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CMOS

BULLETIN

SCMO

Canadian Meteorological and Oceanographic Society

La Société canadienne de météorologie et d'océanographie

June / Juin 2015

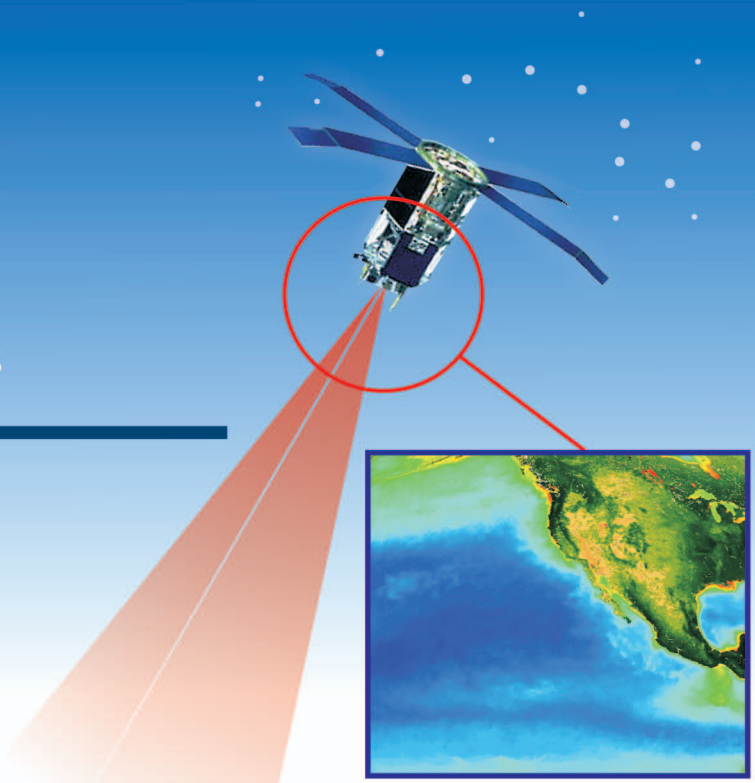
Vol.43 No.3

Typical Arctic River

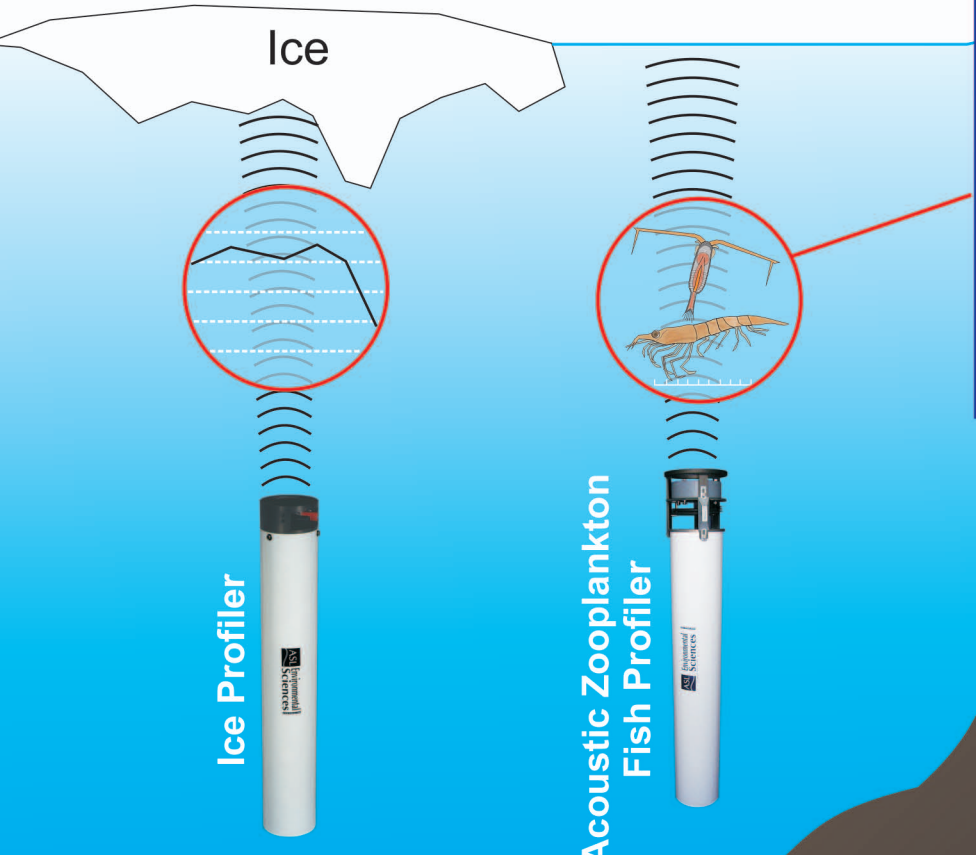
Cours d'eau typique de l'Arctique

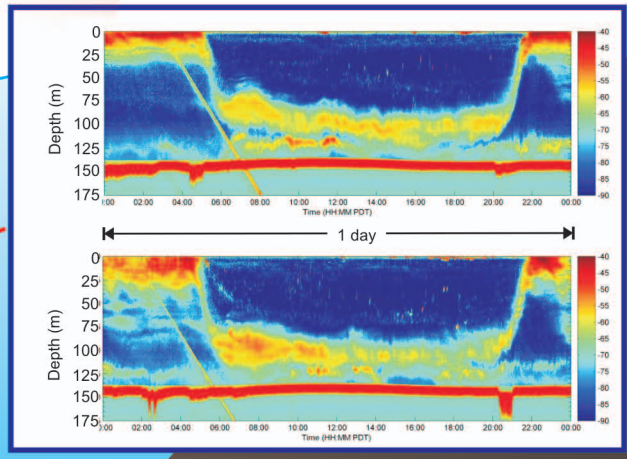
ASL Environmental Sciences

Oceanographic specialists/
Spécialistes océanographiques



Ocean colours are chlorophyll concentrations and land colours are NDVI





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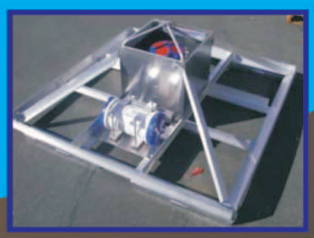

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.... Words from the Outgoing President

Friends and Colleagues:

Harinder Ahluwalia
Outgoing CMOS President
Président sortant de la SCMO

From Rimouski, Quebec to Whistler, British Columbia, my one year term has ended and the baton has been passed to the new team which brings new hope for the development of CMOS into a powerful organization.

First of all I would like to thank Environment Canada - Meteorological Service of Canada (EC-MSC) and the Department of Fisheries and Oceans (DFO) for their continued support of CMOS. We believe that CMOS is an important organization for both departments for the promotion of meteorology, climatology, and oceanography and their wholehearted support is necessary for its success.

Secondly, CMOS is mostly run by volunteers who accepted to take various roles in our Council. We are grateful to these individuals, many of whom work untiringly to serve their organization - CMOS - and their community in general. I would like to specially acknowledge the contribution of David Huard, Martha Anderson, André Giguère, Douw Steyn, and Pierre Gauthier. In addition I acknowledge the contribution of our national office which provides valuable assistance to keep our activities moving. There are many others who do an excellent job at the regional centres level. We greatly appreciate their contribution which is vital for the operation of CMOS. Then there are those who spend an inordinate amount of time organizing CMOS congresses in their regions. We gratefully acknowledge their contribution.

I believe that CMOS is a scientific and professional organization which has a great significance to the field of meteorology, climatology and oceanography in Canada. We believe that the membership fee is reasonable enough and if there is a clear value proposition/benefit seen by these individuals, they will rejoin CMOS. We are trying to create that value by increasing our activities.

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CMOS Bulletin SCMO
"at the service of its members / au service de ses membres"

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Cover page: A typical Arctic River that is poised for change in its hydrology and geochemistry. There are thousands of them throughout the Arctic Ocean margin, contributing to changes in fresh water and organic carbon in the Arctic Ocean, both of which impinge directly on its sensitivity to ocean acidification. Unlike ice cover that can be monitored from space, documenting the changes in these require a sustained network of stations established through international collaboration. To learn more, please read the article on **page 97** by Macdonald *et al*. Also of interest with regard to the Arctic is the report submitted by Ann McMillan on "*The unraveling of the Arctic*" on **page 102.**

Page couverture: un cours d'eau typique de l'Arctique, qui subira sans doute une modification de son hydrologie et de sa géochimie. Il en existe des milliers dans la marge océanique de l'Arctique. Ils influent sur les apports d'eau douce et de carbone organique dans l'océan Arctique. Ces deux flux agissent directement sur la sensibilité de l'océan relativement à son acidification. Contrairement à la couverture de glace marine, qu'on peut surveiller à partir de l'espace, relever ces changements nécessite le maintien d'un réseau de stations implantées dans le cadre de collaborations internationales. Pour en apprendre davantage, consultez l'article de Macdonald et collaborateurs, à la **page 97.** Autre sujet d'intérêt sur l'Arctique, le rapport qu'a soumis Ann McMillan, intitulé *"The unraveling of the Arctic"* (la détérioration de l'Arctique), à la **page 102.**

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.... Words from the Outgoing President

[Continued / Suite]

We have developed a new website and new powerful software to run the affairs of the society including congresses. This software can also be leveraged to help other organizations run their conferences/congresses.

Congresses are identified to be the most important activity of CMOS by its members and potential members because they provide them with an opportunity to present and keep in touch with the latest research in meteorology, climatology, and oceanography and to network with each other. Every effort is being made to make congresses interesting. However, constant reduction in attendees from EC and DFO is causing hardships to the success of the CMOS congresses. CMOS and EC and DFO staff believe that their presence at CMOS congresses gives them great opportunity to interact with their fellow scientists over the duration of the congress. The fact that they cannot attend congresses makes them lose interest in CMOS.

Even for organizing congresses in various cities, we need the assistance of EC and DFO staff. Therefore, for the betterment of meteorology and oceanography in Canada which must be an important objective of EC and DFO, they must provide support to CMOS and allow their staff to fully participate in all required ways. In addition, a very strong effort is required to involve users of meteorology to help plan and participate in these congresses.

We have created a formal relationship with the American Meteorological Society (AMS) through an MOU which we signed during the last year. The important elements of the MOU are being coordinated and implemented by the immediate past-presidents of the two organizations. All members are encouraged to take full advantage of this relationship. In addition to the joint CMOS-AMS Congress on ***"Tropics to Poles: Advancing Science in High Latitudes"*** this year in Whistler, we are co-sponsoring with AMS the 4th Meeting of the International Forum of Meteorological Societies (IFMS) to be held in New Orleans on January 13-14, 2016. This will be held simultaneously with the 96th Conference of AMS in New Orleans which is planned to be held between January 10-14, 2016.

In the World Weather Open Science Conference (WWOSC-2014) held in Montreal in August 2014, CMOS in cooperation with AMS cosponsored three panels consisting of 21 well known personalities of the world in the field of meteorology from the public, private, and university sectors. These panels which consisted of six panelists and one moderator each discussed "***The Future of the Weather Enterprise"*** and how the cooperation between these three sectors and users of meteorology can create a "Weather Ready Globe". An article authored by Jack Hayes, Harinder Ahluwalia and Jim Abraham on these sessions was published in the WMO bulletin. WMO (World Meteorological Organization) is so excited about its success that they want to use our report we have produced for them as an important basis for their **17th session of the World Meteorological Congress** (Cg-17) to be held in Geneva, Switzerland, from 25 May – 12 June 2015. A detailed report is also being produced.

Another similar relationship between CMOS and the Royal Met Society of UK already exists. In addition, we are working on an MOU between CMOS and the Indian Meteorological Society (IMS).

I believe that one of the benefits provided by CMOS should be the connection between scientists from different countries through their meteorological/oceanographic societies. We can advertise interesting projects conceived by our members and if they wish, find interested scientists through our connection with sister societies in other countries. In this highly interconnected world we need to establish relationships with as many societies as possible and IFMS provides that forum for multilateral relationships.

Thanks to Paul-André Bolduc and Savi Narayanan for their lead on *CMOS Bulletin SCMO* and Douw Steyn for his lead on *Atmosphere-Ocean* (*A-O*), these publications are doing very well. We sincerely thank Richard Asselin, the past chair of CMOS Publications who decided to retire after a long and great service to CMOS and we wish him all the best.

Some other important issues are information and advice as well as professional development of our youngsters, the future of our profession. Information and advice can come through congresses, local events at Centre level and especially for younger members through a mentoring program. We encourage EC and DFO to consider CMOS congresses to be very important events for networking of scientists and professionals and request that they send more of their staff to make these congresses successful.

In addition, information is also provided through Webinars and by having a repository of documents on our website and references to important documents at the website of our partners. We have started these programs and the assistance of EC staff (in particular Jennifer Milton for Webinars) and those involved in the Mentoring Program is greatly appreciated.

The P. Met program is considered to be an important program for ensuring that practitioners in our profession meet certain standards. Due to a low number of candidates interested in certification, ECO Canada has shelved the program. CMOS is looking into the feasibility of taking over this program.

This year we decided to have two tour speakers to cover Canada. This made it easier for the speakers to complete the program in time.

Two of the most important things left to resolve are:

- Strengthening Interaction with Public and Media; and,
- Recruiting Large Users.

Although some efforts have been made, a more consolidated effort is required to make these two programs successful. I plan to work more strongly on these two topics during the coming year.

CMOS is nothing but a confluence of all of our local centres whose activities are very important for its members because that is where major networking activities can take place. One of the most important activities the centres do very well is organizing congresses for which we commend them for their dedication. In addition to these congresses, we would like to see many more activities happening in the centres to create learning and networking opportunities.

We are working hard on various activities but we need a lot of help from the local centres. Some centres are doing very well while others need to strengthen their activities. It is only when all centres pitch in that this organization (CMOS) can reach the level it deserves.

Finally, the Fredericton Congress in 2016 is our 50th congress. Therefore, we need to plan a huge celebration to mark this occasion. We can also coordinate with AMS to help us celebrate the Golden Jubilee of our congresses.

This brings me to the point where I would like to warmly welcome the new team to be led by new President Martha Anderson and the proposed Vice-President Martin Taillefer, who are both very dedicated and capable people full of new ideas to take CMOS to a higher level. I believe that they can solidify all the initiatives we have started this year. I, from my side, will always be there to help them in achieving our cherished goal of making CMOS a powerful scientific and professional organization and I urge all those interested in this field to volunteer their services for the betterment of their profession.

Harinder Ahluwalia, Outgoing CMOS President

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 Incoming President

As I take over from Harinder Ahluwalia as president, I first must thank him for his dedication to CMOS. He formulated the Future of CMOS surveys last year as vice-president, and he has worked tirelessly as president to bring most of the ideas presented there to fruition. He truly wants to make CMOS a stronger and more valuable organization, and I intend to ensure we carry the momentum he has started in a number of key areas.

Martha Anderson
Incoming CMOS President
Présidente élue de la SCMO

With my term as president, we now move the national Executive of CMOS to Ottawa. The team from Montreal who held key positions for the past three years deserve our thanks, especially the three presidents Peter Bartello, Pierre Gauthier and Harinder Ahluwalia. This group handled a number of significant changes to the core functions of CMOS: finding a new executive director, the contract for a new website and database, and a new set of by-laws, to name a few. Our executive director Andrew Bell and the CMOS office staff and our new webmaster David Huard deserve a lot of credit for all the work done in getting the new website up and running in fall 2014. It provides a fresh face to our organization to match the drive for renewal that Harinder and the Montreal-based national Executive started. While all these folks were doing nice things, others were keeping the boat afloat including André Giguère, our corresponding secretary, and Nacéra Chergui, our treasurer. Thank you all for the work accomplished during the last three years.

My reflection after my year as vice-president is that CMOS still has challenges ahead to remain relevant in today's world that is dominated by the internet and social media. The generation of young scientists and professionals have the same need to network and share ideas as our older members, but they turn to modern methods to do this. CMOS has started running webinars, having the MetOcean group on LinkedIn and a Twitter Feed, but these each could go much further in their uptake. Travel for government employees has become increasingly limited, so we need to learn to connect on-line as a community.

Likewise, the general public and also other users of our weather and oceanographic advice (oil industry, forest fire

managers, fishers, policy makers, etc.) all naturally turn to the internet for information. The message from the "Future of the Weather Enterprise" at the 2014 World Weather Open Science Conference in Montreal is very valid: governments, academia, and the private sector need to work together to serve these interests. Government programs do not have the resources or the agility to keep up with the international private sector that is delivering on-line information in interesting and accessible ways. My hope is that CMOS can be a stronger catalyst for bringing together the diverse players in our scientific domains and ensure the very best information and advice is made available in this era of vast information accessibility. This can only happen if science professionals of all ages and fields of endeavour are willing to step forward and commit some time to keep CMOS relevant.

The new national executive of CMOS look forward to serving the membership from Ottawa for the next three years. I would like to thank the following people for stepping forward to join the team: Marty Taillefer as Vice-President, Marie-France Gauthier as Recording Secretary, Fiona Robertson as Corresponding Secretary and Boumy Sayavong as Treasurer.

Martha Anderson, Incoming CMOS President

.... Allocution du président sortant

Chers amis et collègues,

De Rimouski (Québec) à Whistler (Colombie-Britannique), mon année à la présidence est terminée. J'ai passé le témoin à la nouvelle équipe, qui nous apporte un espoir ravivé et qui transformera la SCMO en un organisme influent.

Tout d'abord, je remercie Environnement Canada-Service météorologique du Canada (EC-SMC) et le ministère des Pêches et des Océans (MPO) pour leur indéfectible soutien de la SCMO. Nous croyons que notre organisation demeure importante pour ces deux ministères en ce qui concerne la promotion de la météorologie, de la climatologie et de l'océanographie, et nous avons besoin de leur précieux appui pour réussir.

Deuxièmement, la SCMO est presque entièrement dirigée par des bénévoles, qui acceptent d'assumer les diverses fonctions de notre conseil d'administration. Nous sommes reconnaissants à ces gens, dont plusieurs travaillent sans relâche pour servir leur organisation, la SCMO, et leur communauté en général. Je salue notamment la contribution de David Huard, de Martha Anderson, d'André Giguère, de Nacéra Chergui, de Douw Steyn et de Pierre Gauthier. En outre, je suis reconnaissant à notre bureau national, qui fournit une aide précieuse afin que nos activités aillent de l'avant. D'autres effectuent un excellent travail au sein des centres régionaux. Nous les remercions de leur contribution, qui demeure vitale au fonctionnement de la société. Il y a aussi ceux qui travaillent d'arrache-pied pour organiser le congrès de la SCMO dans leur région. Nous leur exprimons notre gratitude pour leur contribution. Nous croyons que la SCMO est un organisme scientifique et professionnel d'importance pour les domaines de la météorologie, de la climatologie et de l'océanographie au Canada. Nous savons que les frais d'adhésion restent raisonnables et que s'il existe une réelle valeur ou un réel avantage à être membre, les gens renouvelleront leur adhésion. Nous nous efforçons d'accroître cette valeur en augmentant nos activités.

Nous avons développé un nouveau site Web et possédons maintenant un logiciel puissant facilitant le fonctionnement de la société, y compris les congrès. Ce logiciel nous permet aussi d'organiser les congrès d'autres groupes.

Les membres et membres potentiels considèrent que les congrès s'avèrent l'activité la plus importante de la SCMO. Et ce, parce que ces rencontres leur fournissent une occasion de présenter leurs plus récents travaux et de rester au courant des dernières avancées en météorologie, en climatologie et en océanographie, ainsi que de réseauter avec leurs collègues. Nous déployons tous les efforts nécessaires pour rendre les congrès intéressants. Toutefois, la participation des employés d'EC et du MPO décline constamment, ce qui mine le succès des congrès de la SCMO. Tout comme la société, le personnel d'EC et celui du MPO croient que leur présence au congrès s'avère une bonne occasion d'interagir avec leurs collègues scientifiques pendant les quelques jours de l'événement. Ne pas pouvoir assister aux congrès diminue leur intérêt pour la SCMO.

