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La Société canadienne de météorologie et d'océanographie

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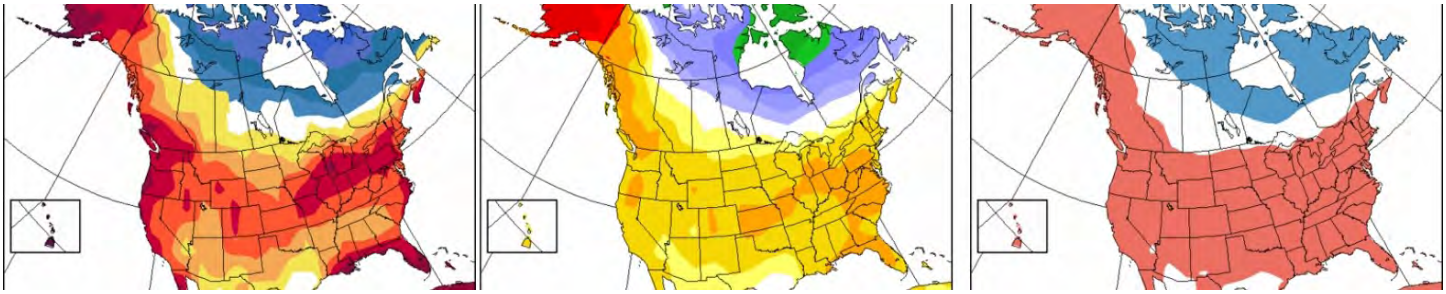
Should CMOS be Communicating More to Canadians on Climate Change?

Supporting the Next Generation of Arctic Researchers



The White Space Project: A Geographically Continuous Seasonal Forecast for North America

Working Together for the Arctic: The Arctic Regional Climate Centre Network (ArcRCC)

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Editor / Rédactrice: Sarah Knight
Director of Publications / Directeur des publications: Douw Steyn

Canadian Meteorological and Oceanographic Society / Société canadienne de météorologie et d'océanographie
E-mail: bulletin@cmos.ca
Courriel: bulletin@scmo.ca

CMOS Office / Bureau de la SCMO

P.O. Box 3211, Station D
Ottawa, Ontario, Canada, K1P 6H7
Homepage: http://www.cmos.ca
Page d'accueil: http://www.scmo.ca

Gordon Griffith, Ing., P. Eng., FEC
Executive Director - Directeur général
Tel/Tél.: 613-990-0300
E-mail/Courriel: cmos@cmos.ca

Ms. Qing Liao
Office Manager - Chef de bureau
Tel/Tél.: 613-990-0196
E-mail/Courriel: accounts@cmos.ca

CMOS exists for the advancement of meteorology and oceanography in Canada.

Le but de la SCMO est de promouvoir l'avancement de la météorologie et l'océanographie au Canada.

Words from the President

Advancing Climate Action in Canada

At the end of February I was grateful for the special opportunity to participate in the National Climate Change Science and Knowledge Priorities Workshop in Ottawa, a well-organized event hosted by Environment and Climate Change Canada. The workshop brought together a wide variety of experts and stakeholders from the natural and social sciences; from First Peoples, federal, provincial and municipal organizations; and from NGOs and industry. It covered research needs and priorities to best advance climate action in Canada, with a particular focus on accomplishing the objectives of the Pan-Canadian Framework on Clean Growth and Climate Change.

We sought to identify knowledge gaps and opportunities for Canadian research in climate change science, from fundamental research, to climate change modelling, to bringing climate data to local scales, and to research on impacts and adaptation for Canadians. We thought about how to address multidisciplinary research challenges, how to carry out integrated research and ensure knowledge mobilization, and how to translate research results into climate action. This ambitious agenda was pursued across four key themes: 1) resilient communities and the built environment, 2) a carbon neutral society, 3) resilient ecosystems, freshwater and marine resources, and 4) sustainable natural resources. As a university-based climate scientist who focuses on atmospheric dynamics and cold region processes it is humbling to consider the vast range of climate change impacts that planners and policymakers have to factor in to establish a strategic vision for Canada's investments in this area. My colleagues from academia and government labs who are involved in fundamental climate science made sure to highlight the continued need for investing in fundamental research in light of the many uncertainties that remain in projected future climate. But we, and all those present, took responsibility for making sure fundamental research would be oriented towards actionable and relevant knowledge beneficial to Canadians in all regions and areas of concern.

This kind of gathering is exactly the kind of dedicated effort we have been advocating for within the Atmosphere-Related Research in Canadian Universities Special Interest Group of CMOS (CMOS ARRCU SIG, arrcu.ca). From this exposure, to the landscape of climate adaptation and impacts research in Canada, I am convinced that there is an urgent need to train new practitioners in climate change science who are abreast of the rapid developments in this field. Sound science needs to be at the foundation of any efforts to mitigate and plan for climate change.

I enjoyed interacting with this engaged and passionate group over a lively two days of panels, breakout discussions, and small-group chats in the corridors of the Shaw Centre in downtown Ottawa and over dinner. I look forward to sharing with you the outcomes of this workshop, which I hope will lead to a coherent federal science research plan with strong opportunities for contributions from the CMOS community.

In other news, all of us on Council are excited by the prospect of the upcoming IUGG General Assembly in Montreal which is locally organized by CGU, CMOS, and JPDL Inc. The IUGG GA runs 8-18 July, but the IAMAS, IAPSO, and IAHS sessions relevant to most of the CMOS membership run during the first week 8-13 July (see http://iugg2019montreal.com/iugg-program.html). Thousands of abstracts have been submitted and our local CMOS organizing team led by Dominique Paquin is putting together a full set of CMOS meetings. We are going to make sure that the Society's regular business, including its Annual General Meeting and banquet, is executed in full. To help develop a more environmentally sustainable practice for the society, CMOS will, for the first time, allow online participation through remote conference call and web access – including the ability to vote – for the AGM. We will also extend this to other committee meetings as logistics permit. So, even if you can't make it to la belle province for IUGG, do make sure to take advantage of this opportunity to engage with us off site: dial in and participate in the AGM and contribute to the important business of your Society.

Paul Kushner

CMOS President and Professor, Department of Physics, University of Toronto
Email : president@cmos.ca;
Tel. : 416 946-3683

Mot du président

Le renforcement des mesures visant le climate au Canada

Je suis reconnaissant de l'occasion spéciale qui m'a été offerte de participer, à la fin de février, à l'Atelier national sur les priorités en science et en connaissances du changement climatique à Ottawa, un événement très bien organisé par Environnement et Changement climatique Canada. L'atelier a réuni un large éventail d'experts et d'intervenants issus des domaines des sciences naturelles et sociales, des Premières Nations, d'organismes fédéraux, provinciaux et municipaux, d'ONG et de l'industrie. Il portait sur les besoins et les priorités de recherche sous-tendant le mieux le renforcement des mesures visant le climat au Canada, notamment afin d'atteindre les objectifs du Cadre pancanadien sur la croissance propre et les changements climatiques.

Nous cherchions à cerner les lacunes dans les connaissances et les occasions de recherche canadiennes en science du changement climatique, qu'il s'agisse de recherche fondamentale, de modélisation de l'évolution du climat, de réduction d'échelle et de recherche sur les impacts et l'adaptation touchant les Canadiens. Nous avons réfléchi à la façon d'aborder les difficultés de la recherche multidisciplinaire, de mener des travaux intégrés, d'assurer le regroupement des connaissances et de traduire les résultats de la recherche en mesures relatives au climat. Nous avons axé ce programme ambitieux sur quatre thèmes principaux : 1) la résilience des communautés et du milieu bâti; 2) une société neutre en carbone; 3) la résilience des écosystèmes, et des ressources d'eaux douces et marines; 4) la pérennité des ressources naturelles.

En tant que spécialiste universitaire du climat qui se concentre sur la dynamique atmosphérique et les processus des régions froides, c'est avec humilité que j'ai pris connaissance de tous les impacts des changements climatiques que les planificateurs et les décideurs doivent prendre en compte pour élaborer une vision stratégique de l'investissement du Canada dans ce domaine. Mes collègues du milieu universitaire et des centres de recherche gouvernementaux qui s'intéressent aux sciences fondamentales du climat ont souligné la nécessité d'investir dans la recherche pure, et ce, compte tenu des nombreuses incertitudes qui subsistent quant à l'évolution du climat. Mais nous, et toutes les personnes qui étaient présentes, veillerons à ce que la recherche fondamentale s'oriente vers des connaissances concrètes et pertinentes, utiles à tous les Canadiens et couvrant toute source de préoccupation.

Ce rassemblement est exactement le genre d'initiative concertée que nous préconisons au sein du groupe d'intérêts spéciaux pour la recherche reliée à l'atmosphère dans les universités canadiennes (ARRCU), relevant de la SCMO (arrcu.ca). Après avoir pris connaissance de l'état de la recherche sur les impacts du climat et l'adaptation à celui-ci au Canada, je suis convaincu qu'il est urgent de former de nouveaux spécialistes en science du changement climatique, afin qu'ils soient au fait des progrès rapides dans ce domaine. Des données scientifiques solides doivent former la base de toute initiative visant une planification adéquate et l'atténuation des changements climatiques.

J'ai pris plaisir à interagir avec ce groupe engagé et passionné au cours de ces deux jours animés qui comprenaient des panels et des groupes de discussion, et permettaient des conversations informelles dans les couloirs du Centre Shaw au centre-ville d'Ottawa et à l'heure du souper. J'ai hâte de partager avec vous les résultats de cet atelier, en espérant qu'ils mèneront à un plan de recherche scientifique fédéral cohérent, qui offrira à la communauté de la SCMO une excellente occasion de contribuer.

Dans un autre ordre d'idée, tous les membres du conseil d'administration sont enthousiasmés par la perspective de la prochaine Assemblée générale de l'UGGI à Montréal, organisée localement par l'UGC, la SCMO et JPdL inc. L'Assemblée générale de l'UGGI aura lieu du 8 au 18 juillet, mais les séances de l'Association internationale de météorologie et de sciences de l'atmosphère, de l'Association internationale des sciences physiques appliquées à l'océan et de l'Association internationale des sciences hydrologiques, qui intéresseront le plus les membres de la SCMO, se tiendront durant la première semaine, du 8 au 13 juillet (http://iugg2019montreal.com/iugg-program.html).

Nous avons reçu des milliers de résumés de communication et notre comité local d'organisation, dirigé par Dominique Paquin, prépare une série de séances relevant de la SCMO. Nous veillerons à ce que les activités habituelles de la Société, y compris son assemblée générale annuelle et son banquet, restent une partie intégrale du congrès. Afin de mettre en œuvre sa pratique écologique, la SCMO permettra, pour la première fois, la participation en ligne et la possibilité de voter à l'AGA, par téléconférence ou accès Web. Nous étendrons également cette pratique à d'autres réunions de comités, dans la mesure du possible. Donc, même si vous ne pouvez vous rendre dans la belle province pour assister à l'AG de UGGI, profitez tout de même de l'occasion de participer à distance : tirez parti des télécommunications pour vous joindre à l'AGA de la SCMO et contribuer aux affaires importantes de votre société.

