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CMOS BULLETIN SCMO

Canadian Meteorological and Oceanographic Society

La Société canadienne de météorologie et d'océanographie

June / juin 2017

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Photo: Frederic Bohbot

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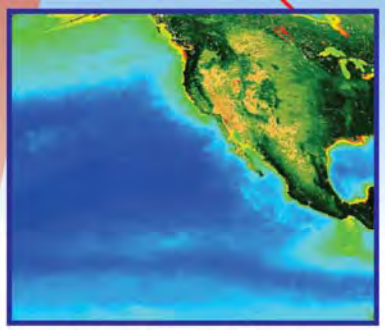

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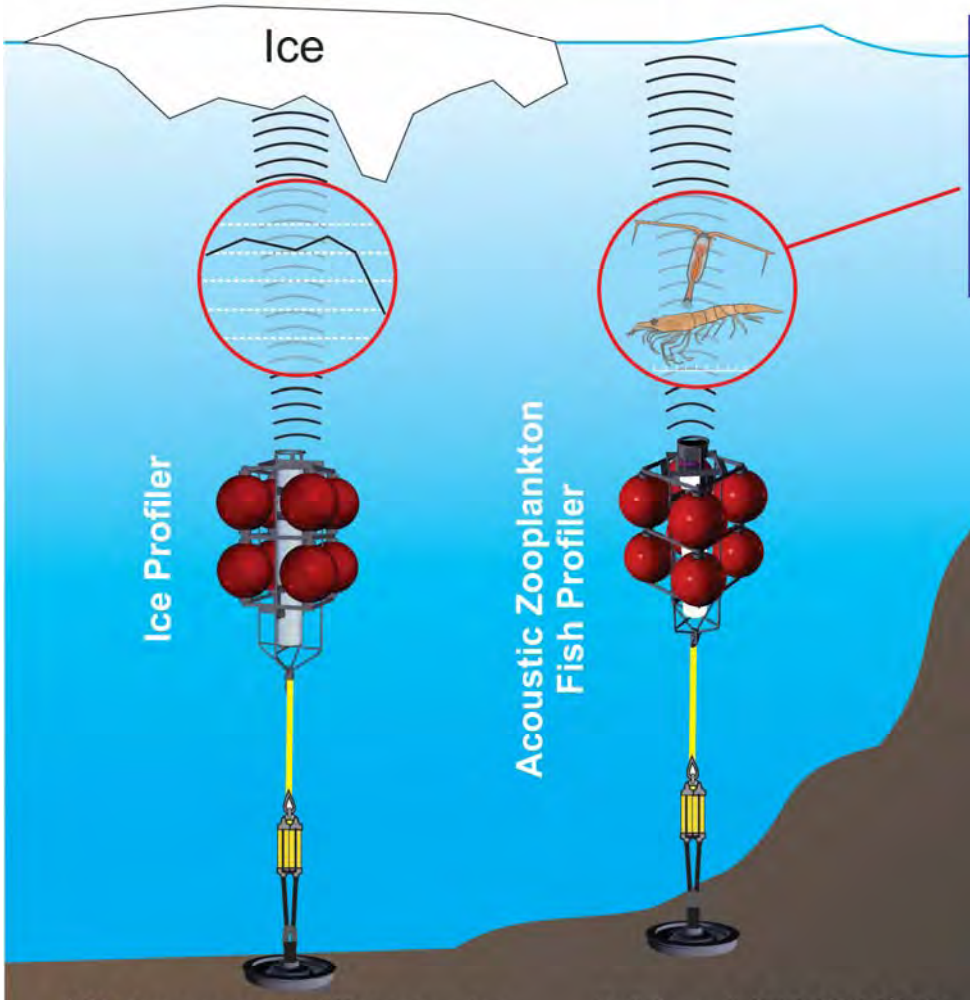

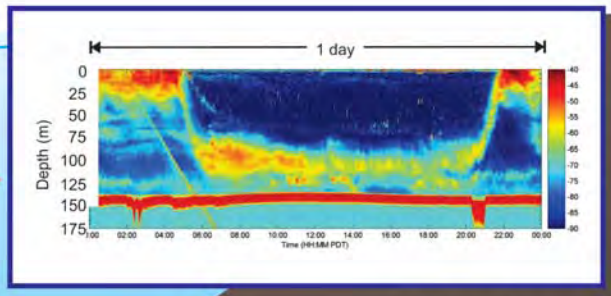

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CMOS exists for the advancement of meteorology and oceanography in Canada.

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

Cover Page / Page couverture

Snow melt in spring normally means a high water season for rivers in Eastern Ontario and Western Quebec, but this year accumulated rainfall in April was much higher than normal for this region, further swelling rivers. More heavy rains fell in the first two weeks of May, pouring into river systems that could not handle the volume, resulting in widespread floods that affected more than 4,000 residences in Quebec.

The cover photo was taken by Frederic Bohbot, an Academy Award winning independent film producer based in Montreal. This still is taken from footage for the upcoming documentary *You Are What You Act*, which deals with the idea that life may be becoming more dangerous for the average person. In this shot, Director Albert Nerenberg walks up a flooded street in Pierrefonds Quebec, on the Island of Montreal. The film is being produced for CBC's Documentary Channel and Canal D.

La fonte printanière des neiges entraîne naturellement une hausse des niveaux d'eau dans l'est de l'Ontario et l'ouest du Québec. Toutefois, cette année, l'accumulation de pluie atteignait en avril des niveaux plus élevés que la normale pour cette région. Ainsi, des cours d'eau ont débordé. Durant les deux premières semaines de mai, des pluies abondantes sont venues gonfler davantage ces cours d'eau déjà à la limite de leur capacité. La crue a inondé plus de 4000 résidences au Québec.

La photo vient de Frederic Bohbot, lauréat d'un Oscar et producteur-réalisateur indépendant montréalais. Elle est tirée du film documentaire à paraître *You Are What You Act*, qui porte sur la notion que la vie devient de plus en plus dangereuse pour le citoyen moyen. Dans cette image, le réalisateur Albert Nerenberg marche dans une rue inondée de Pierrefonds (Québec), sur l'île de Montréal. Le film est destiné à la chaîne documentaire de la CBC et au Canal D.

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Words from the Incoming President

Dear Friends and Colleagues –

Volunteerism continues to keep our CMOS organization functioning. I would like to thank Martha Anderson, our current past President and Marty Taillefer, our current President for their ongoing, outstanding service to CMOS. Martha continues to provide guidance and advice and is leading our celebrations for the CMOS Golden Jubilee this year. Marty has accomplished a number of the objectives that he set last year. As part of our Golden Jubilee programme, we waived fees for our student members this year, and we will discuss the continuation of this benefit for the coming year at the Toronto Congress. We have been vigilant in monitoring our budget and have developed a new draft Strategic Plan for discussion at the Toronto Congress. Our membership has stabilized and has grown by 8% for regular paying members and we have shown a significant doubling in the number of new student members.

Many thanks to Marie France-Gauthier (Recording Secretary) and Fiona Robertson (Corresponding Secretary) for their tireless effort in making sure that the Executive and Council were functioning as smoothly and effectively as possible. Kudos to Michael Crowe, who ably filled in for Boumy Sayavong as Treasurer during the past year and provided excellent input to the development of our new draft Strategic Plan for CMOS.

Our hardworking National Office staff continues to underpin our volunteer CMOS efforts. I look forward to continued support from Gordon Griffith (CMOS Executive Director) and Qing Liao (CMOS Office Manager).

Over the last year as Vice President, I was the inaugural Chair of our new CMOS Centre Executive Committee. The foundation of our strength as a relevant national society dedicated to the advancement of atmospheric and oceanographic sciences and related environmental disciplines is our 14 regional Centres. Having done a lot of work at all levels in our organization, I believe that this Committee will now provide a base for significant improvement in our membership, communications and programme development across Canada. Our Centres provide direct linkages among local universities (with outreach to high schools), government offices and agencies, and private sector companies. Our Centres provide local expertise and capacity to speak out on regional and national issues. Paying attention to the balance sheet, expert public commentary and member growth issues will bring significant long-term benefits to CMOS. I plan to continue working on these issues.