Même pour organiser les congrès dans les différentes villes, nous nécessitons l'aide des employés d'EC et du MPO. En conséquence, pour favoriser l'avancement de la météorologie et de l'océanographie au Canada, qui devrait demeurer un objectif important de ces deux ministères, ceux-ci doivent soutenir la SCMO et permettre à leur personnel de participer pleinement aux activités de la société. De plus, des efforts considérables sont requis pour mobiliser les utilisateurs de services météorologiques, afin qu'ils participent aux congrès et à leur planification.

Nous avons créé un partenariat officiel avec l'American Meteorological Society (AMS) en vertu d'un accord signé au cours de la dernière année. Les présidents sortants actuels des deux organisations se chargent présentement de coordonner et de mettre en œuvre les éléments importants de l'entente. J'encourage tous les membres à profiter pleinement de ce rapprochement. En plus du congrès conjoint SCMO-AMS intitulé **« Des tropiques aux pôles : faire progresser la science dans les hautes latitudes »** et tenu cette année à Whistler, nous commanditons avec l'AMS le 4e congrès de l'International Forum of

Meteorological Societies (IFMS), qui se tiendra à La Nouvelle-Orléans, les 13 et 14 janvier 2016. Celui-ci se déroulera parallèlement au 96e congrès de l'AMS, qui aura aussi lieu à La Nouvelle-Orléans, du 10 au 14 janvier 2016.

Lors de la Conférence scientifique publique mondiale sur la météorologie (WWOSC-2014), tenue à Montréal, en août 2014, la SCMO et l'AMS ont commandité trois panels de discussion composés de 21 personnalités mondiales marquantes, issues du domaine de la météorologie, et des secteurs public, privé et universitaire. Ces panels comportaient six conférenciers et un modérateur chacun. Ils ont permis de débattre de "**l'avenir de l'entreprise météorologique**" et de voir comment la coopération entre les trois secteurs visés et les utilisateurs de services météorologiques peut créer une société résistante aux intempéries. Un article que Jack Hayes, Harinder Ahluwalia et Jim Abraham ont écrit à la suite de ces séances a paru dans le *Bulletin de l'OMM*. L'OMM (Organisation météorologique mondiale) est si ravie du résultat qu'elle veut utiliser ce rapport, produit à son intention, comme base du **Dix-septième Congrès météorologique mondial** (Cg-17), qui se tiendra à Genève (Suisse), du 25 mai au 12 juin 2015. Un rapport détaillé est aussi en cours de production.

Une entente existe aussi entre la SCMO et la Royal Meteorological Society (Royaume-Uni). De plus, nous poursuivons les pourparlers avec l'Indian Meteorological Society (IMS) aux fins de collaboration.

À mon avis, la mise en rapport de scientifiques de différents pays, par le biais de sociétés météorologiques ou océanographiques, présente un avantage que devrait offrir la SCMO. Nous pourrions publiciser les projets intéressants que nos membres entreprennent et, le cas échéant, grâce à nos relations internationales avec des sociétés connexes, trouver des scientifiques qui montrent un intérêt pour ces projets. Dans ce monde hautement interconnecté, nous devons établir des liens avec autant de sociétés savantes que possible. L'IFMS offre une plateforme facilitant les relations multilatérales.

Grâce à Paul-André Bolduc et à Savi Narayanan, à la direction du *CMOS Bulletin SCMO,* et à Douw Steyn, à celle d'*Atmosphere-Ocean* (*A-O*), ces publications se portent très bien. Nous remercions sincèrement le directeur des publications sortant, Richard Asselin, qui a pris sa retraite après de longues années de services remarquables au sein de la SCMO. Nous lui offrons nos meilleurs vœux.

Autre point notable, le développement professionnel, ainsi que l'information et les conseils prodigués à nos jeunes, qui représentent l'avenir de notre profession. Les informations et les conseils peuvent se transmettre dans le cadre de congrès, d'événements locaux que les centres organisent et, pour les jeunes membres, du programme de mentorat. Nous encourageons EC et le MPO à considérer les congrès de la SCMO comme des événements incontournables pour le réseautage des scientifiques et des professionnels. Nous les prions de permettre davantage à leur personnel de participer à ces congrès fructueux.

En outre, l'information passe par des webinaires ou elle est archivée sur notre site Web. Des hyperliens mènent aussi aux documents importants de nos partenaires. Nous avons instauré ces programmes et sommes grandement reconnaissants de l'aide qu'offrent le personnel d'EC (notamment Jennifer Milton pour les webinaires) et ceux qui participent au programme de mentorat.

Le programme de certification des météorologistes professionnels (Mét. P.) est considéré comme étant important pour garantir que les spécialistes de notre profession respectent certaines normes. En raison du faible nombre de candidats se prévalant de cette certification, ECO Canada a mis le programme en veilleuse. La SCMO examine la possibilité de prendre ce programme en charge.

Cette année, nous avions décidé de couvrir le Canada avec deux conférenciers itinérants. De cette façon, ils ont pu terminer leur programme dans les délais impartis.

Deux des points prioritaires qui restent à régler sont :

- Renforcer les interactions avec le public et les médias;
- Recruter les grands utilisateurs.

Bien que nous ayons déjà déployé des efforts en ce sens, il nous faudra consolider ceux-ci afin d'assurer le succès de ces deux programmes. Je compte travailler d'arrache-pied sur ses deux enjeux, au cours de l'année qui vient.

La SCMO reste avant tout le regroupement de tous ses centres, dont les activités s'avèrent indispensables pour les membres. C'est au sein des centres que se déroulent les principales activités de réseautage. Les centres s'acquittent d'ailleurs toujours avec brio de l'une des activités capitales de la société, le congrès, et nous les félicitons de leur dévouement. En plus du congrès, nous souhaiterions voir de nombreuses autres occasions de réseautage et d'apprentissage au sein des centres.

Nous mettons toute notre ardeur à la préparation de diverses activités, mais nécessitons une aide considérable des centres régionaux. Certains centres s'en tirent très bien, tandis que d'autres devront dynamiser leur participation. Seuls les efforts de tous les centres peuvent élever notre organisation (SCMO) au niveau qu'elle mérite.

Finalement, notre 50e congrès se tiendra à Fredericton en 2016. Nous devons donc planifier une grande célébration, afin de marquer cette occasion. Nous pouvons aussi coordonner le congrès avec l'aide de l'AMS, pour célébrer ce jubilé.

Ce qui m'amène au point où j'accueille chaleureusement la nouvelle équipe, que dirigeront la nouvelle présidente, Martha Anderson, et le vice-président proposé, Martin Taillefer, qui sont tous deux aptes à mener la SCMO à un niveau inégalé, grâce à leurs nombreuses idées novatrices. Je crois qu'ils sont en mesure de renforcer toutes les initiatives que nous avons amorcées cette année. Je resterai toujours présent pour les aider à atteindre le but cher à la SCMO, devenir une organisation scientifique et professionnelle influente. Je prie instamment tous ceux qui partagent notre intérêt à ce sujet d'offrir leurs services pour l'avancement de leur profession.

Harinder Ahluwalia, Président sortant de la SCMO

.... Allocution de la présidente élue

Avant de remplacer Harinder Ahluwalia à la présidence, je dois d'abord le remercier pour son dévouement à la SCMO. Il a formulé les sondages sur le futur de la SCMO, l'an passé, en tant que vice-président, et il a travaillé sans relâche en tant que président, afin de concrétiser la majorité des idées que ces sondages ont mises à jour. Il désire ardemment transformer la SCMO en une organisation forte et utile. Je compte donc soutenir l'élan qu'il a imparti à nombre de grands enjeux.

Mon arrivée à la présidence s'accompagne d'un déplacement vers Ottawa de l'exécutif national de la SCMO. L'équipe de Montréal, qui a occupé les postes importants au cours des trois dernières années, mérite notre reconnaissance. Notamment, les trois présidents : Peter Bartello, Pierre Gauthier et Harinder Ahluwalia. Ce groupe a géré nombre de changements fondamentaux aux fonctions principales de la SCMO : la recherche d'un nouveau directeur général, le contrat pour le nouveau site Web et la base de données, et l'implantation du nouveau règlement, entre autres. Notre directeur général Andrew Bell, le personnel du bureau de la SCMO et notre nouveau webmestre David Huard méritent des félicitations pour le travail accompli afin de créer et de mettre en ligne le site Web renouvelé, à l'automne 2014. Le site offre une image rajeunie de notre organisation et celle-ci correspond à la modernisation que Harinder et l'exécutif national de Montréal ont amorcée. Tandis que ces personnes travaillaient sur des projets captivants, d'autres maintenaient le navire à flot, y compris André Giguère, notre secrétaire correspondant et Nacéra Chergui, notre trésorière. Merci à tous pour le travail réalisé au cours des trois dernières années.

Je suis d'avis, après une année passée à la vice-présidence, que la SCMO devra relever des défis afin de rester pertinente dans le monde d'aujourd'hui, qui est dominé par Internet et les médias sociaux. Les scientifiques et les professionnels des nouvelles générations éprouvent le même besoin de réseautage et de partage d'idées que leurs aînés, mais se tournent plutôt vers des méthodes modernes. La SCMO a commencé à présenter des webinaires, elle a créé le groupe MetOcean sur LinkedIn et possède un fil Twitter, mais ces activités pourraient être exploitées davantage. Le gouvernement limite de plus en plus les autorisations de voyages des fonctionnaires. Nous devons donc apprendre, en tant que communauté, à communiquer en ligne.

De même, le grand public et d'autres utilisateurs de nos services météorologiques et océanographiques (l'industrie pétrolière, les gestionnaires d'incendies de forêt, les décideurs, les pêcheurs, etc.) se tournent tous naturellement vers Internet pour obtenir de l'information. Le message qu'a formulé le panel sur « l'avenir de l'entreprise météorologique » lors de la Conférence scientifique publique mondiale sur la météorologie, tenue à Montréal, en 2014, demeure valide : les gouvernements, les universités et le secteur privé doivent travailler ensemble pour répondre à cette préoccupation. Les programmes gouvernementaux ne possèdent pas les ressources ou l'agilité pour suivre le rythme du secteur privé international, qui propose des informations en ligne, de façon conviviale et intéressante. Je souhaite que la SCMO puisse être un catalyseur important, qui regroupera les divers intervenants de nos domaines scientifiques, afin de garantir que les meilleurs conseils et renseignements sont offerts en ces temps de grande accessibilité à l'information. Cette fonction reste tributaire des professionnels de tous âges et de tous les domaines d'activités, et de leur volonté à s'engager dans la SCMO pour que celle-ci reste pertinente.

Le nouvel exécutif national de la Société se réjouit de servir les membres de la SCMO à partir d'Ottawa, pendant les trois prochaines années. Je remercie les personnes suivantes de s'être jointes à l'équipe : Marty Taillefer, vice-président; Marie-France Gauthier, secrétaire d'assemblée; Fiona Robertson, secrétaire correspondante; et Boumy Sayavong, trésorier.

Martha Anderson, Présidente élue de la SCMO

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Articles

Marine Environmental Observation Prediction and Response (MEOPAR)[1]

by Douglas W.R. Wallace[2]

Context - Changing Ocean Risks

The marine environment presents humankind with great economic opportunities coupled to major risks. While this has been the case throughout history, the modern human relationship with the ocean is impacted by a confluence of environmental change on one hand, and new economic and societal opportunities associated with changing uses of the marine environment on the other (Figure 1). This confluence creates some new risks, and is altering the patterns and significance of other existing risks.

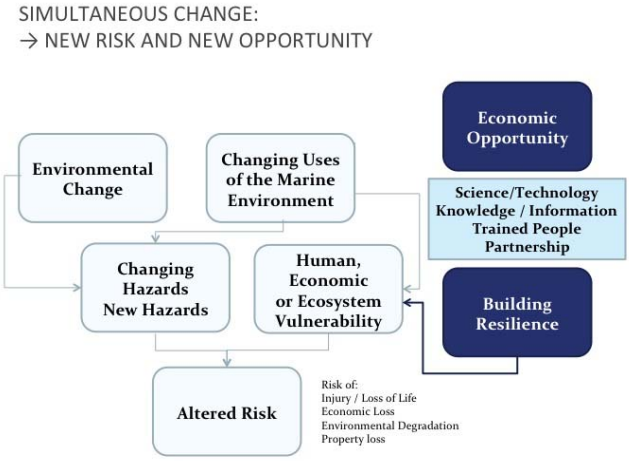

Figure 1: The societal, environmental and economic context for MEOPAR

"Our future depends on an informed relationship with the ocean."

Humankind's relationship with the ocean is the premise and context for the Marine Environmental Observation Prediction and Response (MEOPAR) Network: a national research network initiated in 2012 as one of a family of Networks of Centres of Excellence or "NCEs."

Supported by the Government of Canada, NCEs solve critical issues that require a collaborative approach and wide-ranging research expertise. The NCEs are academic-led, but are intended to be multidisciplinary and involve partners from industry, government, and not-for-profit organizations. NCEs aim to "enable Canadian researchers and students to work with receptor communities to accelerate the creation and application of knowledge." In other words, NCEs are very different from traditional funding instruments for academic research.

MEOPAR's vision is to: "deliver knowledge, technology, and people to enable Canada's communities and industry to enhance resilience and economic opportunity through an informed relationship with the changing marine environment."

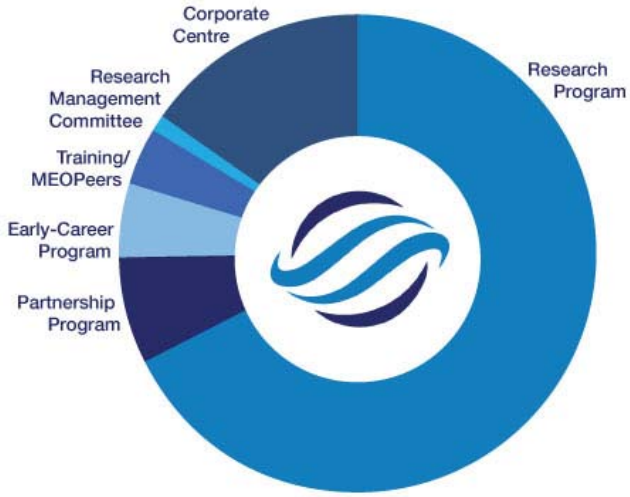

Figure 2: MEOPAR funding allocations

The MEOPAR Network

Managed by a Board of Directors, MEOPAR is a not-for-profit corporation with a corporate centre, hosted by Dalhousie University in Halifax. MEOPAR has a projected lifetime of 15 years and its present, first funding cycle (2012-2017) is supported by $25 million from the NCE program, as well as substantial partner contributions. These funds are allocated to a variety of programs (Figure 2) with the majority allocated to the Research Program. MEOPAR's

[1] First published in Canadian Ocean Newsletter, No.81, March 2015

[2] MEOPAR Scientific Director, Dalhousie University, Halifax, Nova Scotia

activity is guided by a strategic plan developed in close cooperation with the Board, and with advice from an independent International Scientific Advisory Committee. Responsibility for evaluation of the Research Program lies with MEOPAR's Research Management Committee.

MEOPAR Research

Research Projects: Typically, projects involve multiple investigators addressing research topics from a multidisciplinary perspective. These integrated projects are organized under two themes distinguished by timescale: **Theme 1** addresses issues with timescales of hours to a season, whereas **Theme 2** covers seasons to decades. Most are funded according to a three + two year model. Projects receive an initial three years of funding, and can apply for an additional two years, based on a mid-term review.

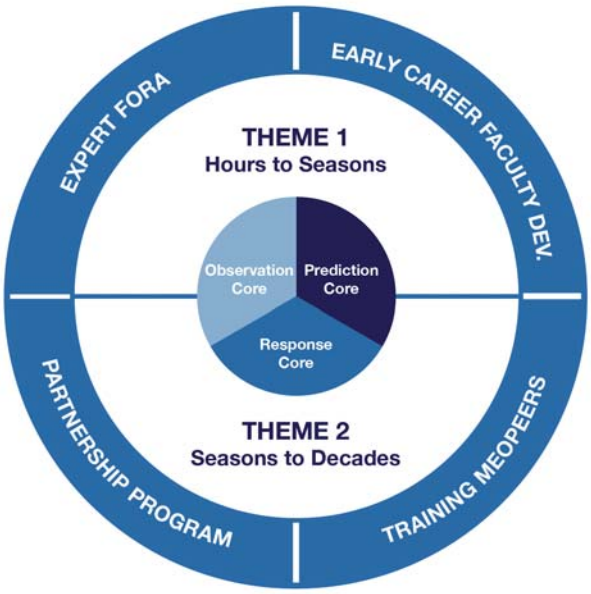

Figure 3: MEOPAR program overview

Projects are selected through *Open Calls for Proposals* organized by MEOPAR's Research Management Committee. An important selection criteria has been *user engagement* in both the formulation and conduct of the research. While MEOPAR supports fundamental research, it also places a strong emphasis on knowledge mobilization and research should be focussed on results that users want and will use. Another key criterion has been multidisciplinarity. MEOPAR seeks to lower barriers between researchers in the natural and social sciences and sees opportunities for new, important areas of research and training emerging at the interface between these two broad disciplinary areas.

At present, MEOPAR supports seven integrated projects under Theme 1, and six under Theme 2. For a complete overview of our research projects, visit http://meopar.ca/our-research/.

Research Cores: MEOPAR's projects require access to common technical expertise, new technologies and models, shared approaches, etc. Cross-cutting activities and expertise are supported by MEOPAR's Observation and Prediction Cores. MEOPAR is developing a third Response Core to support social and economic aspects of the research program.

Early-Career Faculty Development Program: MEOPAR is growing its researcher network, not only in terms of numbers, but also in terms of the breadth of available expertise. A funding program targeting new researchers recently awarded $1.2 million to 12 early-career investigators. MEOPAR is working with these investigators to integrate them, as appropriate, into the activities of existing projects and cores.

MEOPeer Training Program: Education and training of the next generation of highly qualified people (HQP) is a major role of the network. MEOPAR provides a range of training opportunities to engage the network's students and postdocs, or ***MEOPeers***, in activities that cut across projects (e.g. career development, training on project management, statistical programming, etc.). The MEOPeer network is self-organizing, and has its own program of online and regional meetings, as well as active participation in broader MEOPAR committees and events.

Partnership Program: MEOPAR promotes research and knowledge mobilization partnerships with organizations beyond academia that are impacted by marine risks or that can provide tools or capacity to address such risks. This includes industry, all levels of government, NGOs, First Nations, community groups, and associations.

The Partnership Program has a special role in incorporating stakeholders' needs, perspectives, and capabilities into MEOPAR's activities.

The Partnership Program has three components:

1. Workshops: MEOPAR supports workshops that involve both academic researchers and non-academic partners. These might focus on knowledge mobilization from existing MEOPAR projects or can be used to generate ideas for new areas of MEOPAR research.

2. Expert Fora: These bring together Canadian and International researchers and experts for intensive discussions about policy-relevant issues and research. Typically, a forum involves a policy outreach event or activity. MEOPAR held its first Expert Forum on Ocean Acidification in February 2015 and a 2nd forum is planned to address Ocean Data Management in fall 2015.

3. Project Partnerships: MEOPAR can co-fund projects that are initiated or motivated outside of academia. These should involve active participation in the research by partner organization investigators and/or cash or in-kind contributions. The latter may be in the form of equipment donation, equipment use, data provision, or sharing of facilities.

For more information about MEOPAR, please visit our web page at www.meopar.ca, follow us on Twitter (@MEOPAR_NCE) on LinkedIn (www.**linkedin**.com/company/**meopar**), or contact our Corporate Centre.

Retour sur 2014 - Finalistes des événements météorologiques marquants de l'an passé[3]

par David Phillips[4]

Note du Corédacteur: Les finalistes des événements marquants sont des épisodes météorologiques qui ont été considérés, évalués, puis classés mais qui n'ont pas atteint la liste des dix événements les plus marquants de l'année, liste publiée dans le *CMOS Bulletin SCMO* en Février 2015 (Vol.43, No.1, page 24-26).

1. Début janvier, une tempête paralyse le Canada atlantique

Alors que l'hiver ne faisait que commencer mais n'était déjà plus le bienvenu, une forte tempête arrivant de Cape Cod le lendemain du jour de l'An a asséné un coup brutal au Canada atlantique. Elle a commencé par de la neige abondante, qui s'est transformée en blizzard aveuglant, suivi par un refroidissement éolien mordant pendant plusieurs jours. Il est tombé toute une gamme des précipitations variant entre 40 cm de neige et 47 mm de pluie, y compris de 5 à 10 mm de pluie verglaçante à certains endroits du centre du Nouveau-Brunswick. Ajoutons au mélange des bourrasques de vent qui ont atteint 60 km/h et créé des conditions de voile blanc, de la pluie battante et de la neige poudreuse qui a causé plus de problèmes que les accumulations.