Paul Kushner

Président de la SCMO et Professeur, Département de physique, Université de Toronto
Email : president@cmos.ca;
Tél. : 416 946-3683

Working Together for the Arctic: The Arctic Regional Climate Centre Network (ArcRCC)

Michael Crowe, Katherine Wilson, John Parker

The effects of climate change are being felt around the world, but nowhere as intensely and as obviously as in the Arctic. Many sources can be cited that put the rate of temperature increase in the Arctic over the last 30-50 years as at least twice that over the rest of the globe. These temperature increases have led to significant reductions of sea ice, thawing permafrost and coastal erosion that affect all Northerners, including Indigenous communities and industry.

However, climate change does not mean a consistent trend towards warmer temperatures and a reduced ice cover in the Arctic. Climate change is causing great variability in weather and sea-ice conditions in the Arctic. Take, for example, the previous summer of 2018 in which ice conditions in the Canadian Arctic were within normal, but heavier than experienced recently. This caught many mariners off guard resulting in Arctic tourist cruises re-routed and communities in the Western Arctic not receiving their annual sealift. High variability in weather and ice conditions can also mean greater risks to Northerners due to the increased frequency of storms and drifting ice. This reality is causing governments of Arctic nations to focus on new services to assist decision-makers to adapt to these rapid and variable changes in climate. The impacts right now are real and pose serious threats to infrastructure, ecosystems and Communities, including affecting a Northern way of life that remains rooted in traditional ways of living off the bounty of this unique ecosystem.

The World Meteorological Organization (WMO) through its Global Framework for Climate Services is assisting its Members to meet their adaptation planning and decision-making needs by establishing Regional Climate Centres (RCC). Building on this concept, Arctic Nations are partnering to establish the Arctic Regional Climate Centre Network (ArcRCC-Network), a unique version of an RCC to provide ongoing and regular climate information to meet the unique needs of Northerners.

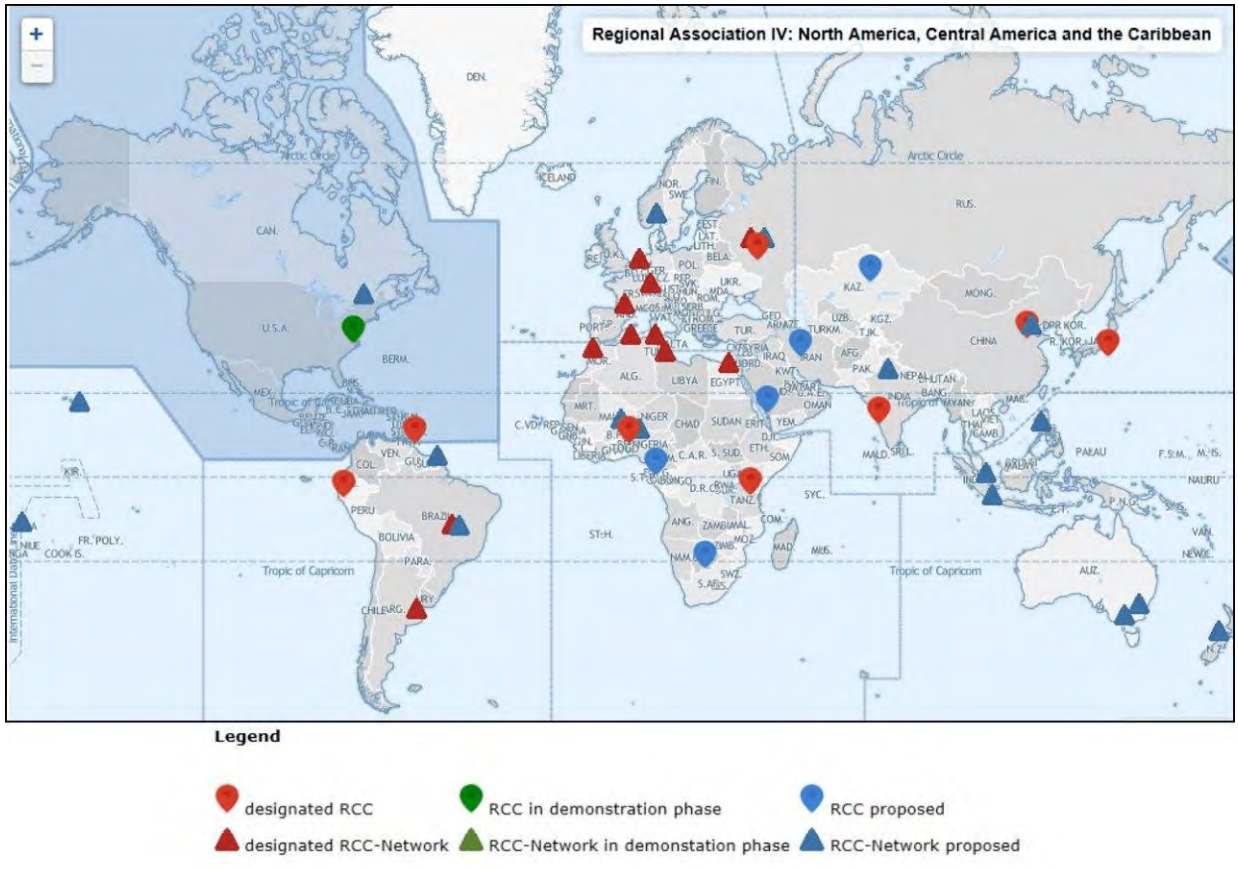

Figure 1: Current global network of RCCs

A key activity of the Network is the conduct of a semi-annual Pan-Arctic Regional Climate Outlook Forums (PARCOF). The PARCOF follows the concept of the Regional Climate Outlook Forum (RCOF), whereby regular meetings are hosted by RCCs with stakeholders to provide climate outlooks and raise awareness.

The ArcRCC-Network is currently in year 1 of a 2-year demonstration phase, as part of the requirements to seek formal designation as a WMO RCC-Network. This article reviews the development and formation of the Network, its PARCOF, the first few meetings and lessons learned, and future plans.

Arctic Regional Climate Centre Network (ArcRCC)

Endorsed by the WMO, RCCs are normally National Meteorological/Hydrological Service Centres that have stepped forward to take responsibility for the provision of an identified suite of climate products and services for a particular region (See Figure 1). The RCCs assist WMO Members in the given region to deliver better climate services and products (such as regional long-range forecasts), and to strengthen their capacity to meet national climate information needs.

The Arctic Regional Climate Centre Network (ArcRCC-Network) is based on the WMO RCC concept, but with active contributions from National Meteorological and Ice Services in all the Arctic Council member countries (Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden, USA) through a mutually agreed virtual structure that divides the responsibilities for the provision of services amongst the members.

<table>
<tr><th colspan="2">National</th><th colspan="2">Regional</th><th>Circumpolar</th></tr>
<tr><td>Countries</td><td>Meteorological Organizations</td><td colspan="2">Regional Climate Centres (RCC)</td><td rowspan="10">Arctic Polar Regional Climate Centre (ArcRCC)</td></tr>
<tr><td>United States</td><td>NOAA</td><td rowspan="2">North American Node</td><td rowspan="2">Forecasting</td></tr>
<tr><td>Canada</td><td>ECCC</td></tr>
<tr><td>Denmark</td><td>DMI</td><td rowspan="5">Northern European/ Greenland Node</td><td rowspan="5">Data Services</td></tr>
<tr><td>Iceland</td><td>IMO</td></tr>
<tr><td>Norway</td><td>NMI</td></tr>
<tr><td>Sweden</td><td>SMHI</td></tr>
<tr><td>Finland</td><td>FMI</td></tr>
<tr><td>Russia</td><td>AARI</td><td>Northern Eurasia Node</td><td>Monitoring</td></tr>
</table>

Figure 2: ArcRCC: Collaboration/Networking across regional nodes and Meteorological Organizations

The sub-regional geographical nodes of the ArcRCC-Network are (i) North America, (ii) Northern Europe and Greenland and (iii) Eurasia. Each node will also undertake a cross-node functional lead for the entire pan-Arctic domain: Canada leads the development of Long-Range Climate Forecasts; the Russian Federation leads Climate Monitoring; and Norway leads operational Climate Data Services. (see table Fig 2).

Members of the ArcRCC-Network are collaborating to:

- Provide climate information products;
- Fill gaps and potentially harmonize products and services between countries; and
- Enhance collaborative research and development

ArcRCC Products

Seasonal Summaries provide an overview of the previous winter/summer season for the circumpolar Arctic. The summaries describe actual temperature, precipitation and sea-ice details/trends based on observations and compared to historical trends.

Seasonal Outlooks provide forecasts for the upcoming winter/summer season:

- Temperature: above/below normal based on model outputs
- Precipitation: above/below normal based on model outputs
- Sea-ice: extend above/below based on model outputs

Arctic Consensus Statement is a collaborate effort by the network which reviews the trends in the historical monitoring data, recent observations, forecasts from models and utilizes regional expertise to fill gaps in the data to develop a consensus forecast for the Arctic region. Please see the ArcRCC website to view the current products at www.arctic-rcc.org.

PARCOF is a flagship activity of RCCs around the world is the Regional Climate Outlook Forum (RCOF). RCCs meet with climate information providers and users on a regular basis (quarterly or semi-annually) to review climate forecast products for the region, to better understand user needs, identify gaps, co-develop products and to generally raise awareness of the changing climate and how the information can be used to better prepare for the changes to come.

The Pan-Arctic Regional Climate Outlook Forum (PARCOF) is held twice per year: a face-to-face meeting in May prior to the Arctic summer season; and a virtual meeting in October prior to the Arctic winter season. The face-to-face forums are dedicated to meeting and working with Arctic climate users to:

- Share the current state of climate products available for the Arctic
- Better understand their needs
- Co-produce the output products (i.e. regions, graphics, plain language text)
- Develop a model for engaging with users in future outlook forums

Results

The first annual cycle of the PARCOF is now complete, with the first in-person summer meeting having taken place in Ottawa, Canada, May 15 to 16, 2018, and the first virtual winter meeting hosted by the Eurasian node Oct. 30, 2018.

The PARCOF-1 meeting invited Arctic Commercial Shipping users and Circumpolar Indigenous organizations to participate, and a key outcome was an integrated ArcRCC Consensus Statement for Summer 2018. The statement synthesized the current climatological conditions and outlooks for temperature, precipitation and sea-ice to highlight potential implications or risks for decision-making by various sectors. This consensus statement was announced through a WMO press release and launched the official start of the ArcRCC demonstration phase.

Of particular interest and value from the PARCOF-1 was the user feedback. The Indigenous and shipping organizations that participated provided comments that were open, honest, gracious, extremely valued, and will help to shape the products and how they are communicated during the PARCOFs ahead. The feedback covered the products themselves, the level at which they were presented, the timeframes that the outlooks covered and much more. Some of the lessons learned based on the feedback:

- Products need to be designed from a user's, not a modelling output perspective. Currently the products are not intuitive. Training and a manual on the products could be useful but training material needs will vary greatly so, better that the products be designed so anyone can understand them without training.
- Arctic Indigenous peoples are not only users, but producers of environmental information. National Meteorological and Ice Services need to look at how to work with Indigenous Knowledge producers to co-develop culturally relevant local and regional scale products.