Support for Science and Technology funding (particularly in government) has been under attack for a number of years in Canada. Massive S&T cuts have recently been proposed in the US. If these US cuts are implemented, the repercussions to our global S&T enterprise will be severe. In Canada the toll on our government science and technology funding and management has become particularly worrisome. We must continue to address these issues and provide knowledgeable and informed input to politicians and the people of Canada on current and emerging meteorological and oceanographic issues and trends.

Before closing I would like to recognize the efforts that have been made over the last year by Douw Steyn, CMOS Director of Publications and Sarah Knight, editor of the CMOS Bulletin, in bringing the Bulletin into a fully digital mode. The Executive has assessed and discussed this shift at great length. We are confident that you will find our transition to an electronic Bulletin to be a positive experience and that we will see an overall improvement in CMOS communications volume, content and information sharing, while we reduce our “printing” expenses and environmental footprint.

I am looking forward to my new role as President of CMOS for the coming year. We are now entering our third year with the CMOS Executive located in Ottawa. Following my term as your President, we will be rotating the Executive functions of CMOS to Toronto. This will occur following our 2018 Congress in Halifax.

Wayne Richardson, P.Eng.

Mot du président à venir

Chers amis et collègues,

Le bénévolat permet à la SCMO de poursuivre son mandat. Je remercie Martha Anderson, notre présidente sortante actuelle et Marty Taillefer, notre président actuel, pour leurs services remarquables au sein de notre organisation. Martha continue de nous guider et de nous conseiller tout en dirigeant les célébrations du jubilé de la SCMO, cette année. Marty a atteint bon nombre des objectifs qu'il avait visés l'an dernier. Dans le cadre du programme du jubilé, nous avons éliminé, cette année, les frais d'adhésion des étudiants. Nous discuterons du maintien de cet avantage au congrès de Toronto. Nous avons surveillé de près notre budget et avons élaboré une nouvelle ébauche de notre plan stratégique, qui fera l'objet de discussions au congrès de Toronto. Le nombre de membres s'est stabilisé et, dans le cas des membres ordinaires, il s'est accru de 8 %. En outre, le nombre de membres étudiants a doublé.

Je remercie Marie France-Gauthier (secrétaire de rédaction) et Fiona Robertson (secrétaire correspondante) d'avoir veillé sans relâche au bon fonctionnement du comité exécutif et du conseil d'administration. Bravo à Michael Crowe, qui a remplacé Boumy Sayavong comme trésorier l'an dernier. Il nous a fourni d'excellents commentaires quant à l'ébauche du plan stratégique de la SCMO.

Notre personnel dévoué du bureau national continue de soutenir les activités bénévoles de la SCMO. Je compte sur le soutien indéfectible de Gordon Griffith (directeur général de la SCMO) et de Qing Liao (administratrice du bureau).

L'an dernier, en tant que vice-président, j'ai été le premier à présider le nouveau comité des présidents de centres de la SCMO. Nos 14 centres régionaux sont la base de notre force en tant que société nationale pertinente dévouée à l'avancement des sciences atmosphériques et océanographiques, et des domaines environnementaux connexes. Ayant travaillé à tous les niveaux de l'organisation, je crois que ce comité nous permettra d'augmenter considérablement le nombre de membres, de renforcer nos communications et d'améliorer nos programmes partout au Canada. Nos centres permettent de tisser des liens directs avec les universités, les organismes gouvernementaux et les entreprises du secteur privé des environs, sans oublier les écoles secondaires. Nos centres fournissent une expertise locale et possèdent la capacité de se prononcer sur des enjeux régionaux et nationaux. Nous concentrer sur notre bilan financier, sur nos prises de position scientifiques et sur l'augmentation du nombre de membres portera des fruits à long terme. Je compte poursuivre le travail lié à ces enjeux.

Pendant plusieurs années au Canada, le soutien financier des sciences et des technologies a fondu, notamment au gouvernement. Des compressions massives guettent aussi les États-Unis. Si nos voisins du sud imposent ces coupes, de graves répercussions se feront sentir mondialement dans le domaine des S & T. Au Canada, le travail de sape minant le soutien gouvernemental et la gestion des sciences et des technologies nous préoccupent particulièrement. Nous devons continuer d'aborder ces thèmes et de fournir des renseignements pertinents et éclairés aux politiciens et au public canadiens sur les tendances et les enjeux météorologiques et océanographiques actuels et futurs.

En terminant, je tiens à remercier Douw Steyn, directeur des publications de la SCMO, et Sarah Knight, rédactrice en chef du *Bulletin de la SCMO*, pour les efforts déployés tout au long de l'année, afin de transformer notre bulletin en une publication totalement et exclusivement numérique. Le comité exécutif a évalué ce virage et en a longuement débattu. Nous croyons que vous trouverez la transition vers un bulletin électronique plutôt réussie et que vous verrez dans l'ensemble une amélioration quant au volume, au contenu et au partage des communications de la SCMO, tandis que nous réduisons nos coûts d'impression et notre empreinte environnementale.

C'est avec plaisir que j'assumerai au cours de l'année mes nouvelles responsabilités en tant que président de la SCMO. Il s'agit là de la troisième année du comité exécutif d'Ottawa. Les responsabilités du comité exécutif seront transférées à l'équipe de Toronto, au congrès 2018 de Halifax, la fin de ma présidence.

Wayne Richardson, ing.

Letter from the Editor - Mot de la rédactrice

I joined CMOS this time last year, and at the 50th Congress in Fredericton I had my first introduction to the Society and its members. My first year with CMOS has been both interesting and professionally rewarding. This issue of the CMOS Bulletin is the sixth for which I have had editorial responsibility, and I must say that I have been pleasantly surprised at how readily CMOS members have supplied high-quality, appealing content. You all have made my job both easy and enjoyable, and I thank you for that!

One year on, and I am delighted to announce that the CMOS Bulletin is moving in to new and exciting territory. Following on from a survey put out to CMOS members last summer, many conversations at executive level, and much research, we have decided to move the CMOS Bulletin to a fully on-line experience. Volume 45, issue number 3, is to be the last print edition of the Bulletin.

The new format will be easily accessed, clearly laid-out, and very dynamic. Content will be posted to a dedicated blog-style site on a timely basis, rather than shared only on a bimonthly cycle, ensuring that what is available is kept as current and relevant as possible. For those of you that enjoy the scheduled CMOS Bulletin input to your email inbox please do not worry, we are not going to lose this aspect! Keeping to the timing that has become familiar, once every two-months we will put together a summary of all of the content, and email that right to you. So, although it means a change, I am sure that you will find the adjustment a painless and positive one.

Moving to an on-line experience is expected to have benefits in a number of areas – reach, appeal, and environmental impact, to name a few. An on-line Bulletin means reducing CMOS' carbon footprint every year by 100,000 pieces of paper and associated printing ink, as well as the emissions connected to delivering approximately 500 kg of printed material to various locations across Canada. A significant step in the right direction for a Society that is looking to lead by example wherever it can.

The new CMOS Bulletin website is expected to be completed by July, so please keep your content coming! We will continue to welcome submissions from all aspects of CMOS-related research, reports, news, outreach, and events, as well as appreciating all feedback and new ideas.

Sarah Knight
CMOS Bulletin Editor

Il y a un an, j'ai adhéré à la Société canadienne de météorologie et d'océanographie. Au 50e Congrès, à Fredericton, j'ai eu un premier contact avec la SCMO et ses membres. Cette première année au sein de la Société s'est avérée très intéressante et professionnellement enrichissante. Ce numéro du *Bulletin de la SCMO* est le sixième paru sous ma direction. J'avoue que j'ai été agréablement surprise de l'empressement des membres à soumettre du contenu captivant et de haute qualité. Vous m'avez rendu la tâche facile et agréable, et je vous en suis reconnaissante.