La tempête a frappé particulièrement fort en Nouvelle-Écosse, où elle a entraîné la fermeture de magasins, des retards dans les déplacements, des conditions de conduite dangereuses, ainsi que l'annulation de vols. La plupart des universités, des campus collégiaux et des bibliothèques ont aussi fermé leurs portes, ainsi que de nombreuses garderies. Les autobus ont cessé de circuler et le service de traversier entre les provinces a été annulé. Des inondations se sont produites localement le long de la côte atlantique de la Nouvelle-Écosse, près de Liverpool, parce que le niveau des eaux était plus élevé qu'à la normale et que d'énormes vagues déferlaient. Des tempêtes de verglas ont privé de courant des milliers d'habitants de l'Île-du-Prince-Édouard et les ont laissés dans le noir. Une fois retombée, la tempête a fait place à un temps glacial, le refroidissement éolien s'établissant entre -35 °C et -45 °C, un froid peu commun dans les Maritimes. Il s'en est fallu de peu qu'un record de froid ne soit battu à Saint John le 2 janvier, journée où le thermomètre est descendu à -26,3 °C et où le refroidissement éolien était de -39 °C; un record a été enregistré à Edmundston, où les températures sont descendues à -38,1 °C. Des records ont également été établis à Bathurst, Charlo, Saint-Léonard Moncton et Fredericton.

Le mauvais temps s'en est pris au réseau électrique du Nouveau-Brunswick, la pluie verglaçante, le vent et la pluie privant d'électricité des milliers d'habitations et d'entreprises. C'était la deuxième tempête de verglas importante en deux semaines. Ensemble, la tempête avant Noël et celle du lendemain du jour de l'An ont coûté 12 millions de dollars en heures supplémentaires à Énergie NB pour la réparation des lignes de transport d'électricité et l'infrastructure endommagées par la mauvaise température. Ces deux tempêtes sont celles qui ont causé le plus de dommages au réseau électrique de la province depuis des décennies, des dommages dont l'ampleur et le coût dépassent de beaucoup ceux de la célèbre tempête de verglas de l'Est canadien en 1998.

La violente tempête qui s'est abattue sur les Maritimes a frappé aussi la presqu'île Avalon, à Terre-Neuve, dans les jours qui ont suivi. Les habitants de St. John's ont constaté au réveil que la grosse tempête leur avait laissé près de 40 cm de neige au sol. Bien que la tempête ne se soit pas attardée, des vents puissants de 111 km/h ont persisté et ont amoncelé la neige en bancs monstrueux, et créé de la poudrerie et des voiles blancs qui ont rendu les conditions de conduite et de marche très périlleuses. La tempête a causé l'annulation des vols, l'interruption du transport en commun et la fermeture des routes, des bureaux gouvernementaux, des universités et des entreprises. Ce sont toutefois les pannes de courant qui sont survenues pendant une des périodes les plus froides depuis des années (facteur éolien de -35 °C) qui ont fait le plus mal. Pour atténuer les conséquences, les responsables ont ouvert partout dans la province des centres où les gens pouvaient aller se réchauffer. Ironiquement, dans les jours qui ont précédé la tempête, les autorités provinciales

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[3] The English version was published in the April 2015 issue of *CMOS Bulletin SCMO*, Vol.43, No.2, pages 58-62.

[4] Climatologue principal, Service Météorologique du Canada, Environnement Canada, Downsview, Ontario, Canada

avaient décidé de couper le courant par intermittence pour éviter de surcharger le réseau. Donc, ce qui était d'abord une interruption touchant une centrale s'est transformée en pannes intermittentes, puis en pannes de courant générales qui ont laissé 90 000 clients grelottant dans le noir et enfouis dans la neige pendant des jours. Au point culminant de la panne d'électricité, quelque 190 000 clients étaient dans le noir, de sorte que les écoles ont dû fermer pendant une semaine.

2. Formation importante de glace, eaux plus froides et niveau des eaux plus élevé dans les Grands Lacs

Avec l'arrivée précoce de l'hiver et des températures plus froides pendant tout l'hiver, il n'est pas surprenant de constater que les glaces sur les Grands Lacs, en 2013-2014, ont été plus épaisses, plus vastes et ont mis plus de temps à disparaître au printemps. Le premier signe d'une saison de glaces épaisses et hâtives fut l'arrivée des brise-glaces à la mi-décembre, soit deux à trois semaines plus tôt que d'habitude. Pendant l'hiver, les voies de navigation sont devenues tellement étouffées par la glace que les brise-glaces de la Garde côtière canadienne et américaine ont été utilisés un nombre d'heures quatre fois plus élevé que la moyenne au cours de la même période des dernières années. Certains brise-glaces ont travaillé sans arrêt pendant 55 jours pour tenter d'ouvrir des voies pour des navires transportant des matières essentielles, comme du mazout domestique, du sel et du charbon. Il faisait si froid en janvier que les Grands Lacs sont devenus de véritables « machines à glace », regelant dès que les brise-glaces se frayaient un passage dans les glaces flottantes. Selon le Service canadien des glaces d'Environnement Canada, c'était l'une des saisons des glaces les plus prolifiques enregistrées pour les Grands Lacs, par rapport aux données enregistrées au cours des 40 dernières années. Les statistiques du Great Lakes Environmental Research Laboratory de la National Oceanic and Atmospheric Administration révèlent que la couverture de glace des Grands Lacs a atteint 92,2 % le 6 mars. Ce pourcentage n'avait pas été atteint depuis 1978-1979, alors que la glace avait atteint le record de 94,7 %. En comparaison, la couverture de glace de l'hiver 2012-2013 n'avait atteint qu'environ 40 % de son sommet. Les statistiques pour les différents lacs incluaient : 95 % ou plus pour les lacs Supérieur, Huron, Érié et la rivière Sainte-Claire; 93 % pour le lac Michigan; et 61 % pour le lac Ontario. Le signe final d'une année remarquable pour les glaces est venu dans la première semaine de juin, lorsque les dernières glaces du lac Supérieur ont fondu, faisant de cette date un record pour les dernières glaces sur les Grands Lacs.

Reliée à la tête des Grands Lacs, la voie maritime du Saint-Laurent a également été touchée, puisque sa 56e saison d'activité maritime ne s'est pas ouverte entièrement avant le 31 mars, soit neuf jours plus tard que l'année précédente, et son ouverture la plus tardive depuis 2009. Après son ouverture, les conditions de glace épaisse ont fait en sorte qu'il a fallu cinq semaines de plus pour que le trafic maritime atteigne ses niveaux normaux sur le lac Supérieur. Les ports et les terminaux ont également été fermés plus longtemps. Cette ouverture tardive a accru le stress et les coûts pour les expéditeurs et les clients, surtout les céréaliculteurs des Prairies qui avaient hâte de commencer l'expédition de l'abondante récolte de la dernière année vers les marchés d'outre-mer. Un point positif est qu'une couverture de glace épaisse et stable a aidé de nombreuses espèces de plantes et d'animaux aquatiques à survivre pendant l'hiver.

Un autre point positif pour plusieurs a été la poursuite de la montée des eaux dans les Grands Lacs. Voici quelques-uns des facteurs qui y ont contribué : un niveau record des chutes de neige et de la neige accumulée; des froids intenses et durables qui ont engendré une couverture de glace presque complète; un début de printemps froid et une fin de printemps tiède; un été plus frais et humide. Le fait qu'une grande partie de la neige venait du bassin versant des Grands Lacs a également contribué à faire monter les niveaux des lacs. En outre, le contenu en eau de la couverture de neige était le plus élevé des dix dernières années pour les lacs Supérieur, Michigan et Huron. Pour la première fois depuis 1998, tous les Grands Lacs étaient au-dessus de leurs niveaux moyens mensuels à long terme (1918-2013) en septembre. Les plus remarquables reprises étaient pour les lacs Supérieur, Michigan et Huron, où les niveaux de l'eau sont remontés à des niveaux jamais vus depuis la fin des années 1990. Étant donné que les lacs Michigan et Huron étaient aux niveaux les plus bas jamais vus en janvier 2013, soit 72 cm plus bas que la moyenne de 1918-2013, la hausse des niveaux de l'eau a été étonnante puisque les niveaux ont dépassé de 17 cm la moyenne en novembre 2014. Il est également important de signaler que la baisse saisonnière des niveaux de l'eau des lacs Supérieur, Michigan et Huron commence habituellement entre le milieu et la fin de l'été alors que celle du lac Supérieur a été retardée jusqu'à assez tard à l'automne et celles des lacs Michigan et Huron n'a pas encore eu lieu. Ceci a été entraîné en partie par la poursuite de conditions météorologiques plus humides que la normale. Selon Environnement Canada, depuis 1918 les niveaux des lacs Michigan et Huron n'ont atteint leur sommet annuel après septembre que pendant sept ans seulement. Les plaisanciers, les propriétaires ou les locataires de chalets près de la plage, les touristes, les pêcheurs commerciaux, les navires de transport et de fret, et les sociétés hydroélectriques figurent parmi les ceux qui ont profité des niveaux élevés de l'eau. C'était également un avantage pour les habitats d'eau douce, les frayères et les aires d'alevinage.

Les Grands Lacs avaient non seulement des niveaux supérieurs à leurs niveaux habituels mais les eaux étaient plus froides. Au milieu des lacs Ontario et Huron, les températures des eaux de surface étaient plus froides d'environ 6 °C le jour de la fête du Canada 2014, par

rapport à la température à la même date l'année précédente. Lors de la longue fin de semaine d'août, les températures des eaux de surface du lac Supérieur étaient plus froides de 2,9 °C par rapport à l'année précédente.

3. Le retour de la glace de mer

Après plusieurs années pendant lesquelles la couverture de la glace de mer a été plus faible que la moyenne le long de la côte Est, la glace a fait un retour impressionnant en 2014 en bloquant le détroit de Belle Isle et en s'étendant vers le sud jusqu'à atteindre l'embouchure du fleuve Saint-Laurent et le long des côtes des provinces maritimes. Du côté de l'Atlantique, la glace s'est étendue très loin dans l'océan, du Labrador en descendant jusqu'à Trinity Bay, dans la presqu'île d'Avalon. La Garde côtière canadienne n'avait pas vu de conditions de glace aussi épaisse dans l'Est de Terre-Neuve depuis 1993-1994. Les brise-glaces ont eu de la difficulté à libérer des glaces les parcours des traversiers et à assurer la navigation des navires commerciaux et des pétroliers dans des eaux encombrées. À la mi-février, après des semaines de froid et de calme inhabituel, les glaces ont commencé à s'accumuler dans le golfe du Saint-Laurent, où la glace atteignait des épaisseurs de 30 à 75 cm. Des vents dominants de l'ouest ont poussé les glaces vers la côte Ouest de Terre-Neuve, en plaques flottantes d'un mètre. On n'avait pas vu de glaces de cette épaisseur au début de mars depuis 25 ans, avec une augmentation de plus de 10 pour cent par rapport à la moyenne sur 30 ans. À la fin de mars, le golfe du Saint-Laurent était presque entièrement couvert d'une glace d'un mètre d'épaisseur. Selon le Service canadien des glaces d'Environnement Canada, l'année 2013-2014 a été la deuxième en importance en 20 ans en ce qui concerne les glaces dans le golfe. En avril, des centaines de passagers à bord de traversiers au large de l'île du Cap-Breton se sont trouvés pris dans les glaces déplacées par les vents. Ce fut une difficile période de deux semaines de retards importants pour Marine Atlantic en raison des phénomènes météorologiques violents et des épaisses glaces dans le détroit de Cabot. Au début de mai, les pêcheurs de homard ont éprouvé de la difficulté à installer leurs cages. Le long de la côte de Terre-Neuve-et-Labrador, une grande accumulation de icebergs (la plus importante depuis plus de dix ans et s'étirant à 500 km plus au sud que la normale) a attiré les regards des touristes enthousiastes, mais inquiétait les marins, surtout ceux qui se sont retrouvés pris dans la brume, secoués par une mer agitée.

Vers le nord, les températures estivales de l'air dans l'Arctique étaient presque d'un degré plus chaudes que la normale. Le mois de juin a été un peu plus frais que la normale, mais les températures se sont élevées en juillet de 2 °C à 4 °C au-dessus des moyennes dans l'océan Arctique central. La chaleur et les vents favorables ont forcé la glace de mer à se retirer rapidement. À la fin de juillet, selon le National Snow and Ice Data Center (NSIDC), situé aux États-Unis, l'étendue des glaces de mer était la quatrième plus faible depuis le début des observations par satellite, il y a 36 ans. Les conditions météorologiques ont changé en août avec des températures plus fraîches et un changement dans les vents, qui ont entraîné une dispersion de la glace. Le 17 septembre, le NSIDC signalait que les glaces de mer de l'Arctique avaient diminué pour atteindre sa sixième étendue la plus basse, accentuant la tendance à long terme à la baisse pour l'étendue des glaces de mer dans l'Arctique. À ce point de son étendue minimum, la glace de mer de l'Arctique couvrait 5,02 millions de km2. C'était 1,6 million de km2 au-dessus du record minimum d'étendue de 2012 et 1,2 million de km2 en dessous du récent minimum de la moyenne sur 30 ans, ou 19 % sous la moyenne. Dans l'Arctique canadien, la baie d'Hudson, la baie de Baffin et le détroit de Davis ont été essentiellement sans glace au milieu de l'été. Dans le chenal Parry, la couverture de glace était de 64 %, soit légèrement supérieure à la normale de saison et supérieure à celle des dix dernières années. Contrairement aux dernières années, le passage du Nord-Ouest, le long de la côte de Sibérie, est demeuré ouvert, avec peu de glace dans la plus grande partie de la voie de navigation.

La découverte du HMS Erebus, l'un des navires perdus de l'expédition de Franklin il y a près de 170 ans, a été une nouvelle vraiment intéressante pour les Canadiens. Derrière la scène, les glaces de mer toujours présentes dans le détroit de Victoria ont joué un rôle en limitant considérablement les efforts de recherche.

4. Inondation d'est en ouest

Au début d'avril, des montagnes de neige commençaient à fondre rapidement, les températures étaient en hausse et de la pluie était sur le point de tomber, ce qui soulevait d'importantes préoccupations concernant un risque d'inondation dans les Maritimes. L'Île-du-Prince-Édouard avait reçu une quantité de chute de neige deux fois la normale en mars, dont la teneur en eau était 36 % supérieure à la normale pour cette période de l'année. De plus, les températures en mars de cinq sous la normale dans les trois provinces avaient empêché la neige de fondre sur le sol encore gelé, réduisant sa capacité d'absorber des pluies excessives. Le 9 avril, tandis que les glaces commençaient à se déplacer sur la plupart des rivières, les niveaux de l'eau le long des rivières Kennebecasis et Nashwaak du Nouveau-Brunswick sont montés en crue. Le dégel soudain du printemps, les pluies printanières et les inondations ont entraîné la fermeture de routes, l'inondation de sous-sols et forcé des centaines de personnes à quitter leur foyer. À la mi-avril, l'eau des rivières se déversait sur les champs agricoles et dans les cours, ce qui causait davantage d'inondations de sous-sols et des dommages aux maisons de campagne et aux caravanes. Les eaux de crue ont aussi emporté des plates-formes routières, coupé des routes principales, délogé des ponts de leurs culées et causé des millions de dollars de dommages à l'infrastructure routière du Nouveau-Brunswick.

Dans le sud du Québec, les averses d'avril, d'une quantité quotidienne de 25 à 45 mm de pluie et la fonte rapide des neiges sur un sol encore gelé ont provoqué d'importants déversements dans les rivières et les lacs. À Beauceville, où il y avait un embâcle d'une longueur d'un kilomètre le long de la rivière Chaudière, les autorités de la sécurité publique ont donné l'ordre d'évacuer à plusieurs dizaines de résidents et d'entreprises. À environ 100 km au nord de Montréal, près de Morin-Heights, un glissement de terrain causé par la pluie a détruit plusieurs chalets d'été. Le terrain des flancs des collines est devenu instable lorsque de la neige fondante et de la pluie diluvienne constante ont saturé le sol et délogé de gros morceaux de terre. À Sherbrooke, la rivière Saint-François a atteint un niveau record de 7,6 m le 15 avril, ce qui a divisé la ville. Le service d'incendie a suggéré à 600 personnes de quitter leur domicile. Les rues inondées du centre-ville ont gelé rapidement lorsque la température est descendue à -8 °C le matin. Le 15 avril, des pluies torrentielles ont provoqué une montée de la rivière Sainte-Anne à St-Raymond, tout juste à l'ouest de Québec, à une vitesse vertigineuse, ce qui a inondé le cœur du centre-ville.

Dans le sud de l'Ontario, la possibilité d'inondations printanières était presque assurée en raison d'une épaisse couche de glace formée avant Noël recouvrait le sol d'une accumulation de neige qui est demeurée tout l'hiver et de températures froides qui ont perduré jusqu'au printemps. Les fortes pluies tombées au cours des crues printanières ont été suffisantes pour faire monter les rivières et provoquer des inondations. En avril, Belleville et d'autres villes situées le long de la rive nord du lac Ontario ont été mises en état d'alerte d'urgence lorsque les niveaux de l'eau de plusieurs ruisseaux et rivières sont montés, y compris les rivières Moira, Salmon et Napanee, ainsi que dans les régions du cours inférieur de la Trent et les zones de protection de la nature de la vallée Rideau. Au cours d'une période de risque d'inondation de dix jours, 1 600 bénévoles plaçant des sacs de sable ont travaillé d'arrache-pied tandis que l'eau de la rivière Moira atteignait le même niveau qu'en 2008, soit la dernière fois où une inondation importante a eu lieu. Les dommages à l'infrastructure ont été estimés à des millions de dollars et des états d'urgence ont été déclarés pour Central Hastings et Tweed, dans l'est de l'Ontario. Dans la rivière Rideau qui gonflait, l'eau se trouvait à son niveau le plus élevé depuis plus de cinq ans. La montée des eaux a aussi entraîné l'émission d'avertissement de crue pour la rivière Grand, au sud de l'Ontario.

En ce qui concerne l'est des Prairies, l'accumulation de neige à la moitié de l'hiver dans le sud du Manitoba était deux fois supérieure à la moyenne, mais sa teneur en eau était étonnamment faible, ce qui a réduit le risque potentiel dû aux inondations printanières. De plus, les conditions du sol plus sèches que la normale en début d'hiver signifiaient que le sol offrait une bonne capacité d'absorption pour la fonte des neiges au printemps. Les autorités étaient toutefois préoccupées par la profondeur atteinte par le gel, soit près de trois mètres sous la surface, ce qui était suffisant pour causer des inondations par ruissellement. Les embâcles étaient aussi une source de préoccupation puisque la glace fluviale était 30 % plus épaisse que la normale. C'est le froid qui a sauvé la mise. Ironiquement, les températures glaciales desquelles les résidents se sont plaints durant tout l'hiver ont permis de garder la neige sèche et, par sublimation, de réduire sa teneur en eau. De plus, les températures printanières fraîches ont permis de ralentir le rythme de la fonte. En fin de compte, le temps est demeuré si froid au Manitoba et en Saskatchewan que les inondations printanières n'ont guère nécessité l'attention. La seule exception a été la rivière Fisher qui traverse la Première Nation de Pequis. Pour la septième fois en cinq ans, elle a débordé sur les rives, submergé des routes, inondé des propriétés et forcé des résidents à quitter leur domicile.