- National and International organizations separate climate and weather services, but users do not. They are interested in all temporal scales from hourly to 2-3 years in advance depending on their use. ArcRCC and their partners at National Meteorological and Ice services will need to find a way to bridge the climate and regional/local weather products.
- To invite and prepare users for the PARCOF takes time and effort. The users that were invited to the Ottawa PARCOF were contacted 6 months in advance and several telephone and/or face-to face conversations took place to explain: the ArcRCC; the objectives of the PARCOF; their role in presenting and in the break-out sessions; and to determine their interest and objectives in participating. This will need to continue to be a shared ArcRCC-Network effort.
- Although the modellers prefer to have the PARCOF in May, as the skill of the forecasts improves as you get closer to the summer season, the shipping and Indigenous representatives noted that May is a very busy time for summer operations and Indigenous peoples are out one the land/sea-ice hunting and fishing. Greater user participation would be possible in April.

PARCOF-2 was hosted virtually by the Norwegian Meteorological Institute of the Northern European/Greenland node, and published another Consensus Statement that included a seasonal summary and forecast verification of the 2018 summer season, and outlook for the first half of the 2018/2019 winter season.

Another key result has been the launch of the Arctic RCC Networks webpage. This site offers a one-stop shop for all information related to the ArcRCC-Network including past meeting reports and Consensus Statements, access to climate monitoring products, datasets, long-range forecasts and links to regional products and services based on the geographic nodes of the Network. Members have noted particular user satisfaction with this single-entry access to climate services related to the Arctic.

Path Forward

Future PARCOFs will be hosted by various ArcRCC network members in other circumpolar countries. The end-user focus of the forums will be discussed amongst the network and will be influenced by where the next forum is held. Arctic Council and Indigenous participants will be invited to all future forums as their needs cut across all sectors. Future PARCOFs may include other Arctic climate users such as (but not limited to):

- Arctic Ecosystems and Wildlife
- Arctic Defence, Marine Safety, Search and Rescue, Regulators, Pollution/Oil Spills
- Arctic Health and Populations
- Natural Resource Development
- Infrastructure: Terrestrial, Marine, Telecommunications
- Arctic Policy/Science

About the Authors

Mike Crowe retired in 2016 after 30 years with the Meteorological Service of Canada. The first part of his career was spent as a field technician in the Western Arctic followed by a few years as an operational weather forecaster in Alberta. He then moved to headquarters and worked in client services for aviation weather services. The last ten years of his career were spent in Corporate Policy and Planning positions where he was involved in MSC contributions to Northern Policy development, among many other things. He continues to stay involved in meteorology at the International and domestic levels with a focus on climate services.

Katherine Wilson is Chief of Strategic Policy and Planning at Canadian Ice Services, and John Parker is the Director of Marine and Ice Services at MSC

The White Space Project: A Geographically Continuous Seasonal Forecast for North America

Marko Markovic[1], Zeng-Zhen Hu[2], Bertrand Denis[1], Arun Kumar[2] and Dave DeWitt[2]

(1) Environment and Climate Change Canada, Meteorological Service of Canada, 2121 Transcanada Highway, Dorval, Canada; (2) Climate Prediction Center, NOAA/NWS/NCEP, College Park, Maryland, USA.

The CanSIPS-CFSv2 seasonal forecast, or "The White Space Project," is a joint effort by Environment and Climate Change Canada (ECCC) and National Oceanic and Atmospheric Administration (NOAA) to deliver a geographically continuous seasonal forecast over the North American continent. At present, both ECCC and the Climate Prediction Center (CPC) of NOAA, perform their respective seasonal forecasts independently on a monthly basis. By doing this, each country applies a geographical mask over their counterpart leaving a "white space" to dominate for the seasonal forecast map of North America (see Fig. 1).

The principal goal of this project is to use the combined CanSIPS (Merryfield et al. 2013) and CFSv2 (Saha et al., 2014) forecasts for the benefit of having a continuous forecast across the United States and Canada borders. One example of such a project is hydrological monitoring over the Great Lakes managed by the International Joint Commission, where the two countries have an agreement on the water quality (https://www.ijc.org/en/watersheds/great-lakes, accessed 27/12/2018).

Another significant goal of this project is an overall improvement of the seasonal forecasts stemming from the multi-model approach. Both countries will benefit from this approach with more skillful seasonal forecasts over the North American continent. Multi-model seasonal forecasting has been recognized to have better results than the single-model forecasting technique.

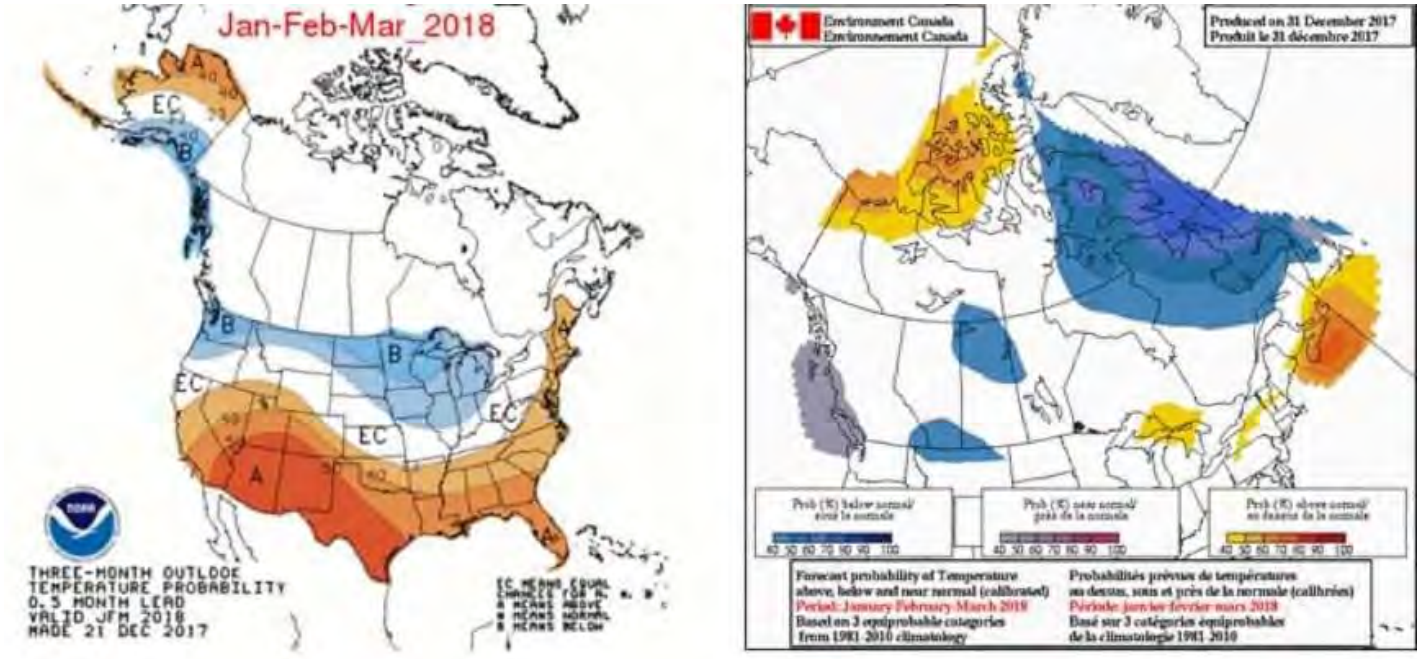

Figure 1. On the left: Seasonal January-February-March 2018 lead 0 seasonal forecast, issued by the Climate Prediction Center. On the right: as on the left, but issued by Environment and Climate Change Canada.

Motivation for the zero-lead forecast

Motivation for this project comes from the fact that both ECCC and the CPC are the operational forecasting centres with an operational production cycle for dynamical seasonal forecasts on a particular day of the month. This is very important for the production of the "zero-lead month" (i.e. difference between the forecast target season and the forecast release is zero) seasonal forecasts, which are known to have better skill scores compared to the forecasts with longer leads (Wang et al., 2010).

The North American Multi-Model Ensemble (NMME) is an example of a project that combines seasonal forecasts stemming from several North American climate models (Kirtman et al. 2014). Once per month, the NMME issues seasonal forecasts for North America targeting seasons having lead times of one to five months. The fact that the combined NMME forecast encompasses real-time seasonal forecasts from a number of production centres makes it very challenging to provide the zero-lead seasonal forecast. Therefore, the combined CanSIPS-CFSv2 real-time seasonal forecasts can be a complementary product to the North American Ensemble, filling the zero-lead gap. Figure 2 shows a comparison between the March-April-May (MAM) historical (1982-2010) percent correct skill scores of zero-lead and one-month lead time seasonal forecasts for near-surface temperature over Canada. Zero-lead forecast skill, calculated for only one model (i.e. CFSv2, Fig2a), is substantially higher than one-month lead time forecast skill from the Multi-Model Ensemble mean (Fig. 2b, six models in total), highlighting the importance of the shorter lead time forecasts over the longer lead multi-model ensemble forecasting approach. Globally performed analysis (not shown) of the percent correct score confirms the results over Canada in MAM and all other seasons.

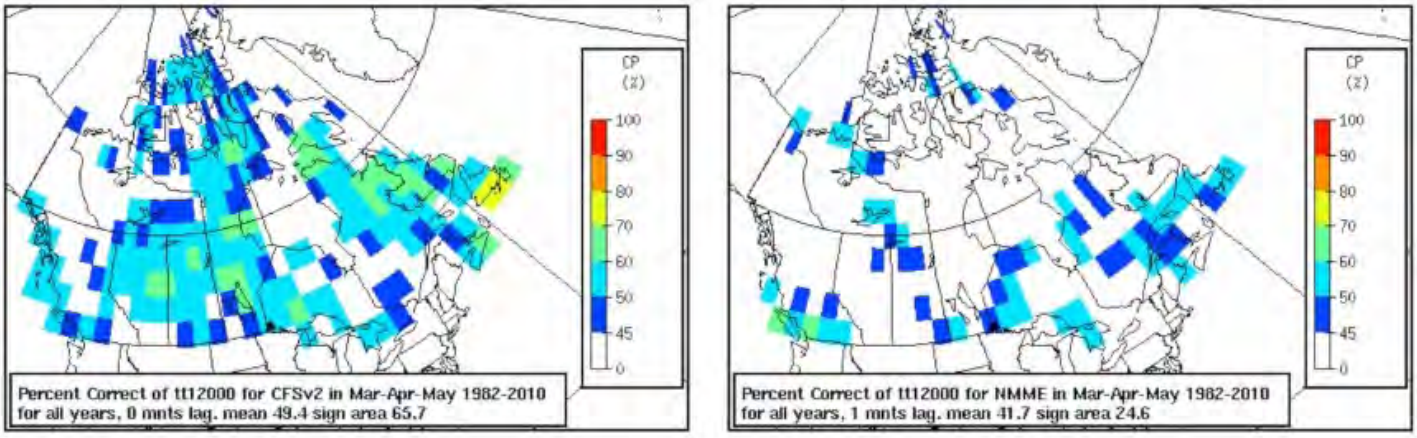

Figure 2. Historical (1982-2010) percent correct score for MAM season for CFSv2 ensemble mean lead 0 (on left), and North American Multi-Model Ensemble mean, lead 1 (on right).

