copernicus journals: Ocean Science – for aspects of tides in the ocean, Nonlinear Processes in Geophysics – for aspects of tidal dynamics including internal tides, Solid Earth – for aspects of solid earth and planetary tides, Atmospheric Chemistry and Physics – for aspects of atmospheric tides, History of Geo- and Space Sciences – for any aspect of the history of tidal science or scientists

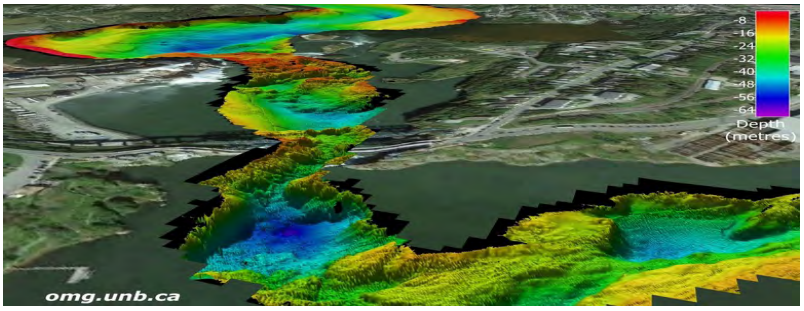
The special issue is open for submissions from 1 January 2018, and will stay open until at least the end of 2019. It is intended to mark the 100th anniversary of the founding of the Liverpool Tidal Institute (LTI). The LTI was established in 1919 and for many years was the world centre for knowledge of the tides, with Joseph Proudman taking the lead in dynamical theories, and Arthur Doodson in the analysis of tidal information from around the world, and on tidal prediction. The year 2019 is also the 100th anniversary of the IUGG. The Montreal Assembly will include a Joint Symposium on Tides (with IAPSO as the lead Association) that will be open to all of the aspects of tidal science mentioned above.

More information can be obtained from the guest editors: Philip Woodworth (plw@noc.ac.uk), Richard Ray (Richard.d.ray@nasa.gov) and Mattias Green (m.green@bangor.ac.uk).

Ocean modelers needs are important. Let's bridge the gap together.

Nowadays, web-mapping applications are a common way to deliver spatial data through the internet, where different geographic layers from different sources can be combined into a single interactive environment. Within the ocean mapping field, ocean data is collected by universities, government or industry; and there is a demand for visualizing and downloading this data online to serve the scientific community. Considering ocean mapping data users, the procedure of getting this data is sometimes tedious, since the users might not know what data is available for a region, or how to access it. My name is Marta Padilla Ruiz, I am a master's student in Geodesy and Geomatics Engineering, and I am a member of the Ocean Mapping Group at the University of New Brunswick (Canada). Last year, we started a research project to develop a web-mapping application to deliver the ocean mapping data from Lower Saint John River (New Brunswick), considering ocean modelers' needs when running an ocean model. This user-centered approach requires the involvement of users in the design process, following iterative evaluations till the needs and expectations are met. Hence, as the first stage for the research, we contacted several ocean modelers and sent out an online survey, which determined the required functionality and data needs. These requirements allowed us to develop the first prototype of the application, and the last step to close the cycle, is to get back to the users and evaluate our prototype. With this purpose, we will be conducting a system evaluation where the users will be able to interact with the prototype, answering a set of question to collect feedback from them. This process will take only a few minutes, and will be distributed online. If you are an ocean modeler and you work with ocean data, you are eligible to participate in this research. If you are interested to contribute, please contact me at mpadilla@unb.ca, and the link to the survey will be sent to you. Your help will be deeply appreciated, and together we can develop a suitable tool that will serve ocean modelers in the best way possible. Finally, I would like to thank all the people who have already contributed to this research, as the project could not have been possible without them.





Marta Padilla Ruiz
MSc Student in Geodesy and Geomatics Engineering
University of New Brunswick
Email: mpadilla@unb.ca

Support for SCOR Visiting Scholars Program

SCOR is currently reviewing applications for its 2018 Visiting Scholars program, the 10th year of the program. Many more good applications were received this year than can be supported through existing funding, even though the number of Scholars funded each year has been expanded to five. So far, 26 Visiting Scholars have served in developing countries in Asia, Africa, and South America. SCOR supports the cost of airfare and some local costs, while hosting institutions provide lodging, keeping the cost per Visiting Scholar to a modest US2,500.

We are seeking funding for one additional Visiting Scholar for 2018. Donations can be made at https://www.razoo.com/story/Yl2u7g.

100% of any donations will be used for the SCOR Visiting Scholars program.

Call for Applications for an Early-Career Scientist to Join the SCOR Executive Committee

The Scientific Committee on Oceanic Research (SCOR) is an international non-governmental organization whose vision is to advance international ocean research, within and across disciplines, by stimulating international cooperation in ocean sciences. More information about SCOR can be found at www.scor-int.org.

At the 2017 annual SCOR meeting, the Executive Committee decided to add an early-career scientist to the committee, to add perspectives from younger scientists to SCOR discussions. **Job Description:** The early-career scientist will have the same responsibilities as other SCOR Executive Committee members (see http://scor-int.org/EC_Job_Descriptions.pdf). The duties of SCOR Executive Committee Members require a few hours each week for responding to emails and reviewing documents, as well as participation in one in-person meeting per year, the annual SCOR meeting. SCOR will pay for the travel costs related to the SCOR meeting. The term of appointment will be for two years.

Full Details
Deadline : 31 March 2018

Previous newsletters may be found on the CNC/SCOR web site. Newsletter #**99** will be distributed in **March 2018**. Please send contributions to David Greenberg david.greenberg@dfo-mpo.gc.ca If you wish to subscribe to this newsletter, please send an email to listserv@lists.mcgill.ca with the following message: **SUBSCRIBE OCEAN-NEWSLETTER** If you wish to cancel your subscription, please send an email to listserv@lists.mcgill.ca with the following message: **SIGNOFF OCEAN-NEWSLETTER**	Les bulletins antérieurs se retrouvent sur le site web du CNC/SCOR. Le Bulletin **#99** sera distribué en **mars** 20**18**. Veuillez faire parvenir vos contributions à David Greenberg, david.greenberg@dfo-mpo.gc.ca Si vous désirez vous abonner à bulletin, veuillez envoyer un courriel à listserv@lists.mcgill.ca avec le message suivant: **SUBSCRIBE OCEAN-NEWSLETTER** Si vous désirez annuler votre abonnement, veuillez envoyer un courriel à listserv@lists.mcgill.ca avec le message suivant: **SIGNOFF OCEAN-NEWSLETTER**

CNC-SCOR

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Le Comité national canadien du Comité scientifique de la recherche océanographique (SCOR) favorise et facilite la coopération internationale. Il reflète la nature multidisciplinaire de la science océanique et de la technologie marine.	The Canadian National Committee of the Scientific Committee for Oceanic Research (CNC-SCOR) fosters and facilitates international cooperation. It is a non-governmental body that reflects the multi-disciplinary nature of ocean science and marine technology.

WWW.CNCSCOR.CA