Ensuite, il y a eu l'Alberta. Seulement quelques jours avant le premier anniversaire de « l'inondation des inondations », une tempête se déplaçant lentement le 17 juin a suscité des craintes de scénario similaire alors que des pluies diluviennes frappaient le sud de l'Alberta. Un avertissement de pluie abondante atteignant jusqu'à 200 mm de pluie a fait grimper le degré d'anxiété dans plusieurs communautés de la région, surtout lorsque des avis de débit élevé ont été émis pour les rivières Bow, Oldman, Milk et Saskatchewan Sud. En fin de compte, les quantités de pluie totales ont certes été élevées (la quantité maximale de pluie pour la tempête a atteint 175 mm à West Castle) mais elles n'ont pas atteint le niveau annoncé, et la région touchée n'a pas été aussi vaste que l'année passée. Même si Calgary a été épargnée par le déluge, plusieurs municipalités et villes ont été durement touchées au sud. Quarante maisons ont été inondées à Claresholm et des états d'urgence ont été déclarés dans des dizaines de collectivités, y compris Medicine Hat, des parties du comté de Lethbridge, High River, Crowsnest Pass, Willow Creek et la réserve indienne de Blood. À Lethbridge, les précipitations totales ont dépassé 246 mm entre le 10 et le 19 juin, dont 171 mm en trois jours entre le 16 et le 18 juin. La moyenne annuelle de pluie à Lethbridge est de 276 mm. En conséquence, la rivière Oldman a monté de 3,5 m et a provoqué l'inondation du sous-sol de 350 maisons. Dans la réserve de Blood, 20 familles ont été forcées de quitter leur maison et on a signalé des dommages dans 200 domiciles, dont la plupart causés par des inondations par ruissellement et un refoulement des égouts.

5. Grands vents sur tout l'Ouest

Chevauchant un écoulement d'air rapide en provenance de la vallée du Mackenzie, les vents chauds du Pacifique ont frayé leur chemin à travers les provinces des Prairies au milieu de janvier. Cette « brise » chargée à bloc a apporté une pause méritée dans ce qui devenait des rigueurs hivernales extrêmes. On a alors battu des douzaines de records de chaleur, notamment à Edmonton, Saskatoon et

Winnipeg. À Edmonton par exemple, le mercure s'est élevé à 9,1 °C, battant le record précédemment enregistré de deux degrés. Avec 7,5 °C le 15 janvier, Saskatoon a connu la plus haute température en saison depuis qu'on a commencé à tenir des statistiques en 1892. Pendant ce temps, les vents prenaient des vitesses d'ouragan à 120 km/h, balayant eux aussi les records. Les grands vents ont secoué et fracassé les fenêtres, fouetté les voitures et causé des dommages aux biens pour des millions de dollars. Les vents de tempête ont soufflé des semi-remorques, arraché enseignes et auvents, abattu des façades au centre-ville, renversé des piétons, tordu des tours de téléphonie cellulaire, écrasé des réservoirs à grain et fauché des feux de circulation. Des débris volants ont menacé les automobilistes et piétons sur les routes et les trottoirs. Du nord de la Colombie-Britannique à l'est du Manitoba, des milliers d'usagers ont été privés d'électricité à cause de chutes d'arbres entraînant des fils électriques. Le redoux de janvier a peu duré et la suite a pris une vilaine tournure avec des grains neigeux, des blizzards et des verglas accompagnés d'orages occasionnels comme surprise en plus. Ces conditions singulières ont chassé les autobus scolaires des routes et gardé les élèves au foyer. La poudrerie, la formation de congères et la glace noire ont fait fermer un grand nombre d'autoroutes et causé deux décès de la route en Alberta.

6. Tempête en guise de poisson d'avril dans les provinces de l'Atlantique

Une tempête de fin de mars qui s'est formée au large de la côte est des États-Unis a pris lentement la direction du sud-est de la Nouvelle-Écosse pour réserver un poisson d'avril à ceux et celles qui, peut-être et seulement peut-être, pensaient que le printemps était de retour dans la région de l'Atlantique. Du coup, les habitants du Nouveau-Brunswick ont encore eu à faire face à une panne d'électricité majeure devant frapper plus de 75 000 usagers dans des conditions de verglas, de grésil et de forte neige. On a dû ouvrir des abris à plusieurs endroits et un certain nombre de régions rurales ont été privées d'eau courante. Fredericton s'est couverte une fois de plus d'un épais manteau glacé qui a fait tomber des arbres sur des fils électriques, fauché des poteaux et arraché des transformateurs. La facture totale a été de plus de 3 millions de dollars pour Énergie NB. Le 1er avril, cette même Fredericton, qui normalement n'aurait qu'environ 5 cm de neige au sol en avait 68 cm, le couvert neigeux le plus épais jamais mesuré dans la capitale en avril. Les chasse-neige ont fait des tours d'horloge, car les congères mesuraient 2 m dans certaines rues, et les bretelles des autoroutes étaient bloquées par la neige et les camions enlisés. Piétinant dans la neige profonde, les cervidés épuisés sont devenus des cibles faciles pour les prédateurs. Dans le port de Sydney, de forts vents persistants du secteur nord-est ont soulevé la glace de mer jusqu'à 3 m par endroits, retardant de plusieurs jours les navettes de transbordeurs de Marine Atlantique. Pour le conseil scolaire régional de Cap Breton-Victoria, les 15 jours de congé de neige de l'année ont presque doublé par rapport à l'an dernier.

L'Île-du-Prince-Édouard, qui a dû s'extraire d'une autre chute de neige record, a paru la plus rudement touchée. La tempête l'a frappée pendant plus de 30 heures. Maritime Electric a comparé ce mélange de neige et de verglas à l'infâme tempête de verglas qui s'était déchaînée sur la province en janvier 2008. En 2013-2014, les tempêtes de neige ont été fréquentes et denses. Charlottetown a connu cinq tempêtes de 25 cm et plus en une journée. Le 26 mars, 48,5 cm de neige sont tombés et, au total, il y a eu quatre jours de fortes chutes de neige de plus que la moyenne. Dans toute la province, les chasse-neige ont été rappelés des routes secondaires et les écoles ont été fermées toute une semaine pendant que la poudrerie et le grésil continuaient à s'abattre sur l'île. En mars, certains élèves ont eu plus de congés forcés que de jours d'école, laissant loin derrière la nouveauté des congés pour cause de neige.

La tempête du début d'avril a également été une des pires d'un « hiver de tempêtes » à Terre-Neuve-et-Labrador, amenant une longue période de forts vents du secteur nord-est avec un mélange de neige, de grésil et de verglas pour le sud de cette province. D'abondantes chutes de neige combinées à des vents violents ont multiplié les congères et les voiles blancs. À St. John's et aux alentours, des conditions de route dangereuses ont fait fermer un grand nombre d'écoles et de commerces.

7. Orages violents en septembre en Ontario

Après une des journées d'été les plus chaudes et les plus humides jamais connues un 5 septembre, un violent orage a traversé le sud de l'Ontario d'ouest en est. Provoqué par un front froid, il a charrié des pluies denses et de forts vents. London a été heurtée de plein fouet. Les vents y ont fauché des arbres et des fils, multipliant les pannes d'électricité dans la ville et aux alentours. Un concert a été annulé en soirée, les organisateurs de la Western Fair fermant la zone d'exposition. Ottawa a aussi été directement frappée avec des chutes d'arbres, des inondations de rues, d'intersections et de sous-sols et l'interruption d'une partie de football du Rouge et Noir d'Ottawa par une panne. À Christian Island au nord-ouest de Midland, les dommages causés ressemblaient dangereusement à ceux d'un ouragan de peu de force, une impression confirmée par la suite. On a parlé d'une force EF0 et de vents de 90 km/h. Les spécialistes ont également confirmé qu'une tornade de force EF1 avait heurté Udney à environ 20 km à l'est d'Orillia avec des vents s'attaquant aux bâtiments, notamment à une grange, un hangar et un pavillon. À Orillia, les dommages ont été soutenus avec des rafales descendantes qui ont abattu des douzaines d'arbres majestueux dans le parc du centre-ville en bordure de lac. Aux alentours de Six Mile Lake, des vents rectilignes d'une vitesse de 90 à 110 km/h ont assailli les arbres. On a relevé les vents de pointe les plus vifs à Windsor (96 km/h) et Lagoon City (85 km/h). La pluviométrie totale était tout aussi inquiétante : 75 mm se sont déversés sur St. Thomas, ce

qui devait faire déborder localement les eaux. Grand Bend, Tillsonburg et Fergus ont été d'autres points chauds ayant reçu 60 à 90 mm de pluie. Fait tragique, la tempête a dérobé deux vies, la première tôt en journée à l'Université de Waterloo où un étudiant a été frappé par la foudre après s'être réfugié sous un arbre, la seconde à Orillia où un cycliste a été assommé par des chutes de branches pour ensuite succomber à ce traumatisme.

Cinq jours plus tard à peine, soit le 10 septembre, une autre puissante tempête traversait les mêmes lieux et déversait une pluie semblable sur le centre et le nord de l'Ontario. Après deux épisodes de denses précipitations en moins d'une semaine, les autorités ont lancé des avertissements d'élévation des eaux et de crue dans les régions basses.

Les forts vents ont également sévi près de London et au sud de cette ville. À Windsor-Amherstburg, agglomération frappée par une seconde tempête de 60 à 100 mm de pluie, le sous-sol de plusieurs résidents s'est inondé à nouveau. La pluie diluvienne a également affecté London, submergeant les rues, étranglant la circulation, renversant des arbres et transformant les sous-sols en piscines intérieures. Pour la seconde fois, les responsables de la Western Fair ont fermé la zone d'exposition. Ensemble, les deux tempêtes ont arrosé London de 123 mm de pluie, Tillsonburg de 108 mm, Waterloo de 117 mm, Fergus de 126 mm et St. Thomas de 113 mm de pluie.

Testing of Manual Rain Gauges

by Kenneth A. Devine[5]

In order to determine the accuracy of rain gauges used in a home environment a total of six manual rain gauges of five different types including two professional gauges were compared. The gauges were arrayed over a level grass surface at heights of 28 to 44 cm. Most of the gauges were arranged within a circle of 60 cm in diameter. While the gauges were sometimes read after the rain had stopped, generally the measurements were made near suppertime. There were a total of 78 rainfall events in 2008. Occasionally one or two of the gauges were knocked over by wind or animals and the readings were lost. Some gauges had built in graduates and others were read using laboratory graduates calibrated in cubic centimetres from which the rainfall was computed. The gauges were tested in Aurora, Ontario, Canada. The setting was urban. The gauges were in the centre of a square area 15 m on a side which was surrounded by a house to the east which was 9 m high and trees on the other three sides varying from 5 to almost 20 m high. Hence this is an overly protected site.

The Type B gauge is an opaque white plastic gauge which has been the standard rain gauge used by MSC (Meteorological Service of Canada) since 1970. It has an orifice area of 100 cm^2 and a built-in graduate. The accuracy of this rain gauge has been reported elsewhere as +0.6% with respect to a WMO (World Meteorological Organization) pit gauge (Devine & Mekis 2008). Hence this gauge was selected as the reference for this comparison. Additionally its agreement of -0.1% with the median of all of the gauges was quite good. This gauge can hold up to 280 mm of rain. The white ABS plastic is both reflective and opaque leading to much lower internal temperatures and evaporation loss than other gauges. However it does tend to accumulate dew in the funnel due to surface radiative cooling of the funnel which is not dissipated due to the low thermal conductivity of the plastic. This gauge was built for the Meteorological Service of Canada (MSC) to an MSC design and is not available to be purchased commercially.

There were two MSC copper gauges in the test with almost identical results. This gauge was the standard rain gauge used by MSC from the mid1930s until about 1978. The gauge is made of copper with a plastic receiver (after 1962), has an orifice area of 10 square inches (64.5 cm^2), and can hold 115 mm of rain. As has been reported elsewhere, its accuracy wrt the WMO pit gauge was -4.5% (Devine & Mekis 2008). This gauge was built for MSC to an MSC design which is similar to gauges used in Canada since the 1870s. Internal temperatures during clear days in this metal gauge were quite high.

The clear plastic gauge was manufactured in Australia and was a copy of the Clearview rain gauge designed by Taylor Instruments of Rochester, New York. The orifice has a diameter of 4" or an area of 81 cm^2. Like the Type B it has a built-in graduate and can hold a large amount of rain. Certain characteristics of Clearview were used in the design of the Type B by MSC in the 1960s, namely: integral graduate, large rainfall capacity, and plastic construction. But the opaque white plastic and graduate mounting below the funnel in the MSC design, made the Type B more accurate and easier to use. The Clearview gauge agreed quite well with the Type B for rainfalls above 3 mm (Doesken, 2005) and has become the gauge for measuring rainfall at this location due to its consistent results. The differences below 3 mm were to be expected with the

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measuring resolutions of 0.1 mm for both the Clearview and the Type B. This type of gauge has been used by many provincial services and reported within 0.2% of the Type B for twenty rain events at Chapleau, Ontario in 2004.

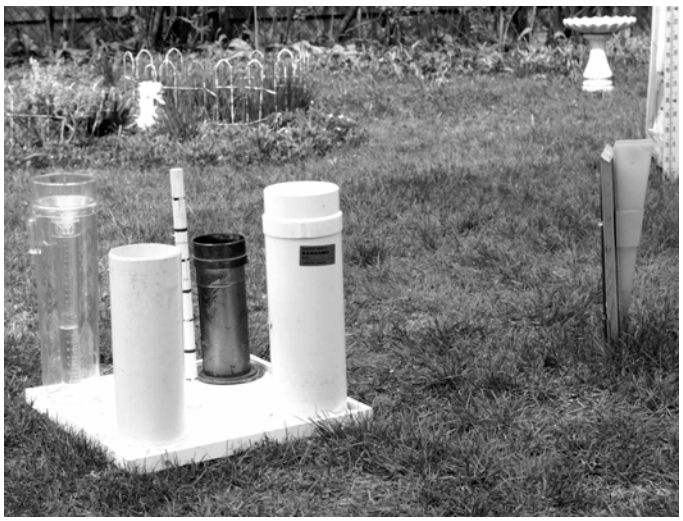

Figure 1: Test Layout with the Rain Gauges arranged as follows from left to right: Clearview, 4" Plastic Pipe, MSC Copper, MSC Type B and farther right TruChek.

The TruChek is a clear plastic gauge which can measure up to 6" or 152 mm of rain (Huff, 1955 & Bruce and Potter, 1958). This inexpensive gauge is a single piece glued construction with the gradations impressed into the plastic. The wedge shape allows for precise readings of 0.01" (0.25 mm) for light rainfalls. It was mounted on the north side of a small board to protect it from the sun's radiation. The top is entirely open and measures 6.4 x 5.9 cm. It was used for measuring rainfall at this location for a decade but the plastic has changed to a yellowish brown over the years. This gauge had the greatest variability of all the gauges when compared to the Type B.

The final gauge was made of 4" (10.2 cm I.D.) white plastic sewer pipe. It was built for collecting snowfall for which it works very well. This type of plastic is translucent and is not opaque. An end cap for this type of pipe was reduced in height and the outside of the pipe filed down so that the cap would fit tightly against the bottom of the pipe. Additionally a small amount of the solvent glue which was used to attach the end cap, was rotated around the bottom to ensure that there were no gaps within which water could collect. The outside top was beveled to reduce splash and to define the orifice. On sunny days following a very light rainfall this gauge would often dry out since it was fully open at the top. Interestingly for rainfalls above 5 mm it appeared to be the best when compared to the Type B gauge. The graduate for the Clearview has been used to measure the water equivalent of snowfall from this gauge since both gauges have the same orifice diameter, i.e. 4".

Ratios of the totals for the same sixty rain events when compared to the Type B rain gauge

	Ratio	Difference	
Clearview	0.996	-0.4%	
MSC1	0.991	-0.9%	
TruChek	1.001	+0.1%	over reads for light rainfalls
4" pipe	0.988	-1.2%	under reads for light rainfalls

A couple of automatic gauges were also tested but they were very inconsistent in their operation so the results were not computed. Small manual rain gauges often available in hardware stores are not of much use except in the heaviest of rainfalls and even then they may overflow since they lack a high capacity. The internet is the best source for the commercially available gauges mentioned in this article.

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Change in the Arctic Ocean – why we need a geochemical observing system

by R.W. Macdonald[1], Z.A. Kuzyk,[2] and S.C. Johannessen[1]

There is little doubt that the Arctic Ocean is losing sea-ice mass and areal coverage: you can see it from space. Beginning in the early 1990s, the polar science community recognized that something out of the ordinary was occurring in the Arctic Ocean (Macdonald, 1996). Since that time sea ice cover has riveted attention, partly because it is such a defining feature of polar oceans, and partly because the demise is so clear in satellite images. Satellite sensors have also informed us of climate-related trends in surface temperature, snow cover, glacier mass balances, permafrost temperature (Comiso and Hall, 2014), chlorophyll (Lowry et al., 2014), and colored dissolved organic matter (CDOM) (Matsuoka et al., 2015). As sea-ice cover shrank toward its historic minimum in late summer of 2012 and striking images of the decline, derived from satellite data, received wide circulation, the literature on Arctic sea ice increased exponentially. Unfortunately, literature describing accompanying changes occurring as a result of, or in addition to, sea-ice change that were not visible from space have not kept pace. One reason for this gap is that satellite proxy data inform us poorly, or not at all, about what is going on beneath the ocean-ice surface. A second reason is that Arctic field work is logistically difficult, especially in autumn and winter, which leads to gappy time-series data (Dickson, 1999). In our view, there have been two other shadow partners of change in the Arctic Ocean – fresh water and organic carbon. Although changes in both of these components relate in part to change in sea-ice cover, we do not understand them nearly as well. Fresh water and organic carbon present parallel challenges to observation in having marine and terrigenous components that are not necessarily in step with each other.

Fresh water has long been a topic of interest in its capacity to alter the Arctic Ocean's functioning; indeed, in 1985 Howard Cattle (1985) wrote an intriguing article on the potential of Soviet river diversion to affect the Arctic Ocean, concluding that major diversions might alter ice formation on the Siberian shelves but not have any great large-scale effect on circulation. Whether or not that conclusion was correct, later observations of a weakening of the cold halocline in the eastern Arctic Ocean were ascribed by Johnson and Polyakov (2001) to a 'natural' diversion of Soviet – now Russian – river water passing over these same shelves, caused not by humans but by wind regimes (i.e., the Arctic Oscillation). One consequence of this sort of freshwater diversion would be an altered storage of fresh water in the Beaufort Gyre of the Arctic Ocean (Proshutinsky et al., 2002), which then leads to altered ocean functioning within the Arctic, and an exportable mechanism of change (i.e., buoyancy) to the North Atlantic convection centres.

Sediment traps like the one shown in this photo from Beaufort Sea has been used to better understand the processes under the ice or beneath the surface, out of satellite's supervision

Unfortunately, we do not have time series appropriate to the questions we need to answer. We cannot see freshwater balances from space, and salinity fields by themselves do not inform us of how the sea-ice and runoff components interact. The importance of distinguishing between processes associated with these two components was pointed out by Ostlund (1982). Although there is evidence of a modest increase in river runoff over the past few decades (McClelland et al., 2006), and probably an increased moisture flux into the Arctic Ocean directly from precipitation, these changes seem much less important quantitatively than the capacity of the Arctic Ocean to store and release liquid freshwater at the decade or longer scale, which might amount to as much as 8000 km^3 (Rabe et al., 2011). To distinguish the seasonal role of sea ice in altering freshwater content of the upper ocean by freezing or melting from the roles of runoff and precipitation, we need to apply geochemical tracers, such as oxygen isotopic composition and alkalinity. Accordingly, we really need an Arctic Ocean wide network of sections to develop a time series of these

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tracers in the Arctic's upper ocean (0-1000 m). Indeed, we face the difficulty of having too many water sources and too few tracers in the Arctic, which demands the inclusion and/or development of even more geochemical measurements that have the potential to distinguish among freshwater sources (e.g., Alkire et al., 2015; Guay et al., 2001; Jones et al., 2003).