Experimental setup of the joined CanSIPS-CFSv2 real-time forecasts

Since the CanSIPS and CFSv2 models use different methods to initialize their respective real-time seasonal forecasts, we used the following configuration, which has been found to be the most suitable for this type of product. To construct the combined seasonal forecast, we have used 20 ensemble members of the CanSIPS system having the “burst initialization” (i.e. all ensemble members are launched at the same time) executed on the last day of each calendar month and the 20 ensemble members of the CFSv2 model that have lagged initial conditions. As the combined CanSIPS-CFSv2 real-time forecast is constructed on the first day of each calendar month, we have used the 20 CFSv2 ensemble members executed with lags closest to the end of the month. This configuration enables the combined system to be as close as possible to zero-lag. The combined forecast is an ensemble prediction using 40 ensemble members that are given equal weight. The ensemble members for the historical CanSIPS and CFSv2 ensembles, needed for the estimation of the system’s climatology and historical forecast skill, are selected using a similar approach as for the real-time forecast ensembles.

Once operational then at the end of each calendar month, we will be issuing a joined CanSIPS-CFSv2 ensemble seasonal forecast for zero and one-month lead times.

Products of the joined system

The CanSIPS and CFSv2 models are combined to form a multi-model ensemble mean where each ensemble member is equally weighted. The flagship product of the joined CanSIPS-CFSv2 forecasting system is the probabilistic forecast for near-surface temperature (Fig.3 on the left), precipitation and sea-surface temperature. In addition to the probabilistic forecast, we also provide an anomaly forecast (Fig. 3 in the middle for temperature) and a deterministic seasonal forecast (Fig. 3 on the right for temperature). The anomaly forecast is an important complement to the probabilistic seasonal forecasting approach, which makes it possible to associate the probability value with the magnitude of an anomaly. The deterministic approach is useful for seasonal forecast evaluation using simple and understandable skill score measures, such as the correlation coefficient or the

percent correct skill score. The joined system seasonal forecasts may be accessed at the following Web page: http://collaboration.cmc.ec.gc.ca/cmc/saison/Joined_CanSIPS_CFSv2/site_web/#t/11/2018/m123/on, (username and password available upon request to marko.markovic@canada.ca)

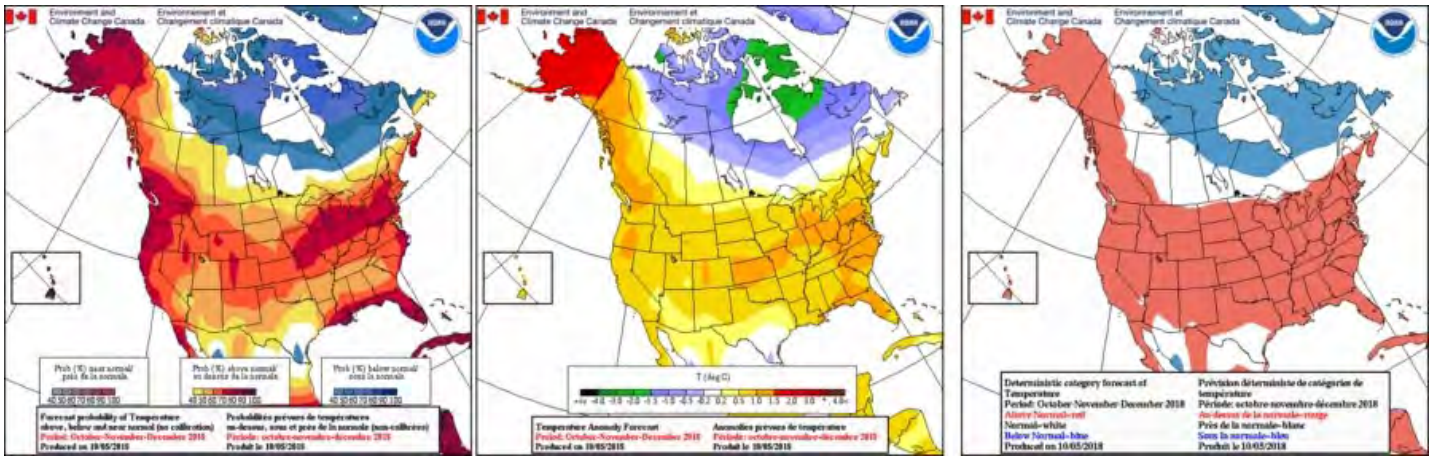

Figure 3. Zero-lead seasonal forecast for October-November-December 2018 from joined CanSIPS-CFSv2 seasonal forecasting system. Left: Probabilistic approach; Middle: anomaly forecast; Right: Deterministic approach.

Conclusions and Future Work

This project highlights the importance of the shorter lead time seasonal forecasts in comparison to longer lead multi-model methodology. The International Alaska-Northwestern Canada Joined Bulletin is the first user of the joined CanSIPS-CFSv2 seasonal forecast (https://www.canada.ca/en/environment-climate-change/services/climate-change/science-research-data/climate-trends-variability/quarterly-bulletins/alaska-northwest-june-2018.html, accessed 28.12.2018). This quarterly publication studies the seasonal climate and the impact of temperature, precipitation and sea ice on the region.

In order to finalize the joined CanSIPS-CFSv2 seasonal forecast project, we need to perform the forecast calibration. This technique is known to improve seasonal forecasts by mitigating forecast biases, such as overall overconfidence, that most of the forecasting systems possess, especially for the higher observational frequencies (Kharin and Zwiers, 2003). Seasonal climate assessments in the northern regions of North America (e.g. Alaska, Yukon) would greatly benefit from seasonal forecasts of sea ice. Therefore, our next step will be the inclusion of the real-time sea-ice forecasts in our forecasting system. Verification of the previous CanSIPS-CFSv2 seasonal forecast should also be included as an important component of the forecasting system. This step would shed light on the system's overall performance and would also build the "forecasting confidence" of the new forecasting system.

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Should CMOS be Communicating More to Canadians on Climate Change?

John Loder, Scientist Emeritus, Fisheries and Oceans Canada, Bedford Institute of Oceanography

Our Society's Bulletin and website indicate that CMOS "exists for the advancement of meteorology and oceanography in Canada". Is this advancement primarily for the benefit of our members, such as improved communications internally or increased funding for our core disciplines? Or, should CMOS also have an emphasis on communicating sound scientific information to the Canadian public, especially on major issues involving our expertise and affecting present and future generations? If there are divisive disagreements amongst Canadians on a topic such as anthropogenic climate change, and these involve misrepresentation or neglect of the overwhelming scientific knowledge in our core disciplines, how proactive should CMOS be in communicating scientific knowledge to the public and governments?

The extent to which CMOS presently considers it a priority to communicate sound and relevant scientific information to the Canadian public on the seemingly urgent issue of anthropogenic climate change is unclear from a quick glimpse at our impressive website. On the other hand, in the latest Bulletin, our President has highlighted the urgent importance of action on this topic.

On the website, the first paragraph under *About CMOS* indicates that our Society's "aim is to promote meteorology and oceanography in Canada" and "serve the interests of … scientists in Canada". Communication to the public is not mentioned in this paragraph nor explicitly in the second paragraph, although the latter indicates that the "Society addresses a broad range of national and international meteorological and oceanographic concerns including …. weather extremes, global warming, … and their effects on all aspects of life in Canada …".

In addition to the question of how proactive CMOS should be in communicating relevant science to the public on the potentially pre-eminent environmental issue of this century, there is also one of the extent to which CMOS should be involved in communications on the scientific soundness of various policy options.

After reading the position statements that CMOS has issued since 2002, which can be found further down on our website, it becomes apparent that CMOS has actually had a strong and commendable proactivity on the science of anthropogenic climate change and its implications for policy decisions. Some excerpts from these statements are listed in the Annex below. My question then becomes whether CMOS has been doing enough in recent years while the societal debate in Canada has been intensifying and becoming more polarized, and the apparent urgency for government and societal action to deal with the emerging global disaster has been increasing.

Our 2018 Position Statement on the IPCC Special Report focuses on the aspirational 1.5 and 2.0°C global warming limits, but does not address the much more likely scenarios of much greater and much more serious anthropogenic climate change and impacts on Canadians and people in other parts of the world where the impacts will be more severe.

The past CMOS statements on anthropogenic climate change provide a strong foundation for further CMOS communications on the science and for advocacy on potential mitigation options. It seems highly likely that the topic will be under continued public debate during the coming months and years, and that clear communication of the science would be extremely valuable to this. With our annual Congresses, public lectures, tour speakers, Centers, website, Bulletin and other communication options, our Society is in a position to make a potentially lasting contribution to present and future generations on this critical issue. One starting point might be a concise summary position statement on anthropogenic climate change, including the more likely and more dangerous probable changes (than for warming of only 1.5 or 2°C) if much more serious action is not taken. With the narrowing time window for greater societal and governmental action to reduce emissions and implement other mitigations in order to avoid potential catastrophic runaway climate change, it seems highly appropriate for CMOS to give urgent consideration to this matter.

Annex: Excerpts from Past CMOS Position Statements related to Climate Change

The 2002 statement entitled *Improved Knowledge Needed for Smarter Decisions* asserts that "a common understanding of the science of climate change and variability is an essential basis for developing effective programs and policies on climate change, including addressing the commitments laid out in the Kyoto Protocol …".

The 2003 statement on the Kyoto Protocol "takes the position that Canada's, and indeed the world's, success in dealing with climate change can only be achieved through an informed population. CMOS affirms its own commitment to the promotion and dissemination of well-founded knowledge on the science of climate change. The public must understand the reasons for and consequences of climate change before they can be expected to accept the need for proactive measures and to participate fully in their implementation."

The 2007 statement entitled *The state of science – Canada's climate is changing dramatically* notes that "Arguments by a few individuals that recent temperature trends may not be unprecedented within the past thousand years and can therefore be fully explained by natural variability … are seriously flawed. While some uncertainty is an inherent aspect of all science, related international research studies continue consistently to refute such conclusions."

The 2009 Brief to the House of Commons Standing Committee on Finance "recommends the introduction of financial incentives to reduce net greenhouse gas emissions rapidly. These measures will complement the present incentives to reduce emissions by 2020 and 2050, and will encourage other nations to rapidly limit their own emissions. … Though Canadian emissions represent only a small fraction of global emissions, it is important for a rich and developed nation such as Canada to lead by example". The Brief further states: "We commend the federal government for its commitment to a '20% reduction in greenhouse gas emissions from 2006 levels by 2020, and a 60 to 70% reduction from the 2006 level by 2050', however, more immediate actions are required."