Après une année à la barre, je suis heureuse de vous annoncer que le *Bulletin de la SCMO* change graduellement de cap. À la suite d'un sondage réalisé auprès des membres de notre société l'été passé, de plusieurs discussions avec l'exécutif et de recherches approfondies, nous avons décidé de publier le *Bulletin* uniquement en ligne. Le numéro 3 du volume 45 est le dernier exemplaire papier de notre bulletin.

La nouvelle version sera facilement accessible et offrira une mise en page claire et très dynamique. Le contenu paraîtra sur un site distinct de style blogue. Il sera actualisé à tout moment, plutôt que partagé tous les deux mois. Ainsi, les informations disponibles resteront actuelles et aussi pertinentes que possible. Pour ceux qui préfèrent recevoir régulièrement le *Bulletin de la SCMO* dans leur boîte de réception, ne vous en faites pas, cette option existe toujours. Suivant le calendrier habituel, tous les deux mois, nous colligerons un résumé du contenu, que vous recevrez par courriel. Bien qu'il s'agisse d'un changement non négligeable, je vous assure que vous trouverez la transition naturelle et positive.

Le virage vers une diffusion uniquement en ligne devrait porter des fruits en ce qui concerne la portée, l'intérêt et les incidences environnementales, entre autres. Une parution en ligne permet à la SCMO de réduire son empreinte de carbone en évitant l'utilisation d'encre et de 100 000 feuilles de papier par année, et en coupant les émissions inhérentes au transport de 500 kg d'imprimés partout au Canada. Une étape notable dans la bonne direction pour une organisation qui cherche à prêcher le plus possible par l'exemple.

Le nouveau site Web du *Bulletin de la SCMO* devrait être achevé d'ici juillet. N'hésitez donc pas à nous envoyer du contenu de votre cru. Nous continuerons de recueillir vos soumissions sur tous les aspects de la SCMO: recherches, rapports, nouvelles, sensibilisation et activités, sans oublier vos commentaires et vos idées novatrices.

Sarah Knight
Rédactrice du Bulletin SCMO

Real Time Ice-Ocean Observations for a Changing Arctic Environment

Jim Hamilton, Merle Pittman, Roger Pettipas, Kirk Phelan, Shannon Nudds, Clark Richards, Jay Barthelotte; Ocean and Ecosystem Sciences Division, DFO, Bedford Institute of Oceanography

Oceanographic data delivered in real time can provide useful input to constrain and verify numerical models being used for ocean forecasting. Real time data from strategic locations can also be useful to marine operators whose activities may be impacted by local oceanographic conditions. This is particularly true where sea ice occurs.

Through support from the DFO Aquatic Climate Change Adaptation program, Department of National Defence, Defence Research and Development Canada and the Canadian Coast Guard, we have developed a cabled observatory technology that started providing real time ocean data from the eastern Northwest Passage in 2011.

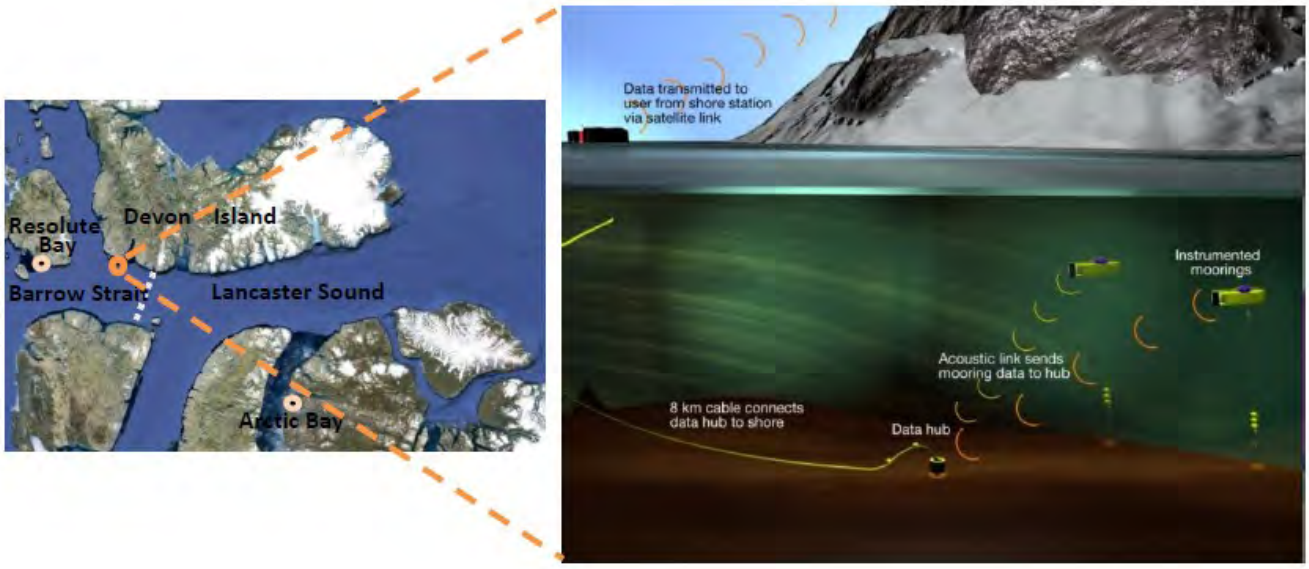

Figure 1. The configuration and location of DFO's real time ocean observatory at Gascoyne Inlet on the north side of the eastern Northwest Passage. The dashed line across the Strait east of the observatory location indicates the location of an instrumented mooring line maintained from 1998 until 2011.

The observatory (Figure 1) uses acoustic modems to pass data from instrumented moorings (the nodes) to the end of an 8 km subsea cable (the hub). The data are then sent through the cable to a shore station where a 2-way satellite link makes the data immediately available on the web. Located on the north side of the Northwest Passage off the coast of Devon Island, the real time observatory site is close to where we maintained a line of instrumented moorings from 1998-2011 as part of a climate change study (*Peterson et al., JGR 117; 2012)*. One of the outcomes from that work was the identification of links between water properties and ice cover on inter-annual time scales (*Hamilton, Collins and Prinsenberg, JGR 113; 2013*). With the real time observatory data, we have been able to exploit this knowledge of inter-connections within the local environment to use summer water temperature to predict the timing of freeze-up in the eastern Northwest Passage with several weeks lead time (*Hamilton and Pittman, Atmos-Ocean 53,5: 2015*). The long term monitoring also revealed links between water temperature and the timing and productivity of the zooplankton growth season. Thus changes in summer water temperature in this area have been shown to impact both the biology and the ice environment.

Water temperatures along the north side of the eastern Northwest Passage have increased dramatically over the last 2 decades. Mean early summer water temperature has risen by 0.2° per decade in the lower two thirds of the water column, and 0.3° per decade in the upper water column (Figure 2). On the north side, mean currents in early summer are near-zero, and then weakly westward (~5 cm/s) in late summer and autumn. In contrast, the mean summer flow over the southern half of the Strait is moderately strong (~25 cm/s) and eastward, and carries with it ice flushing from further west for much of the summer. This tends to keep ship traffic entering the Northwest Passage from Baffin Bay to the north side of Lancaster Sound and Barrow Strait. A continued warming trend there will impact ice conditions, leading to a longer period of accessibility for marine traffic entering the Canadian high Arctic. Understanding the impacts of this observed warming on ice conditions and on the ecosystem is a focus of our continuing research.