A typical Arctic River poised for change in its hydrology and geochemistry

Organic carbon (OC) also has two dominant sources in the Arctic Ocean, one imported from land (OC_{terr}) and another made in the ocean (OC_{mar}). These two forms of OC are not affected in the same way by climate change, and although we can glimpse components of each from satellites (e.g., chlorophyll blooms at the surchemistryface, coloured dissolved organic matter emanating from river water), we cannot quantify the processes affecting these OC components in time and space. Budgets show that OC supplied to the Arctic Ocean from land (~13 Mt yr^{-1}) is much less than that produced in the ocean (~300 Mt yr^{-1}). On the other hand, the burial of particulate carbon in the Arctic Ocean sediments favours OC_{terr} (4.4 Mt yr^{-1}) over that of OC_{mar} (2.2 Mt yr^{-1}) (Stein and Macdonald, 2004a). According to biomarker and isotopic evidence from sediments ($\delta^{13}C$, $\delta^{15}N$), the OC_{mar} is far more digestible than OC_{terr}, and we thus see a very strong recycling engine for the marine carbon, and a strong paleo-recording engine for the terrigenous carbon. But both of these OC engines are undergoing change: in the terrigenous system it is the demise of permafrost and change in vegetation and moisture balance; in the marine system it is the change in sea-ice cover and type of sea ice (first year vs. multiyear), which then produces changes in mixing, nutrient supply, and light climate. How, quantitatively, are these two loci of change going to alter the balance of organic carbon in the Arctic Ocean? Again, this question cannot be answered from space. As in the case of freshwater, this question requires a coherent attack using biogeochemical time series over a wide network of sections. We can immediately define two first-order questions that need answers. First, the OC_{terr} budget proposed above may be in error or the supply of OC_{terr} may already have started to change substantively. In a recent examination of the Siberian Shelf, Vonk et al. (2012) proposed that 44 Mt yr^{-1} of OC_{terr} was being released as part of the demise of ice complexes at the coast, two thirds being metabolized and the remainder buried. This supply is about three times that estimated earlier for the entire Arctic Ocean. Second, Boetius et al. (2013) recently measured a large flux of algal mat material to a depth of 4000 m in the central Arctic basins. How long has this flux been going on? Is this large flux a manifestation of the shift from multi-year ice to first year ice, producing a better habitat for ice algae, which then sloughs off each year? The Boetius et al. estimate of 9 g OC m^{-2} yr^{-1} at 400 m is enormous compared to the traditional view of an impoverished <0.1 g OC m^{-2} yr^{-1} to the basins in the Arctic Ocean (e.g., Honjo et al., 2010; Stein and Macdonald, 2004b). If this large flux is something recent, then we can expect change to occur in the benthic systems of the deep basins, and potentially a change in the rate of drawdown of dissolved oxygen in basin water, which is sluggishly replaced in the Canada Basin. But we run into a problem of sustainability. To supply this flux of OC to the basins, the surface layer must export at least an equivalent amount of OC, and probably quite a bit more to account for metabolism on the way to the bottom. The problem is that this algal flux implies an accompanying flux of nutrients that would be equivalent to a drawdown of over 2 mmol m^{-3} N and 0.1 mmol m^{-3} of P from the top 50 m or so. If this is a new export flux of OC from a surface ocean thought to be already starved of nutrients, how does the system sustain it? Is there now a more substantial supply of new nutrients? Intuitively, the addition of more fresh water would seem to mitigate against nutrient supply by strengthening stratification. Again, we need a network of sustained measurements of the OC system in the Arctic Ocean. These measurements would have to include a measure of particle flux out of the surface layer and into the basin, as well as the biogeochemical composition of such flux.

Over the centuries, lots of people dreamed about reaching the poles. Here is one of the lucky ones, our own Arctic oceanographer, Robie Macdonald, skating around at the North Pole

Importantly, the above two components of change, freshwater and OC cycling, impinge directly on the Arctic Ocean's sensitivity to ocean acidification. Changes in the storage of freshwater, which is poorly buffered, already drive large areas of surface water below solubility thresholds for aragonite on a seasonal basis (Yamamoto-Kawai et al., 2011). At the same time, an increased flux of OC to bottom waters becomes, when metabolized, a strong supply of CO_2, every bit as potent as anthropogenic CO_2 added to the surface ocean. Thus the Arctic Ocean's surface and bottom waters are both likely to be in the vanguard of effects from ocean acidification.

The task of providing a sufficient network of observatories to monitor the changes occurring in the Arctic Ocean's freshwater and organic carbon cycles is beyond one country's capacity, considering the financial, logistical and political hurdles. But it seems a very doable project if the major Arctic countries collaborate by producing a set of data in their respective sectors using common methods in station organization (distribution and depths), target analytes, and sampling/analytical methods. Interpreting these data will, of course, require simultaneous time-series for sea-ice cover, but the latter will never supplant the need for the geochemical section data. Without such data we will not understand what climate change actually means for the greater Arctic Ocean.

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Reports / Rapports

OBIS: Legacy of Census of Marine Life

Submitted by Savithri Narayanan[1]

The *Census of Marine Life* was an international program spanning ten years that recorded the diversity, distribution, and abundance of life in the ocean. With a participation of more than 2,700 scientists from 670 institutions spread over 80 nations, it was one of the largest scientific collaborations ever conducted, that comprised of a major thrust on investigating what now lives in the world's oceans through sampling important kinds of biota in each of the six realms of the global oceans (Human Edges, Hidden Boundaries, Central Waters, Active Geology, Ice Oceans, and Microbe) using a range of technologies. Recognizing the importance of responsible management of the resulting data and information to achieve the overall program objectives, the scientific framework of the program included the establishment of a distributed Ocean Biogeographic Information System (OBIS) assimilating data and information from its own field projects as well as all available historical databases.

OBIS was the result of a vision to create a strategic alliance of people and organizations to make marine biogeographic data, from all over the world, easily and freely available through internet, at a time when a standard system for the retrieval, exchange, and integration of ocean biological data did not exist. Thus OBIS was established as the central access point for the distributed ever-expanding network of portals and databases on marine biodiversity, providing expert geo-referenced data on marine species along with user-friendly spatial/temporal query visualization and data extraction tools. The OBIS portal was widely accepted by the scientific community, particularly as the ownership of the data in the nodes remained within their host institutions, without requiring them to make ongoing transfers of their collections to a central data base. Consequently, many scientists placed their data sets under the OBIS umbrella allowing access by the wider community to a more comprehensive distributed data and information base that can be seamlessly searched by species names, higher taxonomic level, geographic area, depth, and time, and associated environmental data related to the locations.

As the Census of Marine Life Program came to an end and many of the researchers moved on to other projects, the scientific community became concerned about the future of the OBIS, and the fate of many of its nodes. It became clear that there is a real danger of OBIS stagnating or falling apart without stability in funding and international collaboration to keep it alive, growing and adapting to technological advancement. A few countries including Canada proposed that the Intergovernmental Oceanographic Commission (IOC) adopt OBIS as one of its activities under the International Oceanographic Data and Information Exchange (IODE) programme, which was accepted by IOC in 2009. With IOC's allocation of a dedicated staff officer for OBIS and funding support from Member States, OBIS has now been transitioned to an intergovernmental activity under the IOC, managed by a Steering Group composed of the managers of the OBIS nodes, and conforming to its own vision and that of the IOC of open access and data sharing.

In spite of the intergovernmental status of OBIS, any organization, consortium, project or individual may contribute to OBIS and in return benefit from this invaluable global biodiversity data portal. Consequently, many new nodes are linked to the portal each year.

The user community of OBIS is also expanding as a result of the growing awareness of biodiversity issues and because of the strong support from the OBIS secretariat, including the OBIS training modules under the OceanTeacher program of IODE.

Canada has played a leading role in the establishment of OBIS as a program of the Census of Marine Life and through the OBIS Canada, established as a regional OBIS Node hosted partly at the Bedford Institute of Oceanography, has been a major contributor to the global biodiversity database. Canada continues to support the program by adding biodiversity data to its node as and when they become available. The latest Canadian contribution to OBIS is the addition of the Ocean Tracking Network database to the OBIS system of nodes. OBIS Canada is hosted by:

[1] Co-Editor, *CMOC Bulletin SCMO*; formerly Dominion Hydrographer of Canada, and Director General of Ocean Sciences and Canadian Hydrographic Service of Department of Fisheries and Oceans, Ottawa, Ontario

- Centre for Marine Biodiversity (http://obiscanada.marinebiodiversity.ca/)

- Bedford Institute of Oceanography

- Dalhousie University

For additional information on OBIS, please contact the IOC's IODE office at:

OBIS Secretariat
UNESCO-IOC Project Office for IODE
Wandelaarkaai 7/61, 8400 Oostende, Belgium
Project Manager: Mr. Ward Appeltans
Email: w.appeltans@unesco.org
http://www.iobis.org/

Note from the Co-Editor:

Census of Marine Life in the *CMOS Bulletin SCMO*:

2009) Census of Marine Life (CoML) data and the Intergovernmental Oceanographic Commission, report by Geoffrey Holland, Vol.37, No.2, page 64.
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The International Oceanographic Data and Information Exchange (IODE) – XXIII

Submitted by Paul Lyon[2]

In 1961, the Intergovernmental Oceanographic Commission (IOC) of UNESCO (United Nations Educational, Scientific and Cultural Organization), envisioned a process to exchange ocean data and information among Member States. This acknowledgement resulted in the establishment of the International Oceanographic Data and Information Exchange or IODE. Since then, Member States have collaborated, and established over eighty data centres globally, to the benefit of the oceanographic community and users of ocean data and information products.

The 23rd session of the International Oceanographic Data and Information Exchange (IODE) was held in Bruges, Belgium, March 17-20, 2015 in the beautiful gothic style Provincial Court Building located adjacent to Bruges' famous Belfry.

Celebration Session and Scientific Conference, March 16

Gothic style Provincial Court Building located adjacent to Bruges' famous Belfry.
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The 23rd Session of the IODE was preceded by a Celebration Session and Scientific Conference acknowledging the occasion of the 10th anniversary of the opening of the IOC Project Office for IODE in Oostende, Belgium.

Following the official welcoming, participants were provided with a virtual visit to the IOC Project Office. Presentations followed on behalf of: the IODE (Mr. Ariel Troisi, IODE Co-Chair); JCOMM[3] (Dr. Savithri Narayanan, former JCOMM Co-President and Prof. Nadia Pinardi, JCOMM Co-President); and Flander's role in the IOC by Dr. Vladimir Ryabinin, IOC Executive Secretary.

The scientific conference of the program centred on seven keynote presentations covering various topics including; new developments in GOOS (Global Ocean Observing System) and their needs from IODE; the IODE OceanTeacher Global Academy; and a presentation on data/information gaps for marine policy. A series of short papers followed, including a presentation on Fisheries and Oceans Canada's Climate Change Adaptation Services Program by Mr. Paul Lyon.

The day concluded with an IODE Awards Ceremony and reception. Congratulations go out to Canada's Drs. Wendy Watson-Wright (past IOC Executive Secretary) and Savithri Narayanan for their contributions to the IOC, JCOMM, and the IODE.

The 23rd session of the IODE
The Canadian Delegation to the IODE included Paul Lyon, Acting Director, Oceanographic Services, Fisheries and Oceans Canada (DFO) and Mathieu Ouellet, Manager of the Canada's National Ocean Data Centre (DFO) located in

[2] Senior Science Advisor, Fisheries and Oceans Canada, Ottawa, Ontario

[3] Joint Technical Commission for Oceanography and Marine Meteorology)

Ottawa.

Over the three and a half days of this meeting a wide range of topics were discussed by Member States. The following is a synopsis of some of the key agenda items which were addressed.

IODE Quality Management Framework - The IODE has made significant progress in establishing a Quality Management Framework and certification process. Two National Ocean Data Centres were the first to receive certification; the National Marine Data and Information Service (NMDIS), host of the National Oceanographic Data Centre (NODC) of China and the Belgian Marine Data Centre (BMDC). The IODE has set a target to have at least ten NODCs achieve accreditation by the next sessional meeting.

Ocean Data Portal (ODP) - The Ocean Data Portal's objective is to provide access to collections and inventories of marine data from the NODCs in the IODE network through web services. The infrastructure will be supported by the Partnership Centre for the Ocean Data Portal and the IODE Ocean Teacher facilities will be used for training. The World Meteorological Organization is supportive of this initiative and is assisting the project so that the ODP will be interoperable with the WMO's (World Meteorological Organization) information system (WIS). Canada is an active contributor to this project.

Ocean Data Standards and Best Practices – This project seeks to establish consensus on standards and best practices related to ocean data management and exchange. A new standard, the Recommendation for Quality Flag Scheme for the Exchange of Ocean and Marine Meteorological Data was published in April 2013. Additionally, SeaDataNet (SDN) has two proposals being considered this year, the Common Data Index metadata data model and the CDI metadata XML encoding. Further they have, jointly with the Ocean Data Interoperability Platform (ODIP), proposed two additional standards: SeaDataNet Controlled Vocabularies for describing Marine and Oceanographic Datasets and SeaDataNet[4] NetCDF (CF) data transport model for Marine and Oceanographic Datasets. The European Union, the United States, and Australia are partners in ODIP.

The Future of IODE – The results of a survey, conducted in October-November 2014 on the future of IODE designed to assess the importance of IODE to its stakeholders, was of particular interest to Member States. As such, a significant amount of time was set aside in the agenda to discuss the

Paul Lyon at 23rd IODE Session in Belgium.
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results and their implications to the IODE. Highlights from the survey included: (i) 97% of responses stated that there is still a need for an IODE network of data centres and marine libraries, (ii) 50% of responses stated IODE was essential to their work, and (iii) the most important benefits of the IODE programme were being part of a community of practice (17.5%) and obtaining training (16.2%). A new governance model was introduced that would see a reduction in the number of projects and focus IODE efforts. Member States agreed to form an intersessional group to explore the new governance model.

One of the last items on the agenda was the confirmation of a new executive. Member States acknowledged, with gratitude, the outgoing IODE Co-Chairs, Ms. Sissy Iona and Mr. Ariel Troisi and welcomed Cynthia Chandler (United States) and Mr. Yutaka Michida (Japan) to their new role as IODE Co-Chairs.

Report on "*The Unraveling of the Arctic*"

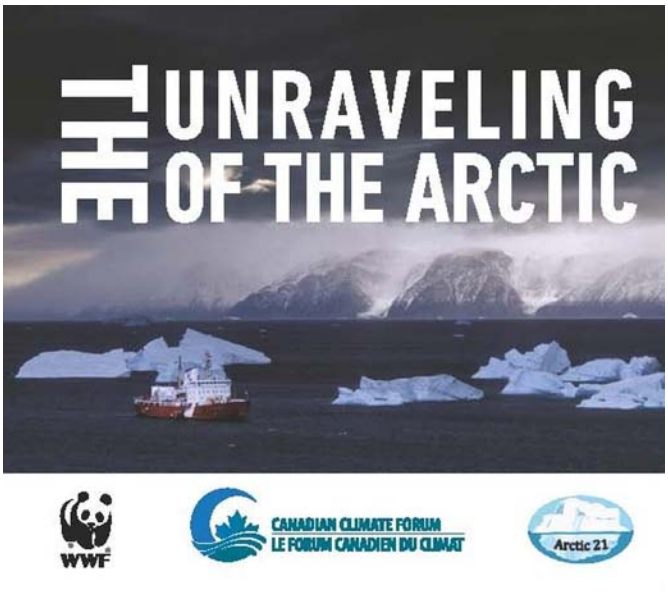
Submitted by Ann McMillan[5]

With the high profile event, *The Unraveling of the Arctic,* the Canadian Climate Forum (the Forum) stepped forward to bridge the gap between science and its implications for the North in the face of a changing climate. This free Earth Day (April 22nd), full house event was hosted at Jean Pigott Place - Ottawa City Hall by the Forum and its event partners; Arctic 21 and World Wildlife Fund Global Arctic Programme (WWF).

[4] For more information on this particular topic, read Robert Keeley's article: *SeaDataNet, CMOS Bulletin SCMO*, Vol. 42, No.6, pages 187-189.

[5] Member, Canadian Climate Forum Board of Directors

The event was triggered by the transition of the Arctic Council from the Canadian Government chairmanship to that of the United States Government that took place in Iqaluit with John Kerry, two days after the Forum's Arctic event. *"The Unraveling of the Arctic"* was the only event in Ottawa prior to the Arctic Council Ministerial transition event and its main objective was to raise awareness about the science of the issues linked to global warming and a dramatically changing Arctic environment. The event was moderated by Dr. Tom Pedersen, Chair of the Forum and Executive Director of the Pacific Institute for Climate Solutions, University of Victoria.



In panel presentation style, the distinguished presenters addressed six main themes including: glaciers; sea ice; permafrost; biodiversity; black carbon (health); and Indigenous (Inuit) social perspective. Mr. Struzik, award winning author (Future Arctic; The Big Thaw), photographer and journalist as well as Fellow at the Institute for Energy and Environmental Policy, School of Policy Studies, Queen's University, wrapped-up the event with "*Future Arctic: Field Notes from a World on the Edge*", a stunning array of images from the North which captured its unique features and inhabitants so that the audience almost felt they were there. The presentations can be found at the Forum's website (http://www.climateforum.ca).

Glaciers – Dr. Martin Sharp, Professor, Department of Earth and Atmospheric Sciences, University of Alberta

Dr. Sharp began by asking "*Why do glaciers matter?*" Of course glacier mass is a first order climate control of sea level but there are many other reasons such as providing feedback on global/regional climate cycles, hydropower potential of melting glaciers, and legacy pollutants trapped in the ice which may re-volatilize. In the period 1958 to 1960 in the Yukon, glaciers occupied 11,622 km^2 while in 2006 to 2008 they shrank to 9,081 $km^{2;}$ a loss in area of 2,541 km^2. Since 2004, the melt season, when the surface temperature is close to the melting point, is now much longer than pre 2004. Furthermore, ice calving is increasing and glacier mass shows a continuous downward trend as shown by satellite gravimetry.

Climate scientists often talk about "feedbacks" in the climate system. Moderate Resolution Imaging Spectroradiometer (MODIS) data is showing that summer minimum albedo over 2000-2012 is decreasing so the surface is absorbing more radiation and in turn getting more melt. Causes of this include faster snow metamorphosis, more deposition of black dust/carbon (causing faster melt), and more pigmented microbial blooms which absorb radiation.

Dr. Sharp summarized that impacts of these changes are global, and we need to slow or stop the warming to begin to slow down the rate of change. Alternatively we need to prepare and budget to deal with the impacts. Dr. Sharp predicts that the cost of insurance will soon become a driver for action.

Permafrost – Dr. Antoni Lewkowicz, President, International Permafrost Association; Dean, Faculty of Arts, Department of Geography, University of Ottawa

Dr. Lewkowicz started by defining permafrost as "earth materials whose temperature remains at or below 0^0C for at least two years". Generally, the surface layer that freezes and thaws annually is the "active layer" with the permafrost underneath. Permafrost may or may not contain moisture, and it covers about 24% of the Earth's land mass.

Permafrost increases the construction and maintenance costs of infrastructure (for example, the Alaska Highway) and as it warms and thaws it may cause damage. Beyond this, we do not understand everything about permafrost and there are still surprises, such as a massive crater that opened up in Siberia.

In addition, permafrost is a source of atmospheric carbon. Terrestrial stocks are enormous, in the range of 1,330 to 1,580 Pg of carbon in total in northern permafrost areas, which is about twice that in the atmosphere. Releases of carbon from thawing permafrost will not all happen at once. Scientists estimate that there will be about 100 Gt/year for the next 100 years or about 1/10 of anthropogenic emissions.

The major message from Dr. Lewkowicz was that at some point in the future, if we haven't taken action to stop the permafrost "car", we will find that the reverse gear does not exist.

Sea Ice – Dr. Bruno Tremblay, Associate Professor, Department of Atmospheric & Oceanic Sciences, McGill University

The next speaker was Dr. Bruno Tremblay who discussed ice/snow and water in the Arctic Ocean. He reviewed the current data showing sea ice decline of about 10% per decade, and examined the possibility of recovery of the ice. The Beaufort Gyre interaction with ice has changed since the 1980's and 1990's when there was little motion of the solid ice sheet, and losses were driven by melt from summer heat. Now ice travels much further, and winter processes are becoming relatively more important. Circulation patterns are also changing in the Arctic; a variety of processes such as storms, eddy shedding, and melt pond feedback can increase melting.