The 2013-2014 *Updated Statement on Human-Induced Climate Change* states "Further CO_2 emissions will lead to greater human-induced change in proportion to total cumulative emissions. Meaningful interventions to mitigate climate change require a reduction in emissions. To avoid societally, economically, and ecologically disruptive changes to the Earth's climate, we will have little choice but to leave much of the unextracted fossil fuel carbon in the ground."

The 2018 *Updated Statement on Global Warming of 1.5°C* states that "Limiting global warming requires staying within a carbon emissions budget. … In order to avoid exceeding the 1.5°C limit, net CO_2 emissions must be cut by about half by 2030, reaching effectively zero (accounting for anthropogenic CO_2 removals) around 2050. Furthermore, emissions of methane and black carbon need to be cut. Achieving these reductions – which is known as mitigation – requires rapid and far-reaching transitions in energy systems, land use, urban planning, infrastructure (including transport and buildings), and industry. The scale of these systems transitions is unprecedented, and implies deep emissions reductions in all sectors." Further, "The report suggests that Canada's emission reduction targets are insufficient to limit warming to 1.5°C and will need to be strengthened if Canada is to do its fair share in reducing global carbon emissions".

About the Author

John is a Scientist Emeritus at BIO, after spending most of his career there as an oceanographic research scientist and manager. His scientific outputs can be found at https://www.researchgate.net/profile/John_Loder.

His past CMOS contributions have included being a member of the national executive and the chair of three national committees and Halifax Centre. His past recognitions have included the Tully Medal from CMOS and multiple Scientific Excellence recognitions within DFO.

The National Biodiversity Cryobank of Canada (NBCC)

The National Biodiversity Cryobank of Canada (NBCC), located at the Canadian Museum of Nature's (CMN) Natural Heritage Campus (1740 Pink Road, Gatineau (Aylmer Sector, Quebec), is the result of a donation by the Beaty family and officially opened in September 2018.

The NBCC is a natural history biorepository of specimens from across Canada and abroad, with a capacity for over a million standard 2 mL cryovials. This state-of-the-art facility uses innovative LN2 freezer technology and greatly enhances the CMN's ability to store frozen collections at -170°C.

The core objective of the NBCC is to provide excellent specimen care with easy access for scientific use. Storage is available for vouchers from research projects outside of the CMN. The collections may contain representatives from all kingdoms of taxonomic classification in the form of tissues, environmental samples, phenotype vouchers, and DNA extractions. As an extension of CMN's collection facility, the operation of the NBCC is compliant with all other policies and procedures for the CMN.

For more information about the facility, send inquiries to nbcc-cncb@nature.ca, visit our webpage (https://nature.ca/en/research-collections/collections/cryobank), or write to National Biodiversity Cryobank of Canada, Canadian Museum of Nature, P.O. 3443, Station D, Ottawa, Ontario, K1P6P4, Canada.

canadian museum of nature
nature
musée canadien de la nature

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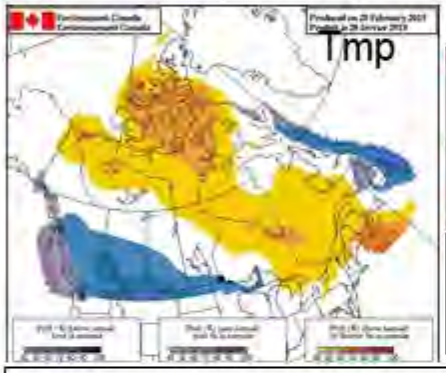
Canada

Seasonal Outlook for the spring 2019 (MAM) based on the official CanSIPS forecast issued on the 28th Feb. 2019

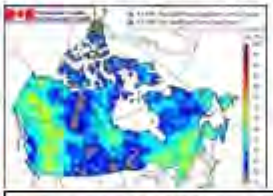
By Marko Markovic, Bill Marryfield and Marielle Alarie

Temperature: odds favour above normal spring in the east, below normal spring in the west. The highest probabilities (>60%) for a warm spring are in the Maritimes, and over the Canadian Archipelago while in southern QC and ON this probability is at least 40%. Below normal spring (40% or more) is expected across the central Prairies stretching to BC. The highest below normal probability is in southern AB an SK (up to 60%). Coastal BC will likely experience near normal spring.

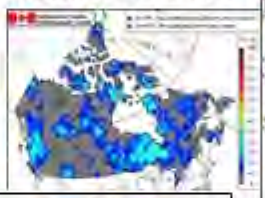
Equal chances for below/near/above normal precipitation across most of Canada. There is a probability of >40% for above normal precip. over the Maritimes, central QC and southern AB and SK. Below normal probabilities of at least 40% are expected over central western BC and over some scattered regions of central AB.



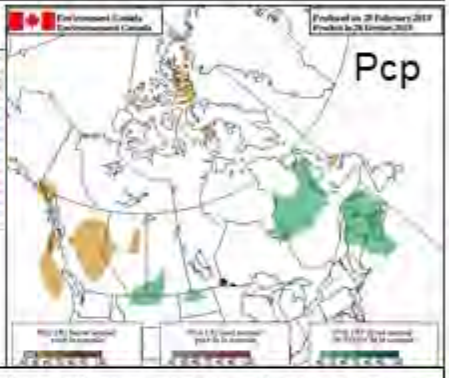
Historical Skill, Tmp



Historical Skill, Pcp



CanSIPS MAM18 forecasted Indices:
Nino3.4 = 0.77 (weak El Nino)
PDO = - 0.71 (moderate negative phase)



What will influence the next season? There are currently weak El Nino conditions in the central equatorial Pacific that are forecast to persist throughout the spring 2019. Historically, El Nino has a mild warming impact over Canada in spring. This year, in combination with a negative **PDO** index, it is not likely to have much warming effect over Canada while a shift of the subtropical jet stream to the north will likely bring below normal temperatures to the western and Prairie Canada.
According to the ENSO forecast issued by International Research Institute (IRI), there is a >50% probability that the El Nino conditions will persist throughout this spring. Positive but weak **NAO** index (according to the NOAA/ CPC prediction) is forecasted at least until mid-March after which the forecasting skill is low. Positive NAO is historically linked with above average temperatures across northeastern Canada. ***PNA*** index will likely turn positive but weak by mid March according to the CPC, providing a weak warm influence across Canada.

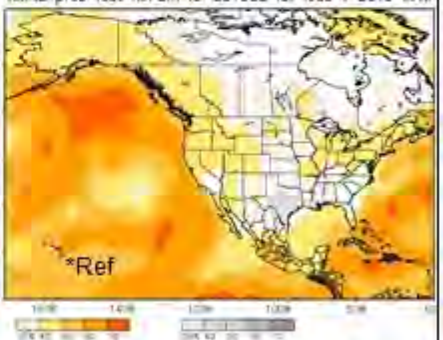
DJF18/19 Obs. Categories

DJF18/19 CanSIPS Catgs.

Verification DJF: Temperature: aside from the north western and far northern Canada, most southern regions are missed by the last winter's forecast.

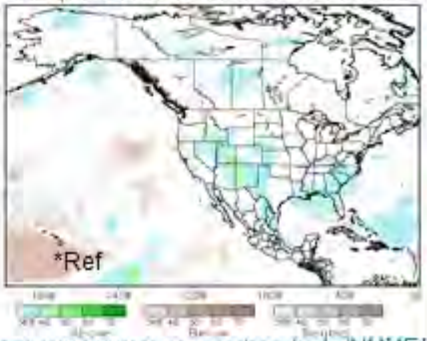
Seasonal forecast by other centers: Temperature: There is a significant difference between CanSIPS and the longer lead forecast from NMME (upper figure) in all Canadian regions. NMME is forecasting equal chances for temperature probability in the northern, central and eastern Canada. According to the NMME there is slightly elevated probability for above normal temperatures over the west coast. Over the eastern Great Lakes region both systems agree on forecasted probabilities of >40% for an above normal Spring.

NMME prob fcst TMP2m IC=201902 for lead 1 2019 MAM



Precipitation: Like CanSIPS, the longer lead forecast from NMME (lower figure) predicts equal chances for below/near/above normal across most Canadian regions. However differences are seen in the locations where these probabilities are elevated to >40% (e.g. central SK, Maritimes and BC).

NMME prob fcst Prate IC=201902 for lead 1 2019 MAM



*Ref: http://www.cpc.ncep.noaa.gov/products/NMME/

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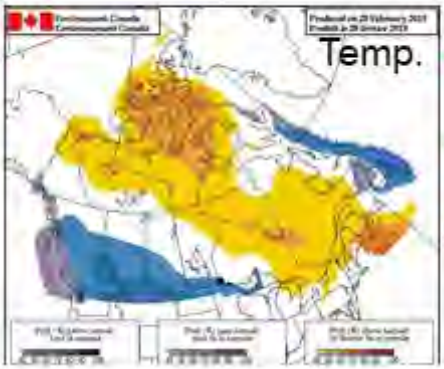
Prévision saisonnière pour le printemps 2019 (MAM) basée sur la prévision officielle de SIPSCan, émise le 28 fév. 2019

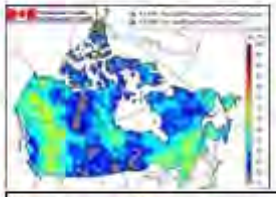
Par Marko Markovic, Bill Merryfield et Marielle Alarie

Température: Probabilités favorables d'observer des valeurs au-dessus des normales sur l'est, et sous les normales sur l'ouest. Les probabilités les plus élevées (>60%) d'un printemps doux se retrouve sur les Maritimes et sur l'Archipel Arctique, tandis que sur l'ON et le QC, cette probabilité est de 40 à 60%. Un printemps sous les normales est prévu (prob. 40 à 60%) sur le sud et le centre des Prairies et la C-B. La plus forte probabilité est prévue sur le sud de l'AB et de la SK. Près de la côte ouest, les températures devraient être près de la normale de saison.

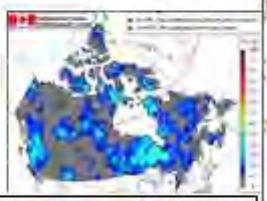
Chance égales d'observer des précipitations inférieures, près ou au-dessus des normales sur la plupart des régions du Canada. Sauf pour les Maritimes, le nord du QC, le sud de la SK et de l'AB où une probabilité >40% est prévue d'observer des précipitation supérieures à la normale ce printemps. Une probabilité >40% d'observer moins de précipitations sur le centre de l'AB et plusieurs régions de la C-B est anticipée.

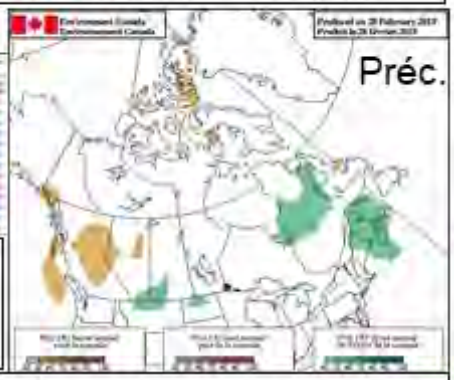


Habileté historique, temp



Habileté historique, préc.