Article: Real Time Ice-Ocean Observations

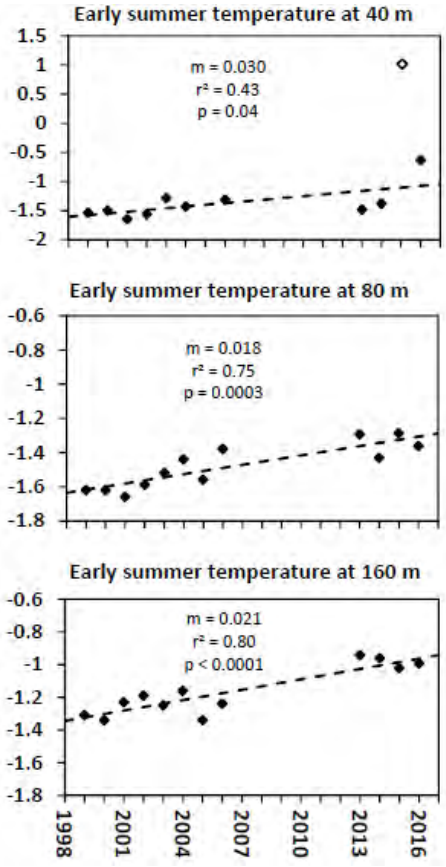

Figure 2: Average early summer water temperature from 3 depths along the 200 m contour on the north side of the eastern Northwest Passage. Early summer is the period from June 21 to Aug 5. Data from 1999 to 2006 are from the Barrow Strait flow-through study and data from 2013-2016 are from the real time observatory.

A novel real time ice draft measurement capability was demonstrated in the winter of 2017 at our second real time observatory in the Strait of Canso, which separates Cape Breton from mainland Nova Scotia. This installation provides us with an accessible location to test new observatory developments before we implement them at our Arctic site. The ice node uses an ASL Environmental Sciences Ltd., Ice Profiling Sonar (IPS) to measure the 2-way travel time between the instrument and the underside of the ice (see Figure 3). These data are passed to our node controller where they are combined with density, speed of sound, and instrument depth data to provide an ice draft measurement (the thickness of the ice below the waterline) every 3 seconds. The data are then processed in 6 hour blocks at the node, passed via acoustic modems to the cable hub and on to the shore station through the cable. The data are corrected with barometric pressure measured at the shore station, and displayed on our observatory web page (http://www.bio.gc.ca/science/newtech-technouvelles/observatory-observatoire-en.php).

The real time data delivery allowed us to watch the evolution of the ice cover as it occurred in the winter of 2017. Ice entered the Strait of Canso from the Northumberland Strait on February 7, driven by strong northwest winds. This ice quickly built to a draft of over a meter, probably due to rafting as the ice was driven against the causeway. Following a brief period of open water on February 10, a draft of about 1¼ m was maintained until reducing to about ¾ m in late February and then slowly declining over the following 6 weeks until break-up on April 12 (see Figure 4).

Histograms of the frequency of occurrence of different ice drafts over each 6 hour block provide more information about the mobility of the ice. Two selected histograms are shown in Figure 5.

When ice is not present, the IPS provides information about the wave field. Negative values (shown in red in Figure 6) are measurements of wave crests, while the positive values (in blue) are measurements in the troughs. Symmetry about zero when there is no ice serves to validate the on-the-fly processing and subsequent ice draft measurements when ice moved in.

Figure 3: The ice draft node prepared for deployment.

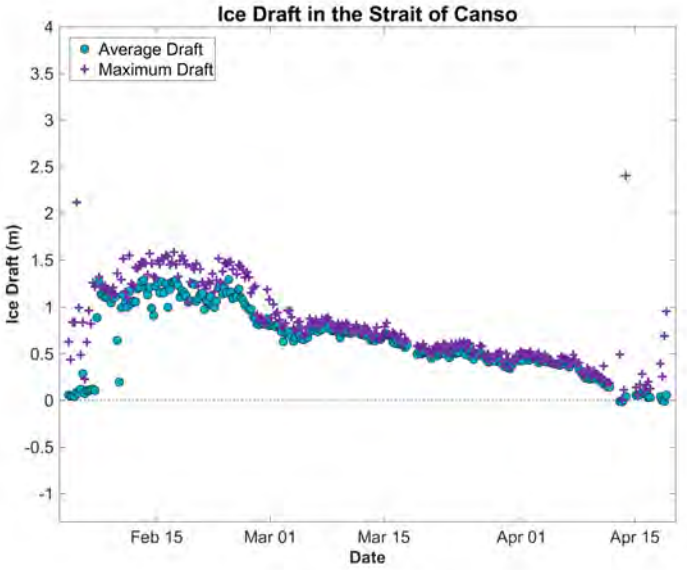

Figure 4: Mean and maximum ice draft measured with the real time observatory located 2.5 km north of the Canso Causeway. Each mean and maximum value is based on 7200 pings over a 6 hour period.

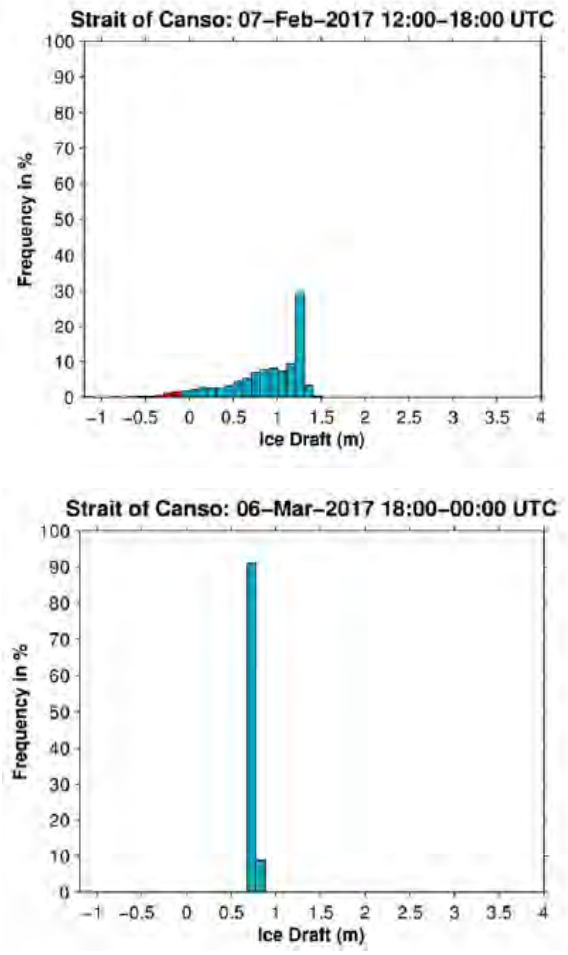

Figure 5: Measured ice draft over two 6 hour periods. Each histogram represents 7200 individual measurements separated into 0.1m bins. The histogram on the left is for the period when ice first pushed into the Strait of Canso from the Northumberland Strait. The broad spread of the histogram indicates that the ice pack was mobile. The histogram on the right is from a period when the ice pack was immobile.

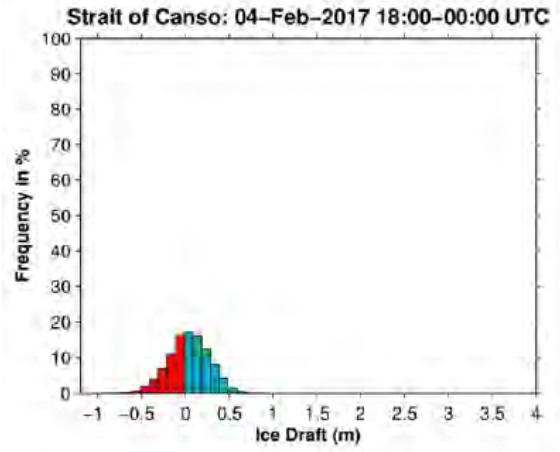

Figure 6: Observations of the sea surface over a 6 hour period prior to ice moving in, revealing the nature of the wave field.