These changes are causing mismatches in what northern species require to be successful. For example, polar bears eat ringed seal which needs snow cover to survive. If the seals do poorly the bears have a harder time. This past, cold winter in the eastern part of Canada caused by the polar vortex shift causing a meandering jet stream will likely be more prevalent in the future. Dr. Tremblay left us with the question, "*Are we reaching a tipping point? If we reduce carbon dioxide emissions will the sea ice recover?"*

Biodiversity – Dr. Risa Smith, International Chair, Conservation of Arctic Flora and Fauna (CAFF) working group of the Arctic Council

Dr. Risa Smith provided a summary of the work on Arctic Species Trend Indices (ASTI) under the Conservation of Arctic Flora and Fauna (CAFF). Some of Dr. Smith's highlights from the report included:

- The average population of Arctic species increased by 16% between 1970 and 2004, however, this is not consistent across biomes, regions, and taxa.
- High Arctic species populations have decreased by an average of 26% between 1970 and 2004.
- Low Arctic species populations, largely dominated by marine species, have increased by an average of 46%.
- Data in the Low Arctic index is heavily biased by Eastern Bering Sea populations, many of which have experienced dramatic increases such as improved stocks from historical overharvest.
- Arctic grazing species (aside from migratory geese) have declined 20% between 1985 and 2004. The reason for the decline is unknown.
- Migratory Arctic nesting geese species have almost doubled since the 1970s largely due to increased agricultural waste.

Dr. Smith went on to illustrate the complexities of interpreting such data with descriptions of some specific situations. For example, walruses need large sea ice to haul out on, breed and give birth. Today there are huge colonies of walruses hauling out on small floes with the difficulties that their babies are more frequently crushed and food is not as close by. However not all wildlife issues are driven only by changes in the Arctic. In the case of the 'Red Knots' shorebird, their numbers are plunging due to the combination of a timing mismatch for successful egg laying in the Arctic, and the loss of habitat in their migration stop-over resting areas.

In summary, Dr. Smith said biological responses vary geographically, depend on the species' ability to adapt, and that the biological effects of climate change are being observed at the ecosystem and population levels.

"The Arctic is warming at about twice the rate of the global average"

World Wildlife Fund
Global Arctic Programme
Fact Sheet 2012

Black Carbon – Erika Rosenthal, Staff Attorney, International Program, Earthjustice; Contributor to the Arctic Black Carbon Framework

Erika Rosenthal presented "*Enhanced Black Carbon and Methane Reductions: An Arctic Council Framework for Action".* According to Ms. Rosenthal, Northern people are observing changes in climate today. She presented a series of attestations, such as *"I notice the depletion of animals more and more*" by Grand Chief Ruth Massie of Lake Lebarge, Yukon.

She briefly reviewed the various aspects of climate change in the Arctic (sea level rise, ice melt, etc.) and suggested that controlling carbon dioxide emissions wasn't happening quickly enough to prevent changes already occurring. She introduced the importance of black carbon in the Arctic as a short-lived climate forcer; one where reducing the emissions would have immediate beneficial outcomes for stabilizing the situation in the Arctic.

She described activities under the Arctic Council which will address this challenge. An Expert Group has been established by the Kiruna Declaration (May, 2013) to assess regional progress, review Framework issues, and develop a regional synthesis report for Arctic Council Ministers presentation in 2015.

Indigenous Perspective (Inuit) – Terry Audla, President, Inuit Tapiriit Kanatami (ITK)

Mr. Terry Audla presented "*The Double Burden of Impacts and Campaigns".* Mr. Audla set the stage by describing Inuit Nunangat which includes 53 communities across the

Inuvialuit Settlement Region (Northwest Territories), Nunavut, Nunavik (Northern Quebec), and Nunatsiavut (Northern Labrador), land claims regions. As such, he represents an area almost the size of Europe, with 50% of Canada's coastline and 40% of Canada's land mass and a population of about 60,000. Between 2006 and 2011 the population increased by 18% and the median age is 23.

In all regions, people observe that the environment and weather have become more unpredictable, and that sea ice and weather are changing. This has serious impacts on livelihoods, especially hunting. In the North, 90% of those who harvest wildlife share with other households. Seventy percent (70%) of food depends on hunting and food insecurity is six times what it is for average southern Canadians. The area is governed by co-management where game and wildlife management councils play key roles. Traditional knowledge is brought forward into these processes.

While according to Mr. Audla, the Inuit call for action on climate change, Southerners use the Arctic and its wildlife as climate change icons. Southerners lack knowledge of the Inuit way of life and misinformed campaigns can have impacts on the Inuit and real conservation efforts. We need to do better.

United States Ambassador to Canada, Mr. Bruce Heyman congratulated the Forum and its partners, WWF, and Arctic21, on the successful event and gave a preview of the United States Arctic Council two year term strategy that will see Mr. John Kerry as the Chair. The three priorities for the Arctic Council under the US Chair include:

1) Arctic Ocean Safety; Security and Stewardship;

2) Climate Change; and,

3) improving the economies and living conditions in the North.

He lauded the close partnership of the US and Canada in the north and mentioned collaborations such as joint Search and Rescue exercises.

In summary, all the presenters provided a consistent view of the climate situation in the Arctic: climate change, which has been underway and predicted for decades, is being seen now in the physical, biological, and socio/cultural aspects of the north; action by southern governments to control carbon dioxide to date is too little, and sadly likely too late to stabilize or reverse the changes. Despite this gloomy outlook, all presenters concluded by stating that there are things that can be done, such as reducing black carbon emissions, new business opportunities like greenhouses, and adapting to the changes and planning for an evolving future. The big question for all of us is whether, with best efforts on the part of the Arctic Council and its eight Member States, we humans can manage the scale and rate of change occurring in the Arctic?

The Future of the Weather Enterprise

by Jack Hayes[6], Harinder Ahluwalia[7] and Jim Abraham[8]

At a time when the impacts of weather and climate are still growing dramatically, it is important to look for strategies to strengthen the science and technology that have resulted in substantial improvements in the skill of weather predictions and services over the past four decades. It was not that long ago – when many baby-boomers were just entering the workforce – that accurate, reliable forecasts did not extend beyond 24 hours. Today, high-quality five to seven day forecasts are the norm. This improvement has resulted in lives being saved and avoidable damage and economic impacts being averted. But much more needs to be done to achieve the full potential societal benefit that can be realized from the products and services provided by the Weather Enterprise.

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The World Weather Open Science Conference (WWOSC-2014) included a Special Session on The Future of the Weather Enterprise, aimed at advancing discussion on the collaboration between the private, public, and academic sectors. WMO (World Meteorological Organization) Deputy Secretary-General Jerry Lengaosa participated in one of the panels, which he noted "embraced not only the science and the technical community, but also the end user community." He viewed the outcomes as "important in doing two things: first is setting priorities for WMO programmes going forward; and, second, in providing a focus for building new partnerships and on strengthening existing ones."

An unprecedented conversation

Three separate panels were conducted – the first two explored the important issues and problems and the final panel was oriented towards finding solutions. Panellists included recognized leaders from the global weather community. The topics stimulated dynamic discussions between participants, including members of the audience. There were a number of common elements raised, which will require serious consideration by all components of the Weather Enterprise.

Panel 1: Weather Services Infrastructure: Sustaining what we have and building for tomorrow - Infrastructure was defined as anything necessary to design, develop, and deliver products and services such as weather and climate observations, models and numerical weather prediction, and applications for specific customer decision-making needs. It also includes the underlying information technologies (data processing, visualization, communications) as well as the education, training, and management of people – weather service providers, research and development scientists and, especially, clients and users.

Panel 2: Weather Services – Present Status, Trends, and Innovations - Weather services were defined as the research and development, production, delivery and evaluation of weather, water and climate information, and knowledge to support customer decision-making. Customers were broadly defined to include governmental, non-governmental, public, industrial and academic agencies, organizations, and enterprises.

Panel 3: Enhancing Weather Community Collaboration to Meet Shared Goals for the Weather Enterprise - Strategies to advance dialogue on the collaboration of private, public and academic elements of the weather enterprise, and next steps that would start the weather community down this path.

Panel 1	***Panel 2***	***Panel 3***
Moderator: David Parsons Director School of Meteorology University of Oklahoma	**Moderator: Jim Abraham** Director-General Monitoring (ret) Environment Canada	**Moderator: Jack Hayes** Senior Vice-President Harris Corporation
Kristin Lyng Chief Legal Officer Norwegian Meteorological Institute	**David Kenny** CEO The Weather Company	**Jerry Lengoasa** Deputy Secretary-General WMO
Bob Marshall CEO Earth Networks	**Barry Myers** CEO Accuweather	**Harinder Ahluwalia** President Canadian Meteorological and Oceanographic Society
Eric Webster Vice-President Exelis Geospatial Systems	**Michael Eilts** CEO Weather Decision Technologies	**Bill Gail** President American Meteorological Society
Anne Miglarese President Planet IQ	**David Grimes** Assistant Deputy Minister Meteorological Service Canada	**Tom Bogdan** President UCAR
Ajit Tyagi Director-General (ret) Indian Meteorological Department	**Hans-Joachim Koppert** Head of Business Deutscher Wetter Dienst	**Brian Day** President WMO Hydro-Meteorological Equipment & Instruments Association
Julia Slingo Chief Scientist UK Met Office	**Roland Stull** Professor University of British Columbia	**Louis Uccellini** Director US National Weather Service

Collaborating for societal benefit

At the outset, there was an implicit understanding that the Weather Enterprise comprised the public, private, and academic sectors. However, panelists made a key point concerning the importance of recognizing contributions from non-governmental organizations such as the scientific and professional societies that can act as intermediaries between the three traditional sectors. Tom Bogdan, the President of the University Corporation for Atmospheric Research (UCAR) reinforced this point: "*we have foundations that are also playing a very large part in our world… these four groups need to start to come together and actually work as a team because they are seeing their business model changing, they are seeing their customer base changing, and they are seeing their global impact changing*." Furthermore, the panels agreed on the benefit of having users of the information produced by the operational components of the Weather Enterprise at the table, given their key role in ensuring societal benefit of weather, water, and climate services.

During the discussions, it was clear that developing nations and, in particular, least developed countries continue to require significant attention. Ajit Tyagi, from the Indian Meteorological Department added, *"A caveat is that this Weather Enterprise consists of countries which are at different stages of economic, social, political and scientific development, and, therefore, are not homogeneous*." The panellists recognized that WMO could play an important role in strengthening international integration of the Weather Enterprise through its capacity building.

There was also common accord on the benefits of international collaboration to allay the rising costs of the infrastructure required for a healthy Weather Enterprise such as space-based satellite observing systems and high performance computing. In fact, relationships need to be strengthened between partners who are well positioned to assist the Weather Enterprise in achieving its objectives.

David Kenney, the Chief Executive Officer (CEO) of the Weather Company shared his passion, *"I am just so excited about our investments in the science and our ability to reduce error, so more people can take action and make better decisions*." He recommended strengthening the relationship between the Weather Enterprise and Silicon Valley in order to take advantage of their expertise in making Big Data available via mobile technology. "*Everything that's happening today in Silicon Valley is Big Data*," he stated.

Indeed, the availability of data was an important part of the discussion on all three panels, with many of the participants promoting the benefits of an "Open Data" policy. Kristin Lyng from the Norwegian Meteorological Institute challenged the group to enable access to meteorological data. "*If the National Institutes are to have a role in the future Weather Enterprise, we should do our job… and we should make data and services open and available*." Bob Marshall, CEO of Earth Networks, reinforced the benefits of public/private partnerships and how they can accelerate the availability of critical weather observations, *"I think we have a great opportunity ahead.*"

Jack Hayes, the Chair of the committee that planned the Special Session, thanked all of the participants for their commitment and leadership, adding, "*I was moved by the presentations and the collective sense of purpose. Our sense of purpose is to better the fate of society in our lifetime, and future lifetimes*."

The outcome of the Special Session, A White Paper on *Future Challenges and Opportunities*, currently in preparation, will serve as an important supporting document for further discussions at the upcoming World Meteorological Congress.

Jack Hayes, moderator panel #3, addressing the audience

Prière de noter que la version française suit.

Introduction to the Special Issue (53-1)

Atmosphere-Ocean

Proceedings of the Twenty-Second QOS

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1. Background

The twenty-second Quadrennial Ozone Symposium (QOS) was held in Toronto in August 2012, a year that marked a number of anniversaries of events related to the study of ozone and connected to Canada. These include the 50-year anniversary of the founding of the World Ozone Data Centre (now the World Ozone and Ultraviolet radiation Data Centre; WOUDC) by Environment Canada scientist Carleton Mateer; the 30-year anniversary of the delivery of the first commercial Brewer Ozone Spectrophotometer to Thessaloniki in Greece; the 25-year anniversary of the signing of the Montréal Protocol on Substances that Deplete the Ozone Layer (a protocol to the Vienna Convention for the Protection of the Ozone Layer) in Montréal; and the 20-year anniversary of the introduction of the Ultraviolet (UV) Index in Canada. These anniversaries speak to the strong commitment that Canada has had to ozone measurement and ozone science.

The twenty-second symposium is also notable for another reason—it was the first QOS to take place after the discovery of the first Arctic ozone hole (Manney *et al*., 2011). A number of papers were presented addressing that event. The QOS2012 saw nearly 300 scientists and students come together to share their research in Toronto. Attendees from 30 countries contributed more than 200 abstracts; 213 posters and 105 oral talks were presented. There are 15 papers in this special issue of *Atmosphere-Ocean.*

2. History of the ozone symposium

The QOS has a long history; the first meeting was held in Paris in 1929. The second meeting was held in 1936 in Oxford, England, and was hosted by Gordon Dobson. Figure 1 is a group photograph from the 1936 meeting. Many of the names of people in the photograph have become familiar to anyone who studies ozone. Table 1 (on page 110) lists the meetings and their locations as derived from the report of Rumen Bojkov (2010) and the website of the International Ozone Commission (IOC; http://ioc.atmos.illinois.edu/). The IOC played an important role, working with the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), in the creation of the international ozone assessment process.

3. Ground-based ozone observations

It was a personal pleasure for me, after working in the ozone field for over 40 years, to have the opportunity to host the QOS in Toronto, the home of Environment Canada's ozone monitoring program. A number of the papers presented at QOS2012 provided data from the use of Brewer Ozone Spectrophotometers. The development of the "Brewer" is a Canadian story and also a Toronto story. In the 1960s, David Wardle, as a graduate student under the supervision of Desmond Walshaw at Cambridge University in England, developed a two-channel diffraction grating spectrophotometer that he used to take measurements of ozone using starlight during the polar winter at Resolute Bay in the Canadian Arctic. After completing his Ph.D., he went to work with Alan Brewer at the University of Toronto. Together with Brewer, he pursued the design of a multi-wavelength spectrophotometer to measure ozone. James Kerr and the author worked with Brewer and Wardle and continued developing the instrument after Wardle left for a position at Macdonald College in Montréal. By 1975 Kerr, Wardle, and the author were all working at the Atmospheric Environment Service of Environment Canada (EC) in Toronto. In the late 1970s, WMO requested that the department pursue the commercial development of the spectrophotometer as a replacement for the Dobson Ozone Spectrophotometers in the global ozone network.

A Canadian company called Sci-Tec Instruments Inc. in Saskatoon, Saskatchewan, was selected by competition to manufacture the instrument for commercial sale. Three instruments were constructed in 1982 with the first, instrument #005, going to Greece. The instrument was acquired by the Laboratory of Atmospheric Physics at the University of Thessaloniki, led by Prof. Christos Zerefos, now president of the IOC. The author and professor Christos Zerefos are shown in Fig. 2 (see page 110); the photograph was taken at QOS2012. Once the first three Brewers were in service, a design modification was made to allow the instrument to measure global UV radiation. This led to the development of the UV Index and the UV Index forecast at EC, which were introduced in 1992. Brewers are now made by Kipp & Zonen B.V. of Delft, the Netherlands. The role of the more than 200 Brewers in the global observing system was well-represented at QOS2012.

[1] Conference Convenor and Guest Editor

Fig. 1 This group photo was taken at the second ozone symposium in Oxford England in 1936. Many of the names of people in the photograph such as Dobson, Chapman, and Götz are now well known to anyone working in the field (photograph from the Oxford University archive contributed by Charles Welch [University of Oxford, 2014]).

Fig. 1. Cette photographie de groupe a été prise lors du deuxième symposium sur l'ozone à Oxford, en Angleterre, en 1936. Le nom de plusieurs des personnes présentes sur la photo, comme Dobson, Chapman et Götz, est maintenant bien connu de tous ceux qui étudient l'ozone [photographie tirée des archives de l'Université d'Oxford, fournie par Charles Welch (University of Oxford, 2014)]

Of course the Brewer is not the only ground-based measurement device nor is it the most important. Dobsons, LIDAR, filter instruments, ozonesondes, and remote-sounding measurements from space all play an important role in maintaining a global picture of the ozone layer. Papers representing all these measurement techniques are part of each Symposium.

4. The importance of the ozone community

The QOS has long been an essential vehicle for advancing ozone science internationally. It has informed the members of the IOC and allowed it to influence the WMO and governments around the world. It led to the 1985 agreement in principle to pursue the development of an international treaty to protect the ozone layer from the destructive potential of ozone-depleting substances, notably chlorofluorocarbons. The Vienna Convention for the Protection of the Ozone Layer was the first outcome of that meeting. It was followed by the Montréal Protocol on Substances that Deplete the Ozone Layer, which was signed in Montréal in September, 1987. Now, 25 years later, it is clear that the Protocol and its amendments have limited the damage from ozone-depleting substances and stabilized the ozone layer. The protocol has successfully limited the release of ozone-depleting substances to levels low enough to enable the eventual recovery of the ozone layer to its former state.

The Montréal Protocol is a sterling example of the power that science and international efforts can have in protecting the environment and altering our behaviour if properly coordinated. It provides hope that our response to other serious challenges, such as climate change, will be equally successful. It also provides the lesson that sound science is essential for guiding the changes needed in society to safeguard our future. The Protocol demonstrates that the economy, as well as individual corporations, can survive regulation, provided that controls are introduced in a way that permits long-term planning and a level playing field for industries around the world.

This special issue celebrates the ongoing contribution to society made by the IOC and the ozone research community and underlines the need to continue monitoring the ozone layer and meeting to exchange information and promulgate knowledge. The ozone community now clearly recognizes the importance of keeping researchers who use groundbased and satellite-based sensors mutually informed and cooperating with each other to provide the best quality global dataset. I would like to acknowledge the important contributions of the associate editors: Jacek Kaminski, Ian McDade, Chris McLinden, Kimberly Strong, and David Tarasick. Until 2016 in Edinburgh, Scotland!

Table 1. Quadrennial Ozone Symposia,
Tableau 1. Symposiums quadriennaux sur l'ozone

No	Location Lieu	Year Année	No	Location Lieu	Year Année
1	Paris, France	1929	12	Arosa, Switzerland	1972
2	Oxford, UK	1936	13	Dresden, Germany	1976
3	Oslo, Norway	1948	14	Boulder, USA	1980
4	Brussels, Belgium	1951	15	Halkidiki, Greece	1984
5	Oxford, UK	1952	16	Göttingen, Germany	1988
6	Rome, Italy	1954	17	Charlottes-ville, USA	1992
7	Toronto, Canada	1957	18	L'Aquila, Italy	1996
8	Oxford, UK	1959	19	Sapporo, Japan	2000
9	Arosa, Switzerland	1961	20	Kos, Greece	2004
10	Albuquer-que, USA	1964	21	Tromsø, Norway	2008
11	Monaco	1968	22	Toronto, Canada	2012

Acknowledgements
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Please note that the English version precedes.

Introduction du numéro spécial (53-1)

Atmosphere-Ocean

Comptes-rendus du vingt-deuxième SQO

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1. Toile de fond

Le Vingt-deuxième Symposium quadriennal sur l'ozone (SQO) s'est tenu à Toronto en août 2012, une année qui a marqué l'anniversaire de plusieurs événements liés à l'étude de l'ozone et auxquels le Canada a participé. Parmi ceux-ci, mentionnons le 50e anniversaire de la fondation du Centre mondial des données sur l'ozone (aujourd'hui le Centre mondial des données sur l'ozone et le rayonnement ultraviolet — WOUDC) par le scientifique canadien Carleton Mateer, d'Environnement Canada; le 30e anniversaire de la livraison du premier spectrophotomètre Brewer commercial pour la mesure de l'ozone à Thessaloniki, en Grèce; le 25e anniversaire de la signature du Protocole de Montréal relatif à des substances qui appauvrissent la couche d'ozone (un protocole de la Convention de Vienne pour la protection de la couche d'ozone) à Montréal; et le 20e anniversaire de l'introduction de l'indice ultraviolet (indice UV) au Canada. Ces anniversaires témoignent du ferme engagement du Canada à l'égard de la mesure de l'ozone et de la science de l'ozone.