Indices climatiques prévus par SPISCan pour MAM19:
Nino3.4 = + 0.77 (faible El Nino)
ODP = - 0.71 (phase négative modérée)

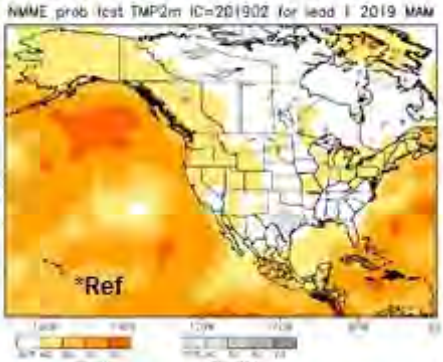
Qu'est-ce qui influencera notre saison? Il y a présentement un faible El Nino observé sur les eaux équatoriales du Pacifique, et ce dernier devrait se maintenir jusqu'au printemps. Selon la prévision de l'ENSO émise par l'International Research Institute (IRI), la probabilité d'observer un El Nino jusqu'au printemps est de plus de 50%. Historiquement, un El Nino a un léger effet de réchauffement sur le Canada au printemps. Cette année, combiné avec une **ODP** (PDO en anglais) négative, il ne devrait pas y avoir d'effet de réchauffement important au Canada, tandis que le déplacement du courant jet subtropical vers le nord entreinera probablement des températures inférieures à la normale sur l'ouest et les Prairies canadiennes. Une phase positive mais faible de l'indice **ONA** (NAO en anglais), selon le CPC/NOAA est prévue au moins jusqu'à la mi-mars, après quoi l'habileté de prévoir est faible. Une ONA positive est historiquement liée aux températures supérieures à la normale dans le nord-est du Canada. L'indice **PNA** (Pacific-North American teleconnection) deviendra probablement positif mais faible d'ici la mi-mars, selon le CPC, produisant une faible influence sur le temps doux à travers le Canada.

DJF18/19 Catégories obs.

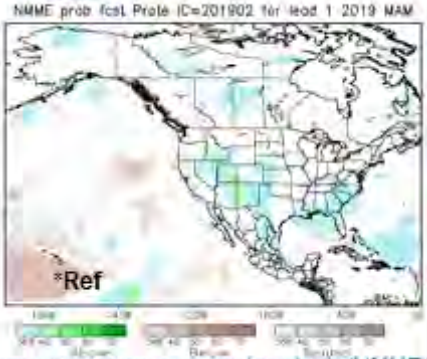
DJF18/19 SIPSCan Catgs.

Vérification DJF1819: Température: à l'exception du nord-ouest et du nord canadien où la prévision a bien vérifié, la prévision de l'hiver a été manquée sur la majorité des régions du sud du Canada.

Prévisions saisonnières des autres centres.
Température: Il y a des différences significatives entre SPISCan et les prévisions du NMME (figure supérieure ci-dessous) sur toutes les régions du Canada. NMME (North America Multi-Model Ensemble) prévoit des probabilités égales pour les températures sur le nord, le centre et l'est. Cependant sur la côte ouest, il y a une faible probabilité d'observer des températures supérieures à la normale. Sur l'est des Grand-Lacs, les deux systèmes de prévisions sont en accord pour prévoir, avec une probabilité >40%, un mercure supérieur à la normale de saison ce printemps



Précipitations: Tout comme SPISCan, la prévision à long terme du système NMME (figure ci-dessous) prévoit d'observer de façon égale des valeurs sous/près/au-dessus des normales pour la majorité des régions canadiennes. Par contre, quelques différences sont observées localement où les probabilités prévues sont > 40% (e.g. le centre des Prairies et localement sur les Maritimes.



***Ref:** http://www.cpc.ncep.noaa.gov/products/NMME/

Article: The Next Generation of Arctic Researchers

Supporting the Next Generation of Arctic Researchers

Chantal Mears, Dalhousie University

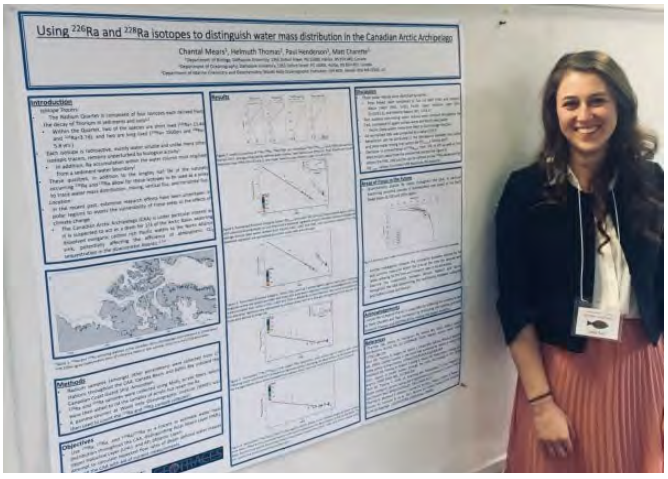
*I had the pleasure of chatting with Dalhousie undergraduate student Chantal Mears at the 2018 CMOS Congress in Halifax. Chantal went on to win the **ASL Environmental Sciences** Best Student Poster prize (for her poster titled: Using 226Ra and 228Ra isotopes to distinguish water mass distribution in the Canadian Arctic Archipelago) at the congress, and I was not surprised. She is a great communicator and full of passion for her studies, and for working to support a better understanding of our oceans. Here, Chantal tells us a bit about the important work that she is involved with in understanding ocean dynamics in the Canadian Arctic.*

Sarah Knight, CMOS Bulletin Editor

About The Project

Climate change headlines globally are emphasizing how deviations in environmental conditions can alter an area's physical, geological, chemical, and biological processes, especially in susceptible regions like the Arctic. The Canadian Arctic, which provides a vital link between the North Pacific and North Atlantic via the Canadian Arctic Archipelago (CAA), is no exception. Spanning from 120°W-80°W, the CAA transits approximately 1/3 of the volume of the Arctic Ocean eastward to the North Atlantic (Coachman & Aagaard, 1974). This is of particular interest as the cool, low alkaline Arctic waters dispersed along the Eastern edge of the CAA into Baffin Bay are responsible for carbon sequestration, as well as instigating deep water formation and contributing to thermohaline circulation in the North Atlantic (eg. Aagaard & Carmack, 1989; Burt et al., 2016; Curry et al., 2011; Hamilton & Wu, 2013; Ingram & Prinsenberg, 1998; Rahmstorf, 2002; Shadwick et al., 2011). Furthermore, these key characteristics allow the CAA to have the potential to act as an early warning system for the effects of climate change globally.

Despite the region's importance, the harsh and remote location of the CAA, as well as its complex bathymetry and topography, pose severe challenges to the understanding of the area's regional oceanography and its responses to climate change (Ingram & Prinsenberg, 1998; Kliem & Greenberg, 2003; Melling, 2000). Our study combated this issue by using the two long-lived Radium (Ra) isotopes from the Radium Quartet, 226Ra and 228Ra (with half-lives of 1500yrs and 5.8yrs, respectively) as tracers for water mass origin and distribution (Charette et al., 2014, 2016; IAEA, 2011; Moore et al., 1980). These radio-isotopes make ideal tracers, as in addition to their long half-lives, they are mostly water soluble and unperturbed by biological activity. Therefore, the quasi- conservative 226Ra and 228Ra isotopes, which are produced by the decay of their largely particle bound Thorium parent isotopes (232Th and 230Th), are capable of tracking water mass dispersion away from coastal and shelf systems. With this understanding, and help from additional chemical constituents, our study was able to identify unique distribution patterns of the Ra isotopes as well as solidify previous findings related to the distinction between upper and lower water column, bulk flow patterns, as well as the connection between the Pacific and Atlantic water masses across the 200 isobath. To complement these results, a Principle Component Analysis (PCA) was preformed in order to provide new insights into the water masses and their unique flow patterns throughout the CAA. Lastly, the PCA was able to yield robust salinity based "apparent" end members for the Ra isotopes and some of the chemical constituents.



Chantal Mears, pictured at the 2018 CMOS Congress in Halifax, beside her prize-winning poster.

Moving forward I hope that this study can provide a springboard for future research initiatives, emphasizing the use of radioactive isotopes and trace metals to distinguish water mass distributions and ocean trajectories, thus, encouraging attentive focus to crucial keystone regions such as the Arctic and the long-term regional and global effects of climate change. I sincerely hope that my research has the opportunity to trigger changes even on the smallest scales, and is capable of inspiring and influencing future research in this important and vulnerable area of study.

An Undergraduate's View of Research and Communication

Further pursuit of this project allowed me to attend the 2018 CMOS Congress in Halifax, where I won the ASL Environmental Sciences Best Student Poster prize. Being my first science conference, this was an exceptional opportunity to meet many brilliant researchers and learn about inspirational projects undertaken by students similar to myself from across Canada. This experience emphasized the importance of science communication, where although the majority of scientific research takes place in the field or behind a desk, effective communication is a critical step in broadcasting research. Due to this, I am extremely appreciative to have had the opportunity to refine my presentation skills, express my research to a panel of peers, gain insightful outlooks on my results, and establish crucial research connections, which lastly, I hope to be able to use in the future. Overall, my participation in the CMOS congress gave me an immense confidence boost, and further encouraged me to pursue a Masters in this field, which with luck I will be starting in the fall.

About Me

By definition, my undergraduate degree defines me as a biology student, but I am extremely grateful for the introduction to the world of chemical oceanography by Dr. Helmuth Thomas, who with the Canadian GEOTRACES initiative made this project possible for me. Particular thanks is awarded to Matt Charette and Paul Henderson at WHOI for analysing the samples collected in 2015 and now moving forward, aiding me in the publication process. Additionally I am also very grateful for the many staff in the Dalhousie Oceanography Department, who helped me tackle the countless unforeseen obstacles I encountered throughout this project. Without all this help, I would not have had the opportunity to pursue this project fully, explore in depth what results my data held, and above all learn a tremendous amount about science.

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The Importance of Supporting Young Researchers

ASL Environmental Sciences Inc. is a physical oceanographic consulting and instrumentation company, with over 40 years of experience in oceanographic, acoustic, remote sensing and ice research products and scientific consulting services. We provide clients with consulting services including: Flow Measurement, Numerical Modeling, Wave Measurement & Analysis, Sediment Transport and Ice Studies. Our products include the well-known, industry standard Ice Profiling Sonar (IPS) and the Acoustic Zooplankton Fish Profiler (AZFP), deployed in hundreds of lcations world-wide.

We believe it is very important to encourage young researchers interested in oceanographic and environmental science, as many of the most pressing issues facing the world today require increasing knowledge and understanding in those sciences. New generations of scientists will be key to progress our understanding of the physical environment, and we are happy to be able to sponsor the Best Student Poster Prize at the annual CMOS Congress to develop that interest.

Many aspects of the world's oceans are changing rapidly, and while the problems may seem large and daunting, the energy and enthusiasm of young researchers to address them is vital for the future.