With a proven ice draft measurement capability, our intention is to redeploy our observatory in the eastern Northwest Passage in August, 2017. This effort includes the installation of a new 8 km cable to replace the cable recovered last summer which had exceeded its operational life expectancy. With a successful redeployment, we will be able to monitor the evolution of the ice cover in this remote Arctic location, watching the changes as they occur. Concurrent real time observatory measurements of water properties and ocean currents will also allow us to forecast freeze-up and potentially break-up as well.

This new ocean observatory technology has design features that make it well suited for replication in other remote Arctic locations. The moored instruments collecting the data offshore are internally powered, eliminating the need to send power out the cable, thereby avoiding the need for any significant infrastructure on shore. The one critical requirement is protection of the cable from ice at the cable landfall. At Gascoyne Inlet (Figure 7), a gravel spit provides good natural protection from heavy ice pushing in from offshore but there is also a buried pipe at the beach which is critical to protecting the cable from ice at this vulnerable spot. Another feature of this observatory design is the ease with which sensors can be serviced or replaced. By using acoustic modems to pass data from the instrumented moorings to the offshore cable hub, the moorings are not physically connected to the cable. This simplifies handling by allowing for independent recovery and deployment of the node moorings and the cable hub. These deployment and recovery operations can be done from any ship, requiring no specialized equipment.

As marine traffic and industrial activities increase in the Arctic, the need for timely ice-ocean information and short term forecasts grows. This information can be used to improve the efficiency and safety of marine operations and also be part of a spill mitigation strategy to minimize potential negative impacts of human activity on the Arctic ecosystem. In local areas of intensified human activity, real time data systems combined with down-scaled operational computer models provide an attractive combination to understand the environment, and to inform and respond to impacts of human activities on that environment. At the same time, these real time systems continue to provide the long term monitoring needed to identify trends, and to build our understanding of the interconnections within the Arctic ecosystem.

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Article: Real Time Ice-Ocean Observations

Figure 7: Fisheries and Oceans Canada is operating a real time ocean observatory at Gascoyne Inlet on the south coast of Devon Island. Science and Coast Guard personnel were not the only visitors there one early September day when hundreds of beluga whales had entered the Inlet. Many of the whales were rolling on the gravel beach, presumably to scratch off old skin, when the CCGS Henry Larsen entered the Inlet. Once personnel came ashore the whales pulled away from the beach but remained close, seemingly as interested in the humans as we were in them! *Photo: Brian Beanlands*

About Jim

Jim is an oceanographer recently retired from his position with Fisheries and Oceans Canada at the Bedford Institute of Oceanography. He has been working in the Canadian Arctic for 2 decades, leading a field program to quantify Arctic Ocean freshwater exports, and to identify trends in water and ice properties in the eastern Northwest Passage. This work has included the development of new instruments and techniques to deal with some of the unique challenges of working in the Arctic.

The History of Weather Forecasting

Phil “The Forecaster” Chadwick

Meteorology and forecasting is the oldest science – starting around 200,000 years ago. Cave people needed to be able to observe and correctly predict the most dangerous weather in order to endure. This brainy skill set was essential for survival.

There are dozens of weather references in the Bible. Some are even weather forecasts like Luke 12:54:

“And he also said to the multitudes, When you see a cloud rise in the west you immediately say, There comes a shower; and it is so.”

These are really simple observation based forecasts. Real forecasting requires much more. The weather and the world is complex. Consider a thin layer of a compressible fluid on a rotating spheroid with a tilted axis in an elliptical orbit about a heat source of varying intensity. Heat and moisture energy in this thin atmosphere requires constant readjustment and stirring just to stay in balance. Weather is the result. Meteorology may not be rocket science – it is much more challenging.

Modern forecasting required the invention of physics. The principle was that if we could analyse the current state of the weather, then the laws of physics could be invoked to move the atmosphere and its energy around and thus predict the future state of the atmosphere – the weather. The laws of nature may be inviolate but the world is a complex place and there is much to analyse and more to understand.

With the problem clearly defined, what do we need to create an accurate forecast?

Communication: We needed modern communication and collaboration with countries around the globe to cooperate and to observe the weather for the common good. Weather knows no borders. We started with telegraph, teletype and then fax using special paper which was very flammable… many a map display went up in flames. Weather data started to trickle into the weather offices.

Observations: We needed tools like upper air balloons to observe the three-dimensional aspects of the weather. And what about the oceans that cover 71% of the earth? We needed weather ships to observe what was happening over the vast oceans. More data started to spurt in every 12 hours or so.

Scientists: We needed a large workforce of meteorologists to do all of this work. These scientists required intensive training in a very complex science. We needed “Meteorologists Without Borders” to really understand the weather - and lots of them.

More observations: The first Television and InfraRed Observation Satellite, TIROS I was launched on April 1, 1960. More data came in but we didn’t know what to do with it. Radar was developed during the Second World War and applied to the weather. Doppler and dual polarized radar were still on the horizon.

Computerization: Modern computer technology really got started in the middle of the last century with equipment that filled rooms if not buildings. Automatic processing of the increasing amount of data was essential. Meteorologists were just starting to “drown in the data”.

Modern meteorology got going with increasing numbers of meteorologists, data, communication and computers. The forecast cycle of the data plot, analysis, diagnosis, forecast and verification was established. Eager clients included the military (World Wars 1 and 2), aviation, shipping and of course the public, especially for severe weather (involving public safety and security). Industrial meteorology evolved in support of special clients and the efficiency of their operations. Applied statistics also came of age using increasing amounts of data to produce statistically probable weather forecasts.

I was lucky to have become a meteorologist at the very start of what I think of as the Golden Age of the science. Meteorologists provided an essential service (we were not even allowed to strike) and the tools and science were improving in leaps and bounds. It was a wonderful time to be a scientist with so much to learn and even invent.

Article: History of Weather Forecasting

Our knowledge of the atmosphere and the weather began to rapidly outstrip our ability to communicate that information to our clients. Meteorologists knew much more than could be related by “weather icons” and a few easily misinterpreted weather words.

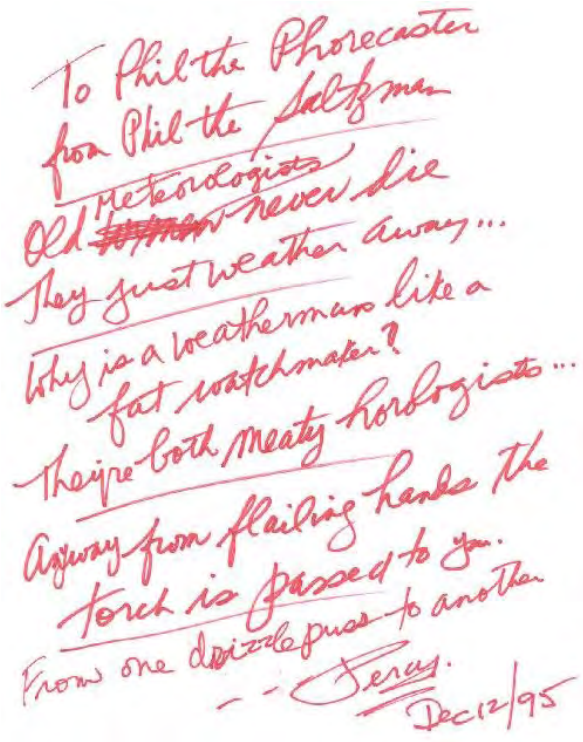
TV and Radio broadcasters help to get the message out. Some of these personalities were even government meteorologists like Rube Hornstein and Percy (Phil) Saltzman. I knew these gentlemen well and could tell you some funny, true stories. The computer and the numerical simulations of the atmosphere became important tools but a keen team of forecasters could use the output to do even better. Weather prediction evolved into a “man-machine mix” with the machine getting faster and more powerful and the “man” becoming swamped with work.