Le vingt-deuxième Symposium est également remarquable pour une autre raison : c'est le premier SQO a avoir lieu après la découverte du premier trou dans la couche d'ozone dans l'Arctique (Manney et al., 2011). Un certain nombre d'articles traitant de cet événement ont été présentés. Au SQO de 2012, près de 300 scientifiques et étudiants se sont réunis à Toronto pour discuter de leurs recherches. Des participants de 30 pays ont apporté une contribution de plus de 200 résumés; 213 affiches et 105 exposés oraux y furent présentés. Il y a 15 articles dans ce numéro spécial d'*Atmosphere-Ocean*.

2. Histoire du symposium sur l'ozone

Le SQO a une longue histoire. Le premier s'est tenu à Paris en 1929. La seconde réunion a eu lieu en 1936 à Oxford, en Angleterre, accueillie par Gordon Dobson. La Fig. 1 (voir page précédente) est une photographie de groupe de la réunion de 1936. Le nom de plusieurs des personnes présentes sur la photo est devenu familier pour tous ceux qui étudient l'ozone. Le Tableau 1 (haut et à gauche de

[2] Animateur de la conférence et rédacteur invité

cette page) donne la liste des réunions et des endroits où elles ont eu lieu, selon le rapport de Rumen Bojkov (2010) et le site Web de la Commission internationale de l'ozone (CIO – http://ioc.atmos.illinois.edu/). La CIO a joué un rôle important, de concert avec l'Organisation météorologique mondiale (OMM) et le Programme des Nations Unies pour l'environnement (PNUE), dans la création du processus international d'évaluation de l'ozone.

3. Observations de l'ozone à partir du sol

Ce fut un réel plaisir pour moi, après avoir travaillé dans le domaine de l'ozone pendant plus de 40 ans, d'avoir la chance d'accueillir le SQO à Toronto, port d'attache du programme de surveillance de l'ozone d'Environnement Canada. Certains des articles soumis au SQO2012 présentaient des données obtenues en utilisant des spectrophotomètres Brewer de mesure de l'ozone. La mise au point du « Brewer » est une histoire canadienne et aussi une histoire Torontoise. Durant les années 1960, David Wardle, un étudiant diplômé, sous la supervision de Desmond Walshaw, de l'Université de Cambridge, en Angleterre, a mis au point un spectrophotomètre à réseau de diffraction à deux canaux qu'il utilisa pour obtenir des mesures d'ozone à partir de la lumière des étoiles durant la nuit polaire à Resolute Bay, dans l'Arctique canadien. Après avoir terminé son doctorat, il est allé travailler avec Alan Brewer à l'Université de Toronto. Avec Brewer, il a travaillé à la conception d'un spectrophotomètre multilongueur d'onde pour mesurer l'ozone. James Kerr et l'auteur ont travaillé avec Brewer et Wardle et ont continué à le mettre au point après que Wardle eut quitté pour un poste au Collège Macdonald, à Montréal. En 1975, Kerr, Wardle et l'auteur travaillaient tous au Service de l'environnement atmosphérique, d'Environnement Canada (EC), à Toronto. Vers la fin des années 1970, l'OMM a demandé que le ministère s'efforce de produire une version commerciale du spectrophotomètre pour remplacer les spectrophotomètres Dobson de mesure de l'ozone du réseau mondial de mesure de l'ozone.

Une compagnie canadienne appelée Sci-Tec Instruments Inc., de Saskatoon, en Saskatchewan, a été sélectionnée par appel d'offres compétitif pour fabriquer l'instrument en vue de sa vente commerciale. Les instruments ont été construits en 1982 et le premier, l'instrument n° 005, est allé à la Grèce. L'instrument a été acheté par le Laboratoire de physique atmosphérique de l'Université de Thessaloniki, à l'initiative du professeur Christos Zerefos, aujourd'hui président de la CIO. L'auteur et le professeur Christos Zerefos apparaissent sur la Fig. 2; la photographie a été prise durant le SQO2012. Après la mise en service des trois premiers Brewers, une modification dans la conception fut apportée pour permettre à l'instrument de mesurer le rayonnement UV global. Cela conduisit à mise au point de l'indice UV et à la prévision de l'indice UV à EC, qui furent introduits en 1992. Les Brewers sont maintenant fabriqués par Kipp & Zonen B.V., de Delft, aux Pays-Bas. Le rôle des plus de 200 Brewers dans le système mondial d'observation

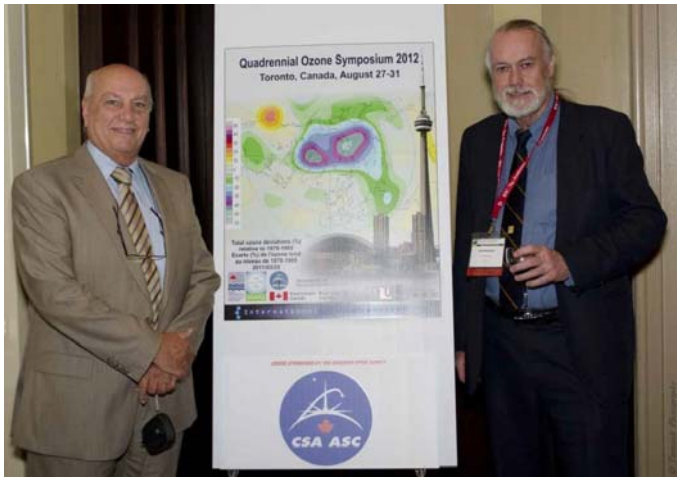

Fig. 2 Professors Christos Zerefos and Tom McElroy at the 2012 Quadrennial Ozone Symposium. McElroy delivered the first Brewer manufactured, #005, to Thessaloniki in 1982 (photo courtesy of Tarasick Photography).

Fig. 2. Professeurs Christos Zerefos et Tom McElroy au Symposium quadriennal sur l'ozone de 2012. McElroy a livré le premier Brewer fabriqué, portant le n° 005, à Thessaloniki, en 1982 (photographie gracieuseté de Tarasick Photography).

était bien en évidence au SQO2012.

Bien sûr, le Brewer n'est pas le seul appareil à pouvoir mesurer l'ozone à partir du sol et n'est pas le plus important d'entre eux. Les Dobsons, LIDAR, instruments à filtre, sondes d'ozone et mesures de télésondage depuis l'espace jouent tous un rôle important en fournissant une image planétaire de la couche d'ozone. Des articles concernant toutes ces méthodes de mesure ont été présentés à chacun des symposiums.

4. Importance de la communauté de l'ozone

Le SQO a longtemps été un véhicule essentiel pour l'avancement de la science de l'ozone à l'échelle internationale. Il a informé les membres de la CIO et a permis à celle-ci d'influencer l'OMM et les gouvernements de par le monde. Il a mené à l'entente de principe de 1985 visant à établir un traité international pour protéger la couche d'ozone du pouvoir destructeur des substances pouvant détruire l'ozone, notamment les chlorofluorocarbones. La Convention de Vienne pour la protection de la couche d'ozone a été le premier résultat de cette réunion. Elle a été suivie par le Protocole de Montréal relatif à des substances qui appauvrissent la couche d'ozone, signé à Montréal en septembre 1987. Aujourd'hui, 25 ans plus tard, il est clair que le Protocole et ses modifications ont limité les dommages des substances qui appauvrissent la couche d'ozone et stabilisé la couche d'ozone. Le Protocole a réussi à limiter le rejet de substances appauvrissant la couche d'ozone à des niveaux assez bas pour permettre l'éventuel rétablissement de la couche d'ozone jusqu'à son état antérieur.

Le Protocole de Montréal est un bel exemple de ce que la science et les efforts internationaux peuvent faire pour protéger l'environnement et modifier notre comportement s'ils sont correctement coordonnés. Il suscite l'espoir que notre réponse à d'autres enjeux importants, comme le changement climatique, sera aussi fructueuse. Il donne aussi cette leçon que des connaissances scientifiques approfondies sont essentielles pour guider les changements à apporter à la société pour garantir notre avenir. Le Protocole fournit la preuve que l'économie, tout comme les entreprises, peut survivre à la réglementation, pourvu que des contrôles soient mis en place de façon à permettre une planification à long terme et des règles du jeu équitables pour les industries partout dans le monde.

Ce numéro spécial célèbre l'engagement continu de la CIO et de la communauté de recherche sur l'ozone envers la société et souligne la nécessité de continuer à surveiller la couche d'ozone et de se réunir pour échanger des informations et diffuser la connaissance. La communauté de l'ozone reconnaît maintenant d'emblée l'importance de voir à ce que les chercheurs qui utilisent des capteurs au sol ou satelliportés se tiennent mutuellement informés et coopèrent pour fournir l'ensemble de données mondiales de la meilleure qualité possible. Je veux remercier les contribuations importantes des directeurs scientifiques associés : Jacek Kaminski, Ian McDade, Chris McLinden, Kimberly Strong, et David Tarasick. Rendez-vous en 2016 à Édimbourg, en Écosse!

Remerciements
Le travail de l'auteur bénéficie du support financier pour la Chaire de recherche industrielle ASC/ABB/CRSNG en télédetection atmosphérique (dossier #413012).

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New CMOS SIG

Aviation Meteorology

Last fall, CMOS President Harinder Ahluwalia approached me with an idea to set up a CMOS Special Interest Group (SIG) for aviation. As someone who has been involved in aviation meteorology for many years (before my retirement from Environment Canada (EC) in 2012, I was the manager responsible for the aviation program), this idea intrigued me. I have put together a plan, based on the excellent work done by Marty Taillefer for the Arctic SIG, and am looking to launch it.

The aviation transportation sector is very important in Canada. In addition to scheduled airline flights, both domestic and international, there are a myriad of air charter operations servicing smaller airports and providing air cargo services. Many of the communities in northern and isolated areas depend on aviation to bring people in and out, and to bring in goods. There are flight training schools, helicopter operations, crop dusting activities, etc.

Canada's northern latitudes means that we see four seasons of weather, and weather is often an important factor in planning and operating flights. This includes major airports such as Toronto Pearson International Airport, where strong winds dictate the active runway (and airport capacity), and both severe summer storms (lightning, wind shear) and winter severe storms (heavy snowfall, icing) present hazards that need to be considered. Fog and low-lying cloud frequently disrupt operations at major coastal airports such as Halifax Stanfield International and St. John's International, and also at many small airports in remote areas.

With the privatization of many of Transport Canada's (TC) functions in the 1990s, responsibility for aviation in Canada is now divided amongst several players. TC retains regulatory oversight, while NAV CANADA, a private not-for-profit organization, runs the Air Navigation System (ANS) for civil aviation activities and DND (Department of National Defence) does likewise for military operations.

Part of NAV CANADA's role is to provide aviation weather services, including aviation weather observations and forecasts, and flight-planning information. It contracts with the government (Environment Canada) for forecasts and some observation services. The Department of National Defence also contracts with EC for forecast and observation services.

Airports, which once were largely owned and operated by the government, have been sold and are now operated by private companies. Airlines, including Air Canada, are privately owned and operated.

Situation Chart for CYYZ

TAF Plus | SIMCOE | WATERLOO | LINNG | MANS | Rwy: 05/23 06/24RL 15/33RL

Thresholds	CYYZ METEOROLOGICAL NOWCAST : VALID AT 2015-05-13 03:50 UTC [INTW, GEM_REG_MOLTS, GEM_LAM_MOLTS, RUC, OBS, M300]																
	03:50	04:00	04:10	04:20	04:30	04:40	04:50	05:00	05:10	05:20	05:30	05:40	05:50	06:50	07:50	08:50	09:50
	OBS	+10m	+20m	+30m	+40m	+50m	+1h	+1:10h	+1:20h	+1:30h	+1:40h	+1:50h	+2h	+3h	+4h	+5h	+6h
05/23 WINDS	260 17G22	260 18G23	270 18G23	270 18G23	270 17G23	270 17G22	270 17G22	270 17G22	280 18G23	280 18G23	280 18G23	280 18G23	280 18G23	280 17G22	290 15G20	290 14G18	290 13G16
06/24RL WINDS	260 17G22	260 18G23	270 18G23	270 18G23	270 17G23	270 17G22	270 17G22	270 17G22	280 18G23	280 18G23	280 18G23	280 18G23	280 18G23	280 17G22	290 15G20	290 14G18	290 13G16
15/33RL WINDS	260 17G22	260 18G23	270 18G23	270 18G23	270 17G23	270 17G22	270 17G22	270 17G22	280 18G23	280 18G23	280 18G23	280 18G23	280 18G23	280 17G22	290 15G20	290 14G18	290 13G16
VISIBILITY	P6SM	P6SM	P6SM	P6SM	P6SM	P6SM	P6SM	P6SM	P6SM	P6SM	P6SM	P6SM	P6SM	P6SM	P6SM	P6SM	P6SM
CEILING	021	021	022	022	024	028	031	033	031	030	029	028	027	031	029	021	040
SHEAR/TURB																	
PRECIP																	
TSTM & LTNG																	
ICING																	

Thresholds	CYYZ OPERATIONS NOWCAST : VALID AT 2015-05-13 03:50 UTC [INTW, GEM_REG_MOLTS, GEM_LAM_MOLTS, RUC, OBS, M300]																
	03:50	04:00	04:10	04:20	04:30	04:40	04:50	05:00	05:10	05:20	05:30	05:40	05:50	06:50	07:50	08:50	09:50
	OBS	+10m	+20m	+30m	+40m	+50m	+1h	+1:10h	+1:20h	+1:30h	+1:40h	+1:50h	+2h	+3h	+4h	+5h	+6h
WX-ONLY AAR		70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
CAT LEVEL	MVFR	MVFR	MVFR	MVFR	MVFR	VFR	VFR	VFR	VFR	VFR	VFR	VFR	VFR	VFR	VFR	MVFR	VFR
05/23 COND																	
06/24RL COND																	
15/33RL COND																	

Figure caption: Shown here is an example of current aviation research in Canada. This "nowcast" product for Toronto Pearson International Airport shows the evolution of several aviation parameters over the next few hours, based on recent weather observations and trends, and on Numerical Weather Prediction output. The info is colour-coded to show its impact on airport operations.

There are a few private companies that provide aviation services in Canada, including Scotia Weather, which provides forecasts for a few helicopter bases.

With responsibility distributed across several bodies, there is a need to coordinate efforts. NAV CANADA has a couple of committees that include representatives from the government, airlines, airports, and unions. It's at these meetings where concerns are raised, priorities are discussed, and plans developed.

Aviation (and weather) is international in scope, and there are two bodies that look after coordinating aviation activities: the International Civil Aviation Organization (ICAO), which represents the users and operators and their needs, and the World Meteorological Organization (WMO), which represents the national weather services units (the weather providers).

There are two important angles that need to be considered in planning aviation operations: safety and efficiency. Weather is an important factor in both of these angles, and there is a desire to improve both the accuracy (reliability) of aviation weather forecasts and also to better factor weather info into flight planning and operation. The latter is becoming more recognized as being important, and addressing it requires aviation users and weather service providers to better understand each other's operation and capabilities.

NAV CANADA, since its creation in 1996, has invested a lot of money into improving its system with the end goal of providing savings to its users; e.g. by allowing flights to better utilize favourable winds and planes to operate more closely together. It lays out its plans in annual publications. Over the next several years, it plans to continue to upgrade its systems, meaning that there's an ongoing role (and need) to carefully consider weather angles.

One of my observations is that while many of the factors are being considered when developing plans for the future, aviation-related science and research is not particularly well integrated into those discussions nor is being considered carefully enough. For example, better decisions depend on better weather information, including better forecasts, but improvement in weather information is limited by a lack of

dedicated and ongoing funding.

TC funds some aviation research and there is access to a small innovation fund (which Scotia Weather has tapped). Environment Canada continues to invest heavily in improving its numerical weather models, which benefits all aspects of meteorology including aviation (e.g. more accurate high-level winds, the probability of severe convection and snow). It also invests in techniques to predict the short-term evolution of weather (nowcasting) which benefits aviation. However, it does not focus much effort on important aviation parameters such as icing, turbulence, crosswinds, low ceilings and visibility, and wake turbulence.

NAV CANADA, in turn, will fund research related to improving the forecasting of these parameters, but it takes a businesslike approach; e.g. it needs to be convinced that an investment in research will return savings to it and/or to its clients; e.g. fuel saved, fewer flight diversions and cancellations, more on-time flights.

To me, this aspect of encouraging and promoting aviation-related research is a natural one for CMOS, via an Aviation SIG, to take on. It can connect the people in government, the private sector, and academia, and it can advocate for the value of investing in aviation meteorology.

This SIG would serve as an advisory organization to the CMOS Executive and Council on matters related to aviation. It would provide a forum for government, public, private, and academia in Canada to work collaboratively in support of issues related to aviation meteorology.

From the terms of reference the **objectives** are:

● Ensuring that CMOS' interests related to aviation meteorology are looked after, and in a coordinated and consistent manner.

● Acting as an advisory group to the Executive and Council and representing CMOS in discussions related to aviation meteorology in Canada.

● Increasing the awareness of planners, meteorologists, and scientists regarding the impact on weather on aviation operations.

● Increasing the awareness of the use of meteorology and related sciences to aviation activities and issues, and helping to ensure that those needs are met.

● Creating a neutral forum in which parties representing government, public, private, and academic (both in Canada and in other countries) can work together in support of aviation meteorology, data and scientific studies.

● Engaging with aviation groups and industry about aviation meteorology, data and scientific studies; specifically, to raise awareness of the application of aviation meteorology to assist in aviation operations for both economic and safety reasons. (Note: this SIG would supplement, not duplicate or interfere with groups and bodies that currently exist within government and the aviation industry that look after the various aspects of aviation weather.)

● Promoting the need for Canadian involvement in aviation-related meteorological research, specifically research of relevance to Canada aviation.

● Facilitating the publishing of articles related to aviation meteorology in *Atmosphere-Ocean* and elsewhere.

The group will normally conduct its business by electronic means such as e-mail, phone, and video conferencing, and it will also explore the tapping of other technologies, such as a newsletter or blog on aviation weather activities and plans, and tapping Social Media (SM) tools, such as a dedicated Facebook group and Twitter account.

It will organize sessions on aviation meteorology at the CMOS Congress, and will collaborate with other national meteorological societies (such as the American Meteorological Society and the Royal Meteorological Society) on aviation-related activities and conferences.

Members who are interested in this SIG should contact me at the email address below.

Steve Ricketts, stevericketts@telus.net
Retired meteorologist, Environment Canada
Aviation consultant (SCR Consulting), Edmonton, Alberta

Next Issue *CMOS Bulletin SCMO*

Next issue of the *CMOS Bulletin SCMO* will be published in **August 2015.** Please send your articles, notes, workshop reports or news items before **July 3rd, 2015** to the electronic address given at the top of page 82. We have an URGENT need for your written contributions.

Prochain numéro du *CMOS Bulletin SCMO*

Le prochain numéro du *CMOS Bulletin SCMO* paraîtra en **août 2015.** Prière de nous faire parvenir avant le **3 juillet 2015** vos articles, notes, rapports d'atelier ou nouvelles à l'adresse électronique indiquée au haut de la page 82. Nous avons un besoin URGENT de vos contributions écrites.

BOOK REVIEW / REVUE de LITTÉRATURE

Sea of Storms – A History of Hurricanes in the Greater Caribbean from Columbus to Katrina

by Stuart B. Schwartz

Princeton University Press, 2015, Hardcover, US $35.00 / £24.95, 472 pp.
ISBN: 9780691157566

Book reviewed by Bob Jones[1]

Readers may have seen my recent review of *Father Benito Viñes - The 19th-Century Life and Contributions of a Cuban Hurricane Observer and Scientist* in the December 2014 Bulletin. When *Sea of Storms* arrived, I turned to the index to see if *Fr. Viñes* appeared and was gratified to see five references. Thinking of reading about more historic hurricane science, I plunged in eagerly.

I was not disappointed, as the scope and coverage in time of this book exceeded the view from Cuba by *Fr. Viñes*, but it surprised me in its lack of science. Nevertheless, *Sea of Storms* is recommended to *CMOS Bulletin SCMO* readers especially those who enjoy descriptive history and geography. In this book they will find some surprises, particularly changed stereotypical views of idyllic Caribbean beaches and lush tropical islands depicted in winter escape travel brochures.