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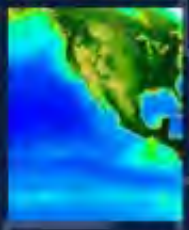

Sea Ice Analysis and Forecasting

Review by André April, Environment and Climate Change Canada

Edited by Tom Carrieres, Mark Buehner, Jean-François Lemieux and Leif Toudal Pedersen, Cambridge University Press, Hardback, 219 pages, ISBN: 9781108417426, $ 143.95 (CAD)

Sea ice is an important indicator of climate change as recent observations of declining ice amounts in the Arctic show. Automatic predictions available in real time are comparable to numerical environmental prediction models and may be very beneficial for national ice forecasting services, with applications to research and transport sectors, for example.

The authors start by discussing sea ice physics and the related numerical modelling techniques needed to produce forecasts, like the ones produced for weather by large-scale operational models. The chapter concludes with a list of recent and future important developments related to sea ice models. The next chapter, on sea ice observations, starts with an introduction to satellite remote sensing and the interaction between electromagnetic radiation and the surface. After comparing passive and active remote sensing, the authors discuss the approach and instruments most commonly used for the observation of sea ice parameters.

Chapter 4 introduces the concept of data assimilation, used to correct the background state by including useful information such as satellite observations, to produce a short-term forecast. Data assimilation techniques such as Kalman filtering, variational analysis, and ensembles, are described in a clear and precise manner. The next chapter describes different automatic prediction systems that are currently under active development in national ice services. These include the Regional Ice Prediction System (RIPS), the Global Ice-Ocean Prediction System (GIOPS) and the Canadian Seasonal to Inter-annual Prediction System (CanSIPS), all three from Environment and Climate Change Canada. The authors then discuss a fundamental step in the development and application of an automatic forecasting system: the validation of the system or measurement of forecast quality.

The last chapter speculates on how national ice information services could evolve and the benefits they could soon reap with the advent of automatic prediction systems. Students, ice forecasters and analysts, researchers, policy makers and specialists working in this field and in the national services will find this book useful.

La glace de mer est un important indicateur des changements climatiques comme l'indiquent les récentes observations de la diminution de la quantité de glace dans l'arctique et les scenarios climatiques futurs de la perte complète de la glace de mer pendant l'été dans l'arctique. Les systèmes de prédictions automatiques seront alors utiles aux usagers du transport ou de la recherche par exemple. Ces systèmes de prédictions automatiques offertes dans un temps réel deviennent alors comparables aux modèles numériques de prédictions environnementales.

Le deuxième chapitre aborde la physique de la glace de mer et ses techniques de modélisation numérique dans un but de produire une prévision, tel que produite par les modèles à grande échelle de type opérationnelle. Pour produire ce type de modèle, celui-ci doit résoudre quatre équations fondamentales : la conservation du momentum, la conservation de la masse, la conservation de l'énergie et enfin, la conservation du sel contenu dans la glace de mer. Dans le cas de la conservation du momentum, on s'attardera particulièrement à différents types de rhéologie pour étudier l'interaction glace-glace. Dans le cas de la conservation de la masse, on présente les modèles d'épaisseur à deux ou plusieurs catégories et la fonction de redistribution de celle-ci. La conservation de l'énergie fait alors intervenir les termes sources

thermodynamiques à l'interface glace-atmosphère et glace océan. Le chapitre se termine avec la présentation des développements importants récents et futurs pour les modèles de la glace de mer. On y retrouve par exemple des études de la trainée au-dessus et en-dessous de la glace, l'interaction vague-glace, la modélisation de la neige sur la glace, de la dynamique du sel et des mares de fonte. Le lecteur trouvera intéressante, au début du chapitre, la comparaison de la colonne d'eau sous la glace, différente dans l'arctique que dans l'antarctique, et son apport à la formation ou la fonte de la glace de mer.

Le chapitre suivant sur les observations de la glace de mer commence par une introduction à la télédétection satellitaire et l'interaction de la radiation électromagnétique avec la surface. Après avoir fait la différence entre télédétection passive et active, les auteurs présentent les méthodes et instruments les plus utilisés dans l'observation des variables de la glace de mer, telles la concentration, l'épaisseur et la dérive. Observation in situ ou près de la surface telles que celles des navires et bouées, ou celles d'instruments à bord d'avions ou d'hélicoptères sont aussi mentionnées. Il existe une large littérature sur les propriétés physiques et diélectriques de la glace de mer ainsi que les méthodes de télédétection pour l'étude de celles-ci. Le lecteur appréciera ici les diverses adresses web mentionnées dans le chapitre pour les résultats et représentations des différentes variables de la glace de mer.

Le quatrième chapitre introduit le concept de l'assimilation de données pour corriger l'état d'ébauche (background state) en incluant des informations utiles comme des observations satellitaires, dans le but d'obtenir notamment une prévision à court terme. Diverses techniques d'assimilation de données ont été développées (filtre de Kalman, approche variationelle) et originalement appliquées aux prévisions atmosphériques et océanographiques. L'application aux modèles de glace de mer est relativement récente et a fait intervenir de nouveaux défis, bien qu'elle ait déjà été effectuée avec succès sous certaines limitations. L'approche basée sur la méthode des ensembles a aussi été implantée aux modèles de prévisions couplées glace-océan et glace-océan-atmosphère et devient un objectif pour le développement futur des systèmes automatiques de prévisions. Les techniques d'assimilation de données sont un sujet complexe, mais les auteurs le présentent progressivement et de façon claire et précise, permettant au lecteur de suivre leur développement.

Le chapitre suivant présente la description de différents systèmes de prévisions automatiques qui sont activement en développement actuellement dans les services d'informations nationaux des glaces. Les auteurs commencent par le système de prédictions régional des glaces (RIPS), suivi du système de prédictions global glace-océan (GIOPS) et du système de prédictions interannuel et saisonnier canadien (CanSIPS), tous les trois d'environnement et changement climatique Canada. Par la suite, les auteurs font une description du système TOPAZ4 du centre de prévision marin de l'arctique de l'Union Européenne et du système de prévision Arctic Cap et océan global (ACNFS) (GOFS) de la US Navy. Pour chacun des systèmes mentionnés, une description du modèle de prévision, de l'assimilation des données et des développements futurs est effectuée. L'avantage ici repose sur les descriptions, qui ont été mises à jour en 2018, donc très actuelles.

Dans le sixième chapitre, les auteurs introduisent une composante fondamentale du développement et de l'application d'un système automatique de prévision, qui est l'évaluation du système. Dans le contexte de ce volume, l'évaluation est le processus de la mesure de qualité de la prévision. À l'aide de l'approche par catégorie, on pourra évaluer l'extension et la pression de la glace. Par l'approche continue, on pourra évaluer la concentration et l'épaisseur de la glace et enfin, par la méthode spatiale, on évaluera la lisière et la dérive de la glace. L'évaluation du système à l'aide des méthodes mentionnées est faite de façon simple, mais rigoureuse.

Le dernier chapitre, plus spéculatif comparativement au précédent, établit comment les services nationaux d'information de glace pourraient évoluer à la venue des systèmes de prévisions automatiques et les bénéfices qu'ils pourraient en recueillir prochainement. La venue probable de plusieurs nouveaux satellites et de stations de travail plus adéquates nécessitera de nouvelles procédures de travail. Les prévisionnistes contribueront, par leur expertise, à raffiner les prévisions provenant du système automatique, effectueront un contrôle de qualité du système et développeront de nouveaux produits surtout pour les régions où les impacts sont plus importants pour les clients.

Enfin, ce volume sera utile pour les étudiant(e)s, les prévisionnistes et analystes des glaces, pour les chercheur(e)s, les décideur(e)s et les professionnel(le)s travaillant dans l'industrie et les services nationaux des glaces. Chaque chapitre se termine avec une liste de références et des figures couleurs sont disponibles.

In case you missed it...

From CMOS Bulletin Volume 46, Number 6:

[Canada's Top Ten Weather Stories of 2018](#)
by David Phillips

[CMOS Statement on the IPCC Special Report on Global Warming of 1.5 deg C](#)

[A look at Ontario's Climate of the Future with the Ontario Climate Data Portal (OCDP)](#)
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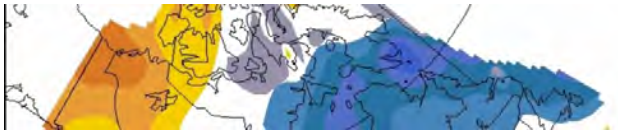

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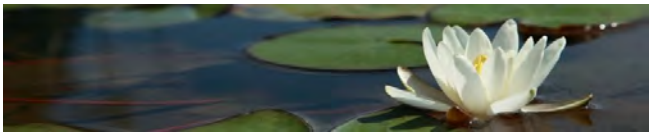

In Memoriam: [Terry Gillespie (1941-2018)](#) & [Bill Gault (1939-2018)](#)

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After 45 years in print, the Bulletin of the Canadian Meteorological and Oceanographic Society (CMOS) has gone virtual. See bulletin.cmos.ca for articles, news, events and updates from Canada's top meteorologists, climatologists and oceanographers.

Après 45 années de publication papier, le Bulletin de la Société canadienne de météorologie et d'océanographie (SCMO) passe en mode virtuel. Consultez le site bulletin.scmo.ca pour lire des articles, des nouvelles, des annonces d'événements et des faits nouveaux que partagent les éminents météorologues, climatologues et océanographes du Canada.

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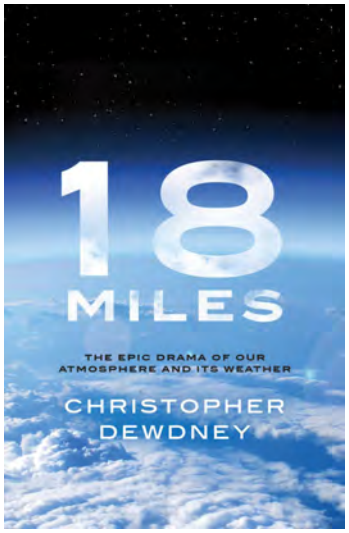
CMOS News

New Book Available for Review



18 Miles: The Epic Drama of Our Atmosphere and Its Weather, 2018. By Christopher Dewdney, ECW Press, ISBN 978-1-77041-346-7 (Paperback), 251 page, $21.95. (2019-1)

Other recent titles still available for review by a CMOS member:

A Bright Future: How Some Countries Have Solved Climate Change and the Rest Can Follow*,* 2019. By Joshua S. Goldstein and Staffan A. Qvist, Hachette Book Group, ISBNs 978-l-5417-241O-5 (hardcover), 978-1-5417-2409-9 (e-book), 288 pages, $34.00. (2018-9)

Trends and Changes in Hydroclimatic Variables: Links to Climate Variability and Change, 2019. Edited by Ramesh Teegavarapu, Elsevier Inc., ISBN 978-0-12-810985-4, 400 pages, US$127 (2017-10)

Tropical Extremes: Natural Variabilities and Trends, 2019. Edited by V. Venugopal, Jai Sukhatme, Raghu Murtugudde, Remy Roca, Elsevier Inc. ISBN 978-0-12.809248-4, 333 pages, US$110 (2018-11)

World Seas, An Environmental Evaluation. VOLUME III: Ecological Issues and Environmental Impacts, Second Edition, 2019. Edited by Charles Sheppard, Elsevier Inc. ISBN 978-0-12-805052-1, 633 pages, US$250. (2018-12)

Synoptic Analysis and Forecasting, An Introductory Toolkit, 2017. By Shawn Milrad, Elsevier, ISBN 9780128092477, 246 pages, US$125.00 (2018-1)

Ice Caves*,* 2017. Edited by Aurel Persoiu, Elsevier, ISBN 9780128117392, 752 pages, $225.00 (2018-2)

Rainbows: Nature and Culture, 2018. By Daniel MacCannell, The University of Chicago Press and Reaktion Books Ltd, ISBN 9781780239200, 208 pages, US$24.95 (2018-4)

Verner Suomi: The Life and Work of the Founder of Satellite Meteorology*,* 2018. By John M. Lewis, The University of Chicago Press and the American Meteorological Society, ISBN 9781944970222, paperback,168 pages, US$30.00. (2018-5)

The Deep Pull: A Major Advance in the Science of Ocean Tides.
By Walter Hayduk, FriesenPress, ISBN 9781525518706 (hardcover) $35.49, 9781525518713 (softcover) $27.49, 9781525517820 (eBook) $11.99, 251 pages. (2018-7)

Never reviewed a book before? No problem! Check out some of these past reviews for ideas: Ice: Nature and Culture; Weather in the Courtroom; Convenient Mistruths: A Novel of Intrigue, Danger and Global Warming.