The big challenge in these Golden years was to convince our clients to take action based on our increasingly accurate forecasts. A perfect prediction has no value unless it is believed and the appropriate actions for safety and security are taken. Improvement in forecast accuracy, communication and performance measurement would be needed to create a stronger linkage between service and action.

But science is also an art – my forté. Thankfully the new remote sensing tools of satellite and radar were improving as fast as the computer. The patterns and shapes in these new data feeds reminded me of my early cave-man days. I let the computer crunch numbers and calculate and do things it did really, really well. I focused my time on the patterns and shapes and encouraged my fellow meteorologists to do the same. Meteorologists are humans and work best using the skills that allowed us to crawl out of the cave. Computers work best in the digital binary world and crunch numbers much faster than any human.

The remote sensing patterns of weather repeat themselves. Conceptual models of the atmospheric processes could be based on these patterns and used to evaluate the numerical weather simulations (NWP) so that corrective measures could be taken only where they were needed. Essentially one could use these patterns to identify the “Concern of the Day” or “Problem du jour”. The conceptual models using remote sensing and NWP would be the guide to an even better prediction. The conceptual understanding of the current weather concern could be updated and refined with each new image. New information was now arriving constantly via a fire hose of data.

The Weather Network realized the increasing requirement for the accurate communication of the weather – at various levels of weather sophistication. The Weather Network started back on September 1, 1988 as WeatherNow. The Golden Age of meteorology was in full swing.



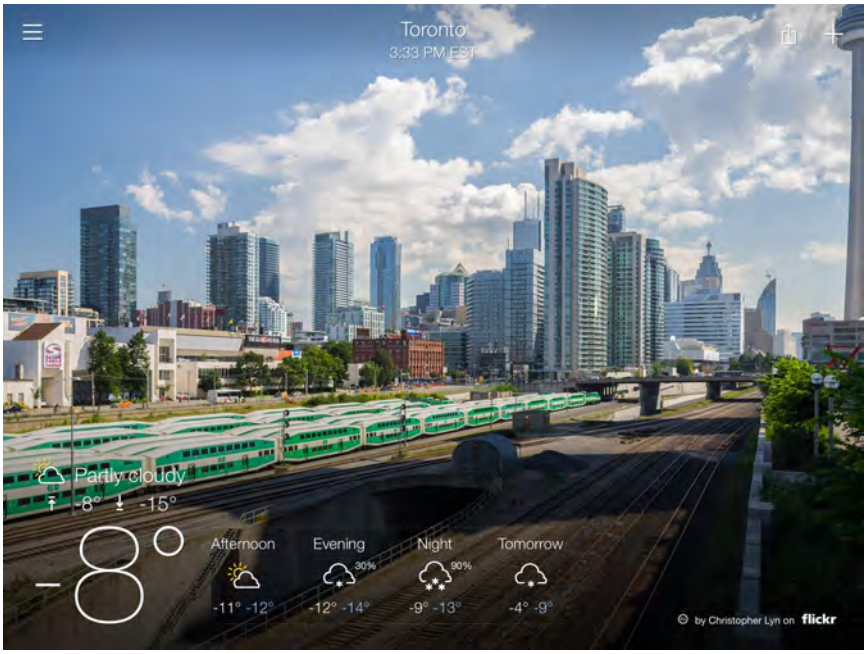
Percy Saltzman was a meteorologist and television personality best remembered for being the first weatherman in Canadian television history. Above, from Phil Chadwick’s personal collection, is an autographed photo of Percy Saltzman, complete with a bit of Percy’s meteorological good humour.

Article: History of Weather Forecasting

Increasing computer power has even permitted “Ensembles of numerical forecasts” – not just one! The sensitivity of any weather situation to errors in observing the current conditions can be used to estimate the confidence in the prediction and much, much more.

All forecasts have a best-before date or shelf-life. New and updated forecasts are always under production. With faster computers and more weather simulations, fewer meteorologists were able to keep up with the demand for weather services.

However, even more training and applied research is required to keep pace with the technology. The science of meteorology was evolving! I finished the last several years of my career in Boulder, Colorado developing meteorological training material for COMET (Co-operative Program for Operational Meteorology, Education and Training.). The COMET mission has expanded, and today COMET uses innovative methods to disseminate and enhance scientific knowledge in the environmental sciences, particularly meteorology, but also including diverse areas such as oceanography, hydrology, space weather and emergency management. All of this education and training is free at http://www.comet.ucar.edu/. Meteorologists like free stuff.



A screenshot from one of the many weather apps now widely available.

The future of forecasting? Weather Apps available for smart phones have taken the communication of weather information to the next plateau. Clients have immediate access to current and forecast weather conditions on a multitude of devices. Social media gets the updated information out at the speed of light. Satellite, radar and current observations are all available. Confidence in the accuracy of a well communicated forecast has increased along with a new level of weather awareness. Knowledgeable use of this information has certainly improved safety and security and increased the taking of action based on the predictions. The next, much higher level of communication would have to include some kind of “what the weather feels like app” where the client actually “feels” the weather in the forecast.

The science and art of weather has come a long way from those of the cave person. Weather observation, knowledge, prediction and communication have reached new heights – hopefully in time to face the challenge of climate change. Weather related insurance costs have skyrocketed. Billion dollar storms were once rare but are now common – there were 41 around the globe in 2013. The upward trend will continue. The $10 per person estimated cost of Canadian weather services is money well spent yielding services and benefits with values far outstripping this minimal investment in science and knowledge.

Forecasting may have come a long way but there are even bigger challenges in the future. Stay tuned…

About Phil:

Trained at Queen's University as a nuclear physicist, “Phil the Forecaster" has been a professional meteorologist since 1976. However, painting has always been his passion. Phil is an avid “plein air” painter when he’s not learning to be a better cook or looking after nature on Singleton Lake.

https://flipboard.com/@PhilChadwic2016; http://1-phil-chadwick.pixels.com/; http://philtheforecaster.blogspot.ca/; http://philipchadwick.homestead.com/

Interview with Dr. Andrew Weaver

Interview with Dr. Andrew Weaver, Climate Scientist, CMOS Member, and Leader of the BC Green Party


Photo: www.bcgreens.ca

Dr. Andrew Weaver is the lead author of the 2001 *Atmosphere-Ocean* (A-O) paper *The UVic Earth System Climate Model: Model description, climatology, and application to the past, present and future climates*. This paper is one of the ten most-cited A-O papers being including in the new book published by CMOS to celebrate the 50th anniversary of the Society.

When Andrew agreed to be interviewed, initially on the subject of this paper, I took the opportunity to venture beyond the impact of this publication to the impact that he is now having on Canadian politics and society as the leader of the BC Green Party. The full interview with Andrew can be heard on the 51st CMOS Congress podcast channel (http://www.hipcast.com/podcast/HYQcpQ6Q); below are some selected extracts.

-Sarah Knight, Editor

Q: You have not tried to hide your viewpoints that climate change is real, that it is happening, and that there is a strong human component in this change. So was climate change, and your obvious stance on the importance of individual responsibility, the primary driver in your decision to move in to politics?

As you know I have been teaching climate science, atmospheric science, and ocean science since the mid 1980's.

I developed a course at the University of Victoria, called "Climate and Society", designed to give a broad survey of the science, impacts, adaptation aspects, vulnerabilities, and the mitigation opportunities available on the whole topic of climate science.

The course would essentially frame the issue of Global Warming in to one question. I'd show how the decisions we make today are what will fundamentally play out in the next generation; however, those making the decisions will not have to live the consequences of their decisions. The issue of global warming and whether we should deal with it or not fundamentally boils down to one question:

Do we the present generation owe anything to the future generations in terms of the quality of the environment that we leave behind?