Sea of Storms is a history book which followed from a *Lawrence Stone Lecture* given recently at Princeton University by Stuart Schwartz. Stuart Schwartz is a professor of history and chair of the Council on Latin American and Iberian Studies at Yale University. Lawrence Stone was a noted historian from Oxford and Princeton universities. Historians selected for these lectures often follow up with a book covering their talks. Therefore, *Sea of Storms* is very well documented with a 12-page preface, 49 pages of reference notes and footnotes, a 31-page bibliography, a 12-page index, five pages of acknowledgements, and even one page of defined acronyms.

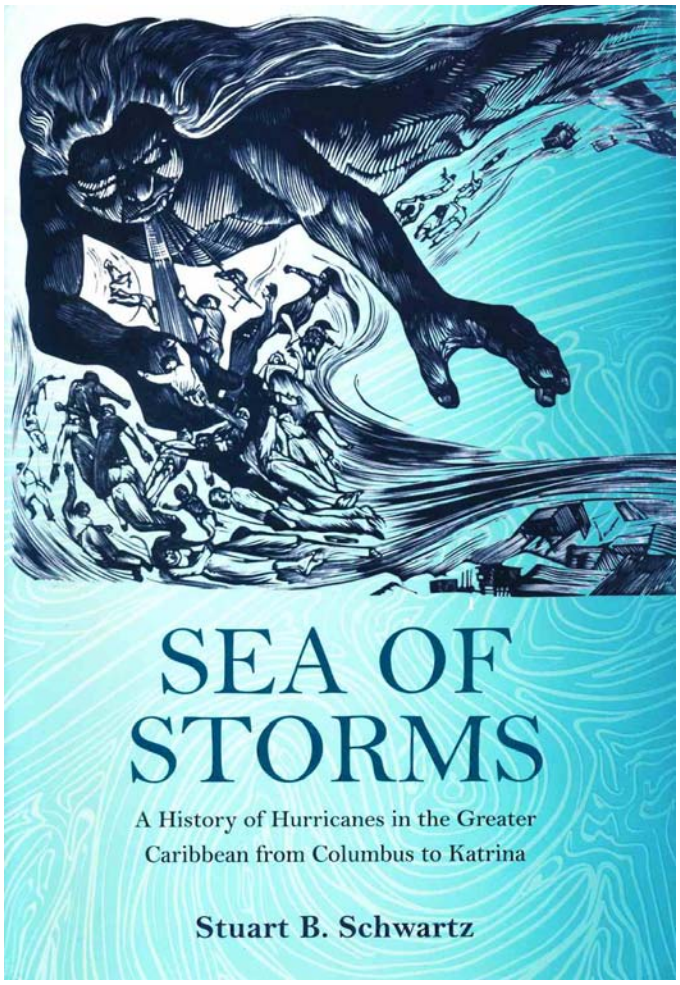
Schwartz begins by explaining the origins of the word "hurricane" and even discovered the Cuban aboriginal (*Taino* people) source, on pottery dating from before Columbus, for the now familiar comma symbol which designates hurricanes on weather maps. The first eight chapters are descriptions of hurricanes and their devastating effects in the greater Caribbean area. Locations included the continental Americas, and time beginning with Columbus and moving through colonial times into the 20th Century when forecasting and mitigation strategies were becoming better developed. As the centuries progressed, the focus becomes stronger on Puerto Rico and Cuba, but the author tries to cover all the major storms and locations where they hit. In his descriptions, high wind speeds, lowest recorded barometric pressures (once barometers were invented), number of ships sunk and most importantly numbers of lives lost, are recorded for many storms. The scientist in me cried out for a matrix or spreadsheet of all this data from which we could draw conclusions. This has likely been done elsewhere, and since *Sea of Storms* is a history book, few maps, charts or tables can be found. Instead, much is written about the effects hurricanes had on political aspects, religious beliefs, and ambitions of settlers and colonial rulers of the islands.

A criticism of these first eight chapters is that the author jumps back and forth in time and place as he explores his chosen themes of conquest, war, slavery, recovery, and politics. The book does progress forward in time after Columbus, but the order is often obscured by the many details described.

The last chapter is about the recent impacts on the USA of *Katrina* and *Sandy*. Some science is mentioned here such as the discovery that El Niño / La Niña events can be correlated to active and less active hurricane seasons. Climate change due to fossil fuel burning is mentioned as well, but the author concludes that the frequency and severity of hurricanes are continuing unabated, with low and high cycles that have been detected since Columbus' time.

In summary, *Sea of Storms* points out that colonization of the Caribbean by Spain and several European countries, involved deforestation, huge sugar plantations, and slave labourers from Africa undertaken in the shadow of hurricanes and other natural disasters which plague the region. In the history of every island, Schwartz unearthed horrific stories of the hurricanes, and these are in addition to earthquakes, insect plagues, and volcanic eruptions

[1] CMOS Archivist, Ottawa, Ontario.



affecting many islands. These difficulties were far worse than the colonists experienced in their European homelands. To maintain the plantations, the number of slaves reached 80% or more of the populations in the areas most visited by hurricanes, and the losses of lives and property by the poor always far exceeded the rich. No area in the Caribbean Sea is safe from a big storm. Readers of *Sea of Storms* will conclude that those idyllic vacation spots we snowbirds take for granted are not always the paradises they appear. As if the hurricanes and natural hazards were not enough, the residents and slaves in the Caribbean experienced centuries of brutal conquests and re-conquests from varying colonial powers. This is in stark contrast to our tamer Canadian history.

Note: An excellent example of the above paradise contradiction is the city of San Juan, Puerto Rico. Schwartz writes that on at least one occasion San Juan was completely levelled by a strong hurricane with lives lost in the thousands. This reviewer has visited San Juan several times while with Canadian Navy and always found the city and the region to be a delightful tropical environment in the winter months (non hurricane season). It is now clear to the author of this review that such a tropical paradise was an illusion, founded upon the seasonal delights of the Caribbean in non-hurricane season.

Particles in the Coastal Ocean: Theory and Applications

Daniel R. Lynch, David A. Greenberg,
Ata Bilgili, Dennis J. McGillicuddy, Jr.,
James P. Manning, Alfredo L. Aretxabaleta

Cambridge University Press, ISBN 978-1-107-06175-0
2015, Hardcover, xxvii + 510 pages, $130.95

Book reviewed by J.J.P. Smith[2]

In recent months, Canadians have been confronted with dramatic, if comparatively minor, incidents of coastal pollution. The *CMOS Bulletin SCMO* reported (in a paper by John N. Smith and others, April 2015) that radioactive materials have arrived in the waters of British Columbia after being transported by ocean circulation from a damaged nuclear power station in Japan. *"Public concerns have focused on the eventual magnitude of the Fukushima radioactivity signal in the ocean and the impact of this radioactivity in marine organisms*." (p. 55) The same month, a cargo ship anchored near Vancouver spilled fuel oil, the event receiving much public attention. For their part, Americans who reside around the Gulf Coast are reckoning with the aftermath, five years on, of the *Deepwater Horizon* petroleum disaster. The understanding of the physical processes of coastal oceans is important for public policy, governance, and the pursuit of science to reconcile complex phenomena of pollution, habitat dynamics for living resources, and responses to climate change. *Particles in the Coastal Ocean*, a much needed work, arrives at the right time.

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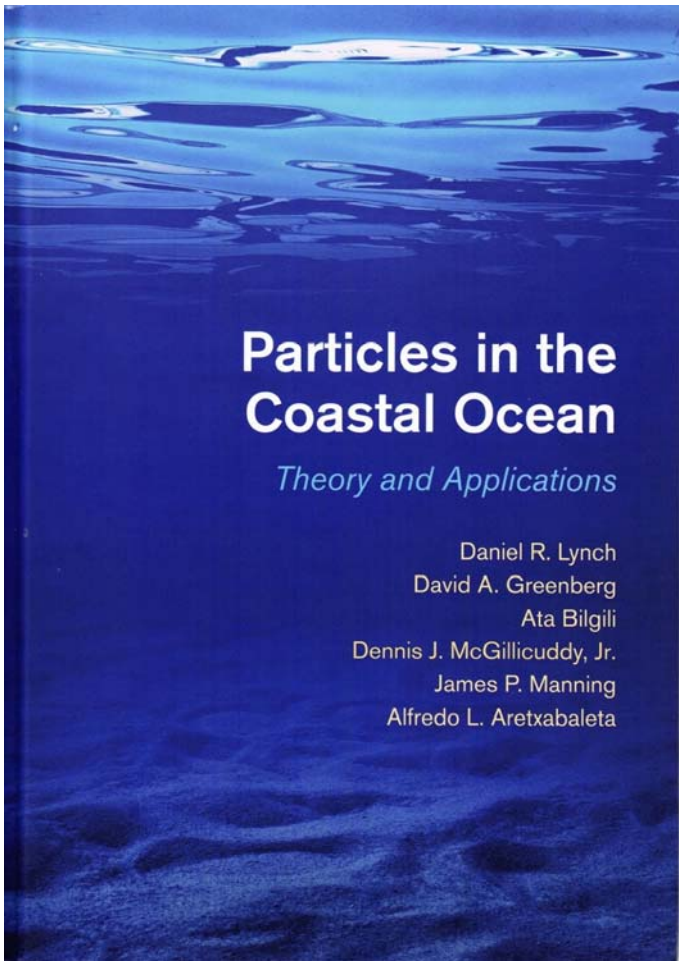
[2] McGill and Carleton Universities, and the government of the Saharawi Arab Democratic Republic



This book satisfies an ambitious project of its six authors, nothing less than a compiled work of Langrangian models essential to understanding of the movement of particles in the nearshore environment. The authors modestly note that their work is not intended to replace *"conventional descriptions of the coastal ocean*", but it is at least a unifying synthesis and therefore an important resource about particle simulation – drift, diffusion, entrainment, turbulence, and scattering in physically bounded, shallow seas. The authors define the geographic extent of their laboratory as the waters which extend across the continental shelf, an area politically and legally defined by states as the exclusive economic zone. The transport and fate of waterborne particles in this setting has been approached in the various disciplines, including physics, ocean circulation, numerical analysis and modelling, and Langrangian dynamics. *Particles in the Coastal Ocean* reconciles what is now a considerable body of research in presenting models that simulate particle dynamics.

The authors are well known in oceanography circles, experienced and published in their various disciplines of numerical methods, modelling, circulation simulation, and practical field work. David Greenberg of Canada's Bedford Institute of Oceanography is known for his four decades of research on tidal mechanisms and numerical modelling of coastal circulation. His influence on the theoretical discussion of meshes (discussed below), the core of the book's pedagogy, seems apparent.

The other authors have, not surprisingly, been associated with Woods Hole Oceanographic Institution (WHOI) or universities that are part of the northeast United States oceanographic community. Daniel Lynch in the Faculty of Engineering at Dartmouth College is a leading figure in modeling theory and author of *Natural Resource Management for Scientists and Engineers* (2009). Ata Bilgili, now at Istanbul Technical University, has done considerable work in Eulerian and Langrangian methods for tidal modeling in coastal systems and *"bed-load transport of coarse sediments*". Dennis McGillicuddy is an interdisciplinary oceanographer, known for his work in chemical ocean processes and algal bloom circulation. James Manning of NOAA's Northeast Fisheries Science Center, has been acclaimed for his drift modeling work with practical implications for fisheries. Alfredo Aretxabaleta, presently at WHOI, conducts sediment transport research for the US Geological Survey, and with McGillicuddy, Manning, and Lynch has researched the Bay of Fundy gyre.

For a composition of six authors, *Particles in the Coastal Ocean* is consistent throughout, revealing a firm sense of editing. No one chapter or thematic area seems to be the particular work of one author. Moreover, the six cite widely from the published works of others, resulting in a bibliography of more than 500 sources (including the classics of eustarine circulation and tidal mechanics by Charles Officer and David Pugh). The book is in four parts: (**I**) background; (**II**) elements; (**III**) applications; and (**IV**) appendices. The six chapters of **Part I**, across some 200 pages, ably canvas the field of particle motion and simulation in the coastal setting, addressing drifters and model validation (chapter 2), a review of statistics (chapter 3) (including fine explanations of covariance and "particles in a box"), dispersion under random walk models (chapter 4), boundary conditions (chapter 5) and turbulence closures (chapter 6). The presentation of boundaries and boundary layer methods in chapter 5 is outstanding (would that it had been available in this reviewer's undergraduate oceanography studies). Chapters in this part have useful concluding summaries.

Part II has two adeptly written chapters in 70 pages about "*the handling of unstructured grids*": meshes (their interpolation, navigation, and fields) (chapter 7), and particles and fields, here essentially the scattering of particles within elements, notably triangular meshes (chapter 8). **Part III** presents the applications of such simulation modeling in three thematic chapters of 150 pages: non-cohesive sediment transport, dispersion, and entrainment (chapter 9), oil as a "*chemically active particle*" in its nature as a parcel in the water column and its behavior in motion and dissipation (chapter 10), and biological ("biotic") particles in their dynamics, including the effects of growth cycles (chapter 11). **Part IV** is a 50-page collection of necessary ancillary formulae: series, limits, sums; complex numbers; Wiener Integrals; rates and rate limiters in ecological modeling; diffusion solutions; shear and convergence matrix for Eulerian flow; a summary of ARn recursions; and distribution properties for linear triangles. Twenty-four (24) pages of colour images which illustrate drift tracks in particular coastal settings, drawings, photos and water column graphs are at the centre of the book, usefully adding to the application studies in **Part III**.

For teachers and theorists, the heart of *Particles in the Coastal Ocean* will be **Parts I** and **II**. For those engaged in field research, what are effectively the modeling case studies at **Part III** will be invaluable. The writing here is at its best in the book, cogent and well-illustrated. This will ensure a readership beyond oceanographers concerned with modeling. Chapter 10, on oil, exemplifies the authors' ability to organize research to date and build upon it in an accessible manner. Here the book is state of the art, a balanced qualitative explanation of oil degradation and transport with well-reasoned mathematical models. The authors capably review the *Deepwater Horizon* seabed blowout, with a brief commentary about particle tracking and plume models evaluated after the event. In the discussion, they set the stage for further vital research into subsurface oil propagation and dispersion.

There are few shortcomings in *Particles in the Coastal Ocean.* While some chapters might have benefitted from longer introductory passages, chapter one usefully offers a review of large-scale coastal processes, together with a comprehensive discussion of drift dynamics in chapter 2. The review of statistics in chapter 3 could be improved by connecting the topic's relevance to the modeling discussion in later chapters, although the presentation of distribution formulae (uniform, Gaussian, Gamma, Erlang, discrete distributions, and others) is comprehensive. Perhaps a commentary about methodology in computer simulation would also add to the book, if in an appendix or a chapter. We might anticipate this in a second edition.

Particles in the Coastal Ocean deserves a place on the reference bookshelves of every oceanographer, and others such as advanced undergraduate and graduate students, fisheries and pollution researchers, coastal engineers, and fluid modeling simulation experts. This excellent book reveals the gap that existed previously, in both its subject and its quality.

Books in search of a Reviewer (Partial list)
Livres en quête d'un critique (Liste partielle)

Latest Books received / Derniers livres reçus

2015-3) *An Observer's Guide to Clouds and Weather, A Northern Primer on Prediction*, by Tony Carlson, Paul Knight, and Celia Wyckoff, American Meteorological Society and distributed by the University of Chicago Press, ISBN 978-1-935-70458-4, Paperback, 210 pages, US$30.00.

2015-12) *Thermodynamics, Kinetics, and Microphysics of Clouds,*, by Vitaly I. Khvorostyanov and Judith A. Curry, Cambridge University Press, 978-1-107-01603-3, Hardback, 782 pages, $108.95.

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BRIEF NEWS / NOUVELLES BRÈVES

Oceanography and Meteorology Working Together

Operational centre for ocean observation inauguration in Brest

The Intergovernmental Oceanographic Commission of UNESCO inaugurated the new JCOMMOPS centre with the World Meteorological Organization (WMO) on 18 March 2015. The in situ Observing Platform Support Centre of the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMMOPS), which monitors ocean observing networks, is thus moving its centre of gravity from Toulouse to Brest in order to be closer to the high concentration of ocean professionals on the French coast.

"*There are 10,000 buoys, floats and ships with equipment that take the pulse of the ocean, in addition to satellites*," explained the centre's director, Mathieu Belbéoch. They contribute to the Global Ocean Observing System (GOOS), the permanent global system for ocean observations over the long term. GOOS plays a vital role in improving the collection of data required for the development of climate forecasts and climate change detection.

The JCOMMOPS support centre assesses networks' performance while encouraging their harmonization and optimization. It also assists in the establishment and maintenance of several observation networks, such as Argo and DBCP (Data Buoy Cooperation Panel), which require 2 000 deployments per year. This colossal global effort is facilitated by a dedicated team, in constant dialogue with the ocean community, and by stakeholders of all maritime fields that contribute to the deployment of equipment and to data collection.

The Centre is hosted by the French Research Institute for Exploitation of the Sea (Ifremer, Brest) and the Collecte Localisation Satellites group (CLS, a subsidiary of CNES (Centre national d'études spatiales), Ifremer and the 'Ardian investment company, Toulouse) for the collection of data transmitted via satellite platforms. The move from Toulouse Brest was done with the support of the local authorities of Brittany, including Brest metropolis, the General Council of Finistère and the Regional Council of Brittany. The Centre will keep its information system in Toulouse, as part of the IT infrastructure of CLS and CNES, and will continue to develop a historic professional cooperation that began in 1987.

Source: WMO Website visited on April 19, 2015.

L'océanographie et la météorologie travaillent ensemble

Inauguration du centre opérationnel d'observation de l'océan à Brest

La Commission océanographique intergouvernementale de l'UNESCO a inauguré, le mercredi 18 mai, le nouveau centre de JCOMMOPS avec l'Organisation météorologique mondiale (OMM). Ce Centre de soutien pour les plates-formes d'observation in situ de la Commission technique mixte OMM/COI d'océanographie et de météorologie maritime (JCOMMOPS), qui suit les réseaux d'observation de l'océan, déplace ainsi son centre de gravité de Toulouse vers Brest, afin de se rapprocher des professionnels de l'océan concentrés sur le littoral breton.

"*On compte 10 000 bouées, flotteurs et navires avec des instruments qui prennent le pouls de l'océan, en complément des satellites*», explique le directeur, Mathieu Belbéoch. Ils contribuent au Système mondial d'observation de l'océan (GOOS), le système international d'observation soutenue de l'océan sur le long terme. GOOS joue un rôle essentiel en améliorant la collecte des données requises pour l'élaboration de prévisions climatiques et de la détection des changements climatiques.

Le centre de soutien JCOMMOPS évalue la performance des réseaux tout en encourageant leur harmonisation et leur optimisation. Il contribue de plus à la mise en place et à la maintenance de certains d'entre eux, tel le réseau Argo ou le DBCP (Data Buoy Cooperation Panel) qui nécessitent 2 000 déploiements par an. Cet effort mondial colossal est facilité par une équipe compétente, en lien quotidien avec l'ensemble de la communauté de l'océan, et des acteurs dans tous les domaines maritimes qui participent au déploiement de matériel et à la collecte de données.

Le Centre est hébergé par l'Institut Français de recherche pour l'exploitation de la mer (Ifremer Centre Bretagne, à Brest) et par le groupe Collecte Localisation Satellites, (CLS, filiale du CNES (Centre national d'études spatiales), de l'Ifremer et de la société d'investissement Ardian, à Toulouse), pour la collecte des données transmises par les plateformes via satellites. Le déménagement de Toulouse à Brest s'est effectué avec le soutien des autorités locales bretonnes, dont Brest métropole, le Conseil général du Finistère et le Conseil régional de Bretagne. Le Centre gardera son système d'information à Toulouse dans l'infrastructure informatique de CLS et du CNES, et continuera à développer une coopération professionnelle historique qui a lieu depuis 1987.

Source: Site Web de l'OMM visité le 19 avril 2015.

2016 Joint Scientific Congress of CMOS and CGU
Congrès scientifique 2016, SCMO, UGC

Monitoring and Adapting to Extreme Events and Long-Term Variations

La Surveillance et l'adaptation aux événements extrêmes et aux variations à long terme

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29 mai – 2 juin / May 29 – June 2, 2016

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