Call for Nominations 2018 – Patterson Medal

I am pleased to announce the call for nominations for this year's celebration of excellence and exceptional accomplishments to residents of Canada for their distinguished service to Meteorology through the Meteorological Service of Canada (MSC) award; The Patterson Medal.

We ask nominators to prepare a short 2-page resume describing how the nominee contributed to meteorology as laid out in the Patterson Medal criteria. For additional information, please refer to the attached document, "Instructions to Nominators". The deadline for the submission of nominations for the 2018 Patterson Medal is March 22, 2019. Should you require additional information, please contact Jennifer Hebert by email at Jennifer.Hebert@Canada.ca or by telephone at 819-938-4388. Please distribute to those interested.

David Grimes Assistant Deputy Minister Meteorological Service of Canada

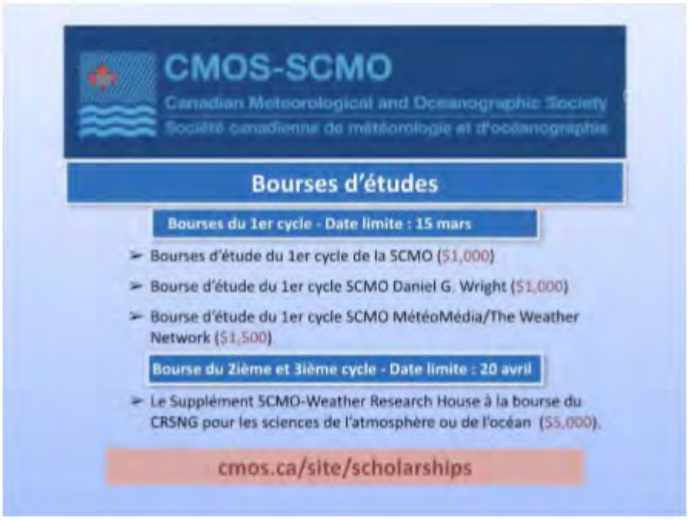
CMOS News

Long-time CMOS member Ray Desjardins recently awarded the Order of Canada

Ray's accomplishments include: developing a fast-response carbon dioxide analyzer to measure field scale crop photosynthesis and respiration, pioneering the use of instrumented aircraft to measure regional photosynthesis, evapotranspiration and other greenhouse gases and developing a greenhouse gas calculator that enables farmers to estimate the emissions from their own farms. During his 56-yr career, Ray was a key player of major national and international scientific initiatives to quantify the functioning of terrestrial ecosystems and their contribution to greenhouse gas exchange. He spent more than 30 years working with the Commission for Agricultural Meteorology of the World Meteorological Organization, leading a team to disseminate knowledge on the impact of agriculture on climate and helping transfer agricultural technologies to developing counties.

Ray has over 55 years of service with Agriculture Canada, and is a 25-year+ member of CMOS. He continues to actively contribute to our Society - recently Ray joined the CMOS Ottawa Centre executive and will be helping to plan our 2020 Congress in Ottawa.

Congratulations Ray!



IUGG Gold Medal for William Richard Peltier

The IUGG Gold Medal is bestowed on William Richard Peltier (University of Toronto, Canada) for “his scientific contributions that have been pioneering and profound in deep earth physics and climate system processes, and for his unselfish contributions to international scientific collaboration”. “Professor Peltier is certainly one of the few living geophysicists who have had profound influence in the field of the Earth system evolution. His work is truly interdisciplinary, involving geophysics, geodesy, glaciology, climate and paleo-climate science, atmospheric science and geophysical fluid dynamics”, IUGG Fellow Anny Cazenave (France) tells about her colleague.

W. Richard Peltier gain a BSc in Physics, in 1967 from the University of British Columbia, MSc and PhD, both in Physics, in 1969 and 1971, respectively, from the University of Toronto, and DSc from University of Waterloo in 2007. He moved from the position of Assistant Professor (1974) to Full Professorship of the University of Toronto in five years. He was visiting professor of UCLA (USA), NCAR (Boulder, Colorado), Cambridge University (UK), IPGP and ENS Paris (France), and University of Bergen, (Norway). W. Richard Peltier has distinction of having been made a Fellow of the American Geophysical Union, the American Meteorological Society, the Royal Society of Canada, and the Norwegian Academy of Science and Letters. He received a number of awards including the top prizes of Canada and the United States.

The Gold Medal will be presented to W. R. Peltier by the IUGG President at the Award Ceremony of the XXVII IUGG General Assembly on 13 July 2019 in Montreal, Canada. The Medalist will receive also a certificate of IUGG Honorary Membership, and a Fellow pin.

For information: Alik Ismail-Zadeh, IUGG Secretary General

2019 CMOS Congress at IUGG, Montreal, July 8-13.

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The CMOS Bulletin has moved on-line to http://bulletin.cmos.ca. Please continue to send articles, notes, workshop reports and news items to bulletin@cmos.ca. We will be accepting, reviewing, and publishing content on an on-going basis.

This publication is produced under the authority of the Canadian Meteorological and Oceanographic Society. Except where explicitly stated, opinions expressed in this publication are those of the authors and are not necessarily endorsed by the Society.

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Le *Bulletin de la SCMO* se trouve maintenant en ligne à http://bulletin.scmo.ca/. N'hésitez pas à soumettre notes, rapports d'atelier et nouvelles à l'adresse bulletin@scmo.ca. Nous accepterons, réviserons et publierons vos contenus sur une base continue.

Cette publication est produite sous la responsabilité de la Société canadienne de météorologie et d'océanographie. À moins d'avis contraire, les opinions exprimées sont celles des auteurs et ne reflètent pas nécessairement celles de la Société.

Thank you to Bob Jones and Paul-André Bolduc, for their continued editorial assistance and guidance.

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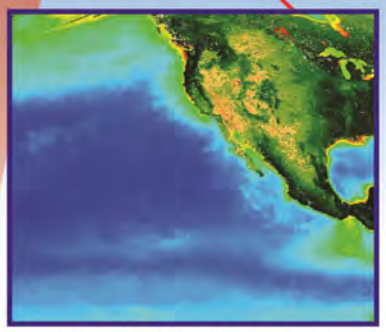

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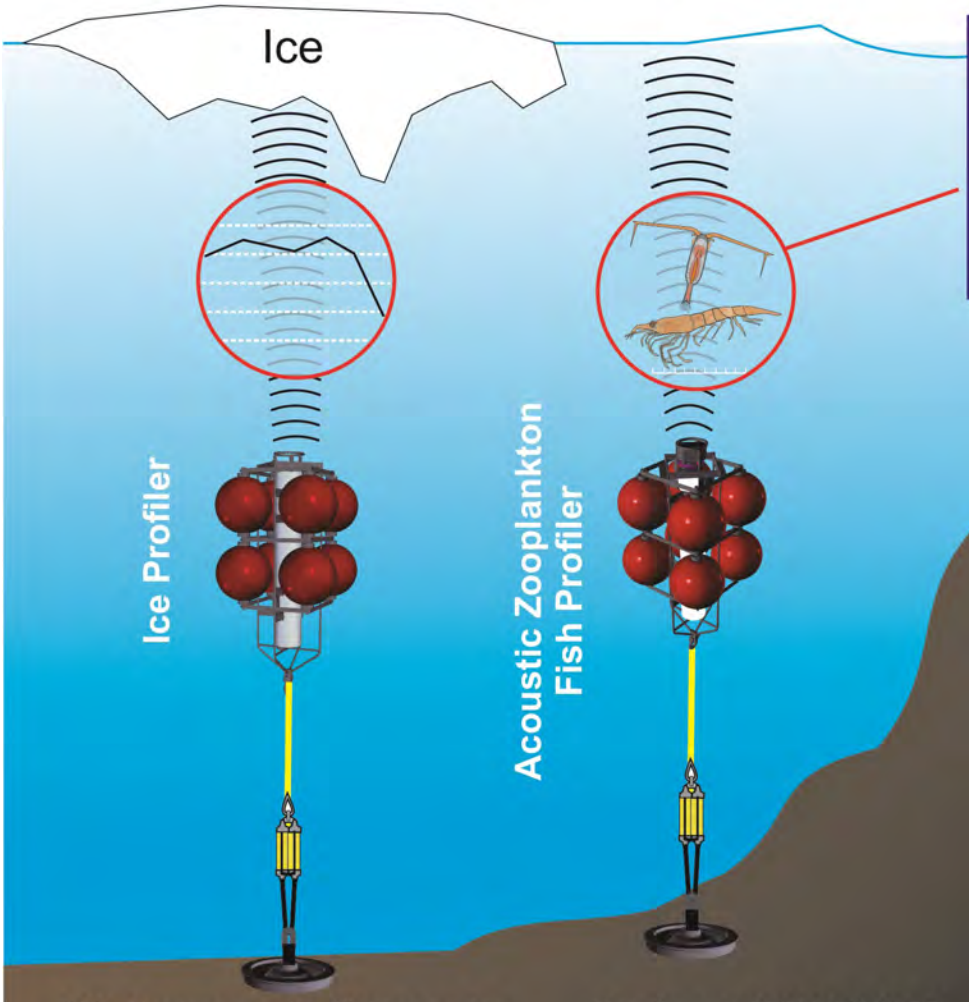

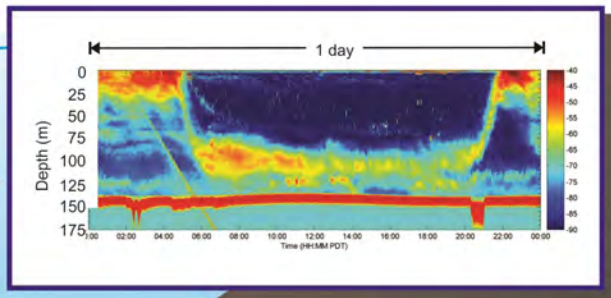

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