That is a question that science can never answer. It's a question that requires societal values, and delves into faith-based belief systems. And it is something that people often don't think about – the issue of intergenerational equity.

We know that the decisions that we make today must take into account that the effects of global warming will manifest themselves in future generations largely because of social-economic inertia.

The decision makers of today, those that must put in the correct policy measures to ensure that the next generation has an environment that is similar to what we have, those decision makers don't have an incentive to do that because they are worrying about 4-year electoral cycles.

So, the fourth time I was approached by Jane Sterk, leader of the BC Green Party…I took a look in the mirror and thought *I can't go on telling my students what they need to do, I need to practise what I preach*. I chose to run as a point of principle…as a point of saying *we will not change the system unless we get engaged*. So that I could stand up in front of my students and say *look I did it, you can too*.

Interview with Dr. Andrew Weaver

Q: I think the value of having scientists involved in politics goes beyond their knowledge and understanding of scientific facts, and goes to one of an understanding of the scientific approach - approaching things based evidence, and valuing facts and accuracy. Can you comment?

There's very disturbing trend in Canadian, US & British politics towards decision-based evidence making. Governing through ideology, and then alternate facts, half-truths, and statements taken out of context used after the fact to back up the decision that was made. Whereas as scientists we are much more accustomed to evidence-based decision making - that is the decision that we make flows from the evidence before us.

We should govern based on [situations] where problems are identified, then evidence is sought to analyse the problems, stakeholders are engaged, and solutions are proposed and tested against stakeholders. That's scientific method. Frankly the scientific method applied to problem solving in political discourse is the way it should go, in my view. Recognizing of course that there are judgements to be made all along, and that solicitation of input is a form of information that must be accounted for. But what happens far too much is "I want to introduce this policy, what evidence can I find to support that?" That's decision-based evidence making. We see that in climate science. The science is very clear. We know that the world is warming and that the overwhelming majority of that is coming from human activity. We know that does not bode well for the future of our climate or in particular for the ecosystems on this planet in the decades ahead. But those involved in decision-based evidence making would suggest something like…"ok global warming is not happening". That's the ideology. And then evidence is sought to justify that.

Q: You've been a longstanding member of CMOS, and certainly one of the missions of the Society is to support public understanding. Where do you see the role of national scientific societies?

They play an absolutely critical role in terms of organizing activities that can allow for the public education of various aspects of science.

What we also need is more scientists to step outside of their comfort zone. A lot of scientists feel that it is someone else's job to communicate the work that they do. That is not acceptable in today's society. Today's society behoves us to stand up and tell people what we do, through offering to speak in schools, giving public lectures on your work, informing the public - giving back to the people who ultimately fund almost all of the work that we do.

Q: Is the sense of urgency in much of what you are saying a reflection of how you feel personally, or as a scientist, in regards to how much time we have left to "up our game"?

The reality is that Paris was a game changer. The signing of Paris meant that effective immediately we must start decarbonizing our energy systems. To think that somehow we could continue to expand the production of oil from the Alberta oil sands, or that thermal coal could be continued to be used as combustion in electricity production - it's just cognitive dissonance. That's the reason why I ran. These messages need to be there in the legislature. Otherwise people simply are not telling the truth.

As a society we may not want to deal with global warming, that's a legitimate value statement, but I do think that there should be an honest discourse. Because frankly we are not going to meet 2 degrees; we are on track to meet 3 degrees this century if we don't do something now.

Q: What do you feel is the role of the citizen in regards to climate action?

The public needs to educate themselves on the importance of dealing with climate change. It ultimately is a question of intergenerational equity. Do we the present generation owe anything to future generations in regards to the quality to the environment that we leave behind?

Most people would say *yes we do*. So if you say *yes we do* then we have to start acting now.

There's three things people can do. One, is that we all have a wallet and we can use that wallet to signal to the market the direction that we want to head. Buying electric vehicles, buying things that have less packaging, buying things that are less carbon intensive. Using electricity that is produced by hydro instead of coal. The second is that people can vote, and put in place people who recognize that this is an issue and will take the appropriate steps to ensure that policy is put in place to deal with it. The third thing is education. Educate other people about the importance of one and two.

It's almost trivial how we can do it. One you use your wallet, two you vote, and three tell everyone you know to do one and two. And then we are on the path.

50th Anniversary: Interviews

To celebrate the 50th anniversary of CMOS, the Society is publishing a book, to include a compilation of papers published in the CMOS flagship journal *Atmosphere-Ocean*. The republished papers were selected from all papers published in *Atmosphere-Ocean*, and its predecessor *Atmosphere,* on the basis of being the most-cited papers in the past five years.

In the first three issues of Volume 45 of the CMOS Bulletin, readers can enjoy interviews conducted by CMOS Bulletin Editor Sarah Knight with the authors of the papers included in the book. The book will be available in time for the June CMOS Congress in Toronto.

Interview with Knut von Salzen

Dr. Knut von Salzen is the lead author of the 2013 paper *The Canadian Fourth Generation Atmospheric Global Climate Model (CanAM4). Part I: Representation of Physical Processes.* This is the most recently published paper of the ten that are included in the book.

Q: What motivated you to pursue this area of research?

I owe the decision to pursue a PhD in atmospheric sciences largely to the influence of different research scientists during my graduate studies, which came at an important time for me because I was beginning to wonder about the direction of my studies in Physics. I thought that their research on air quality and climate was inspiring and I am still intrigued by the fact that atmospheric processes interact with each over a very wide range of spatial and temporal scales and thereby influence the health and well-being of people. After completing my PhD I have focused on the development of parameterizations for aerosols, clouds, and convection, in collaboration with many colleagues and mentors. The paper that motivated this interview represents the result of a major team effort that unfolded over more than a decade which involved scientists in government and research networks.

Q: How, since publication, has this research informed/impacted other research in this area, in Canada or around the world?

CanAM4 is the current generation of the atmospheric global climate model at the Canadian Centre for Climate Modelling and Analysis (CCCma), which was completed in 2012 in order to support simulations for the IPCC 5th Assessment Report. The same physics parameterizations are used in a range of different models, including the Canadian Earth System Model (CanESM2), the Canadian Seasonal to Inter-annual Prediction System (CanSIPS), and the Canadian Regional Climate Model (CanRCM4). Studies of changes in Arctic climate and North American climate variability by Canadian authors have benefited from improved modelling capabilities for radiation, clouds, and aerosols in CanAM4, for instance. Internationally, model results have been used in multi-model studies of projected future changes in global climate and cloud feedbacks on climate. As one measure of success, CanESM2 is currently the third most highly cited model among 69 global climate models that were used in the Coupled Model Intercomparison Project Phase 5 (CMIP5). This is despite the fact that CCCma is one of the smaller modelling groups that participated in CMIP5.

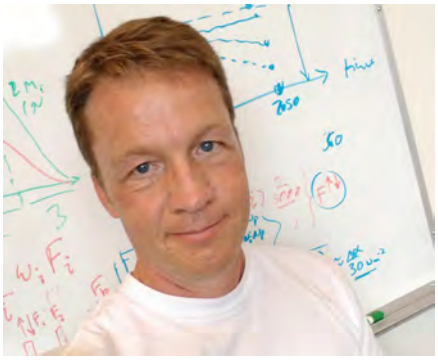
Q: In light of the recent study commissioned by the Arctic Council on Arctic warming, are CanAM4 and CanESM2 still suitable? Are there new, or changed, parameters that will need to be included to incorporate the more rapid decline in Arctic sea ice cover and ice sheets?

Simulated multi-decadal trends in temperature and sea ice in CanESM2 agree well with available observations in the Arctic, similar to several other models that participated in CMIP5. Recent changes in Arctic temperature and sea ice can be largely attributed to combined radiative forcings of greenhouse gas and short-lived climate forcers (SLCFs). According to results CanESM2, the Arctic Ocean could be largely free of sea ice in summer by 2050, perhaps even a few years earlier. However, there are still substantial uncertainties in projected future changes of Arctic temperature and sea ice, partly due to uncertainties in greenhouse gas emissions, SLCF climate effects, and feedbacks of clouds. From my perspective as an atmospheric model development scientist, a focus at CCCma and other modelling centres on simulations of SLCFs is certainly reasonable with

regard to rapid changes that are currently underway in the Arctic. For instance, we are in the process of including aerosol microphysical processes in CanESM and started working towards coupled aerosol and gas-phase chemical processes. On the other hand, more accurate simulations of ice sheets and sea level rise will likely require modelling capabilities for ice dynamical processes at very high model resolution. However, this is beyond the scope of activities in most global climate modelling centres.

Q: What are your hopes for atmospheric modelling research in general, in the future?

In a nutshell, my hope is that young and innovative atmospheric model development scientists will receive broad support and encouragement to pursue new ideas. There is an ever increasing need for detailed information about climate, air quality, and weather, which necessitates the development of new and improved models based on a profound scientific understanding of complex physical and chemical processes. There are still many unanswered questions in atmospheric and computer sciences which will take substantial commitment and patience to answer. For instance, we are just beginning to understand SLCFs and their highly complex interactions with climate, especially on regional scales. Model development scientists at CCCma and elsewhere are trying to catch up to demands for information by society and policy makers in this area. We also face the need for improved modelling capabilities for climate extremes, which requires parameterizations that can be used at much higher model resolutions. Convection and other small-scale processes will likely have to be parameterized in global earth system models for many more years, even at the current rate of growth of high performance computing capacity. Continuous, long-term training and research opportunities are important in order to motivate bright students to pursue a career in atmospheric model development.



About Knut

Dr. Knut von Salzen has been a research scientist at the Canadian Centre for Climate Modelling and Analysis at Environment and Climate Change Canada since 2001. His main interest is the representation of atmospheric processes in climate models, especially processes associated with SLCFs, clouds, and convection. He has been representing Canadian climate research as a member of the Arctic Monitoring and Assessment Programme (AMAP) expert group on black carbon and ozone and has contributed to other national and international committees.

Paper Summary

The Canadian Fourth Generation Atmospheric Global Climate Model (CanAM4). Part I: Representation of Physical Processes. **von Salzen, K., Scinocca, J.F., McFarlane, N.A., Li, J., Cole, J.N.S., Plummer, D., Verseghy, D., Reader, M.C., Ma, X., Lazare, M., Solheim, L., 2013.**

The authors provide a summary of physical processes in the Canadian fourth Generation Atmospheric Global Climate model (CanAM4), which is the latest in a long series of models, starting with the Canadian Climate Centre Spectral Atmospheric General Circulation model in the early 1980's. CanAM4 continues to represent the backbone of the Canadian Earth System Model developed by the Canadian Centre for Climate Modelling and Analysis, Environment and Climate Change Canada. Substantially improved parameterizations of clouds, aerosols, and radiation distinguish CanAM4 from earlier versions of the model. Important applications of CanAM4 include projections of future global climate for CMIP5 (the Coupled Model Intercomparison Project, Phase 5) in support of the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment report (AR5) and its operational use for seasonal forecasts of temperature and precipitation for Canada. CanAM4 has also been widely used to study changes in Arctic climate and short-lived climate pollutants. In the near future, CanAM4 will be replaced by an updated version of the model which includes further improved representation of atmospheric physical processes.

Interview with Norman McFarlane and Guang Zhang

Dr. Guang Zhang and Dr. Norman McFarlane are the authors of the 1995 paper *Sensitivity of Climate Simulations to the Parameterization of Cumulus Convection in the Canadian Climate Center General-Circulation Model.* Dr. McFarlane is also an author on one of the other papers included in the book: *The Canadian Fourth Generation Atmospheric Global Climate Model (CanAM4). Part I: Representation of Physical Processes* (von Salzen et al., 2013). Here, both authors offer their insights on their 1995 paper.

Q: What motivated you to pursue this area of research?

The Zhang-McFarlane (ZM) convection scheme was developed to be used in the Global Climate Model (GCM) of the Canadian Climate Centre (CCC). At the time Guang Zhang took up a visiting fellowship in the modelling division of the CCC (later to be transferred to Victoria and expanded into the current Canadian Centre for Climate Modelling and Analysis). Guang had done his Ph.D. work at the University of Toronto on the topic of the effects of momentum transfer by deep cumulus clouds on the larger-scale circulation of the atmosphere. In part, development of the ZM scheme was a necessary precursor to parameterizing cumulus momentum transfer effects in the GCM and studying its impact. However, it quickly became apparent that implementing the new convection scheme resulted in generally improved climate simulations. Consequently it has been retained and used much as initially formulated in succeeding generations of the Canadian Climate Models, including the latest operational versions of the Canadian Earth System Model (CanESM2).

Q: How, since publication, has this research informed other research in this area, in Canada or around the world?

Following his fellowship in the Canadian Climate Centre, Guang took up his position as a research scientist at the Scripps Institution of Oceanography. One of his early research projects in that position involved collaboration with National Center for Atmospheric Research (NCAR) scientists through the Center for Clouds, Chemistry and Climate (C^4) to implement the ZM scheme in the NCAR Community Climate Model. It also worked well in that model, and as a result it has been used in succeeding generations of the NCAR GCMs, including the next generation Community Earth System Model CESM2, which will be released next month. The ZM scheme has also been adopted by the new US Department of Energy climate model Accelerated Climate Modeling for Energy (ACME) and research groups in several institutions with climate modelling research programs in China.

Guang and collaborators have continued to be very active in this area of research and have published numerous significant contributions on parameterization of moist convection and on the role of moist convection in the atmospheric circulation. These contributions include addition of the representation of microphysical processes in the ZM scheme, and a better simulation and understanding of intraseasonal variability and Intertropical Convergence Zone.

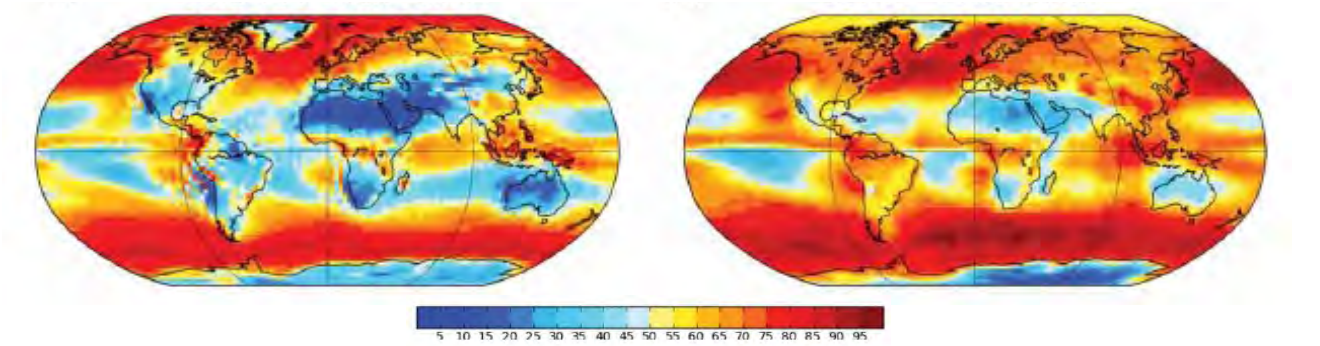
Q: What do you perceive was the main impact of this research?

Because of its wide use in global climate and Earth system models for climate simulation and climate change research, the ZM scheme's main impact is in science and policy areas. Close to twenty of the models that participated in CMIP3 and CMIP5 have used the scheme for climate change projection simulations. This impacted not only the understanding of uncertainties in climate sensitivity, but also policy making in mitigating climate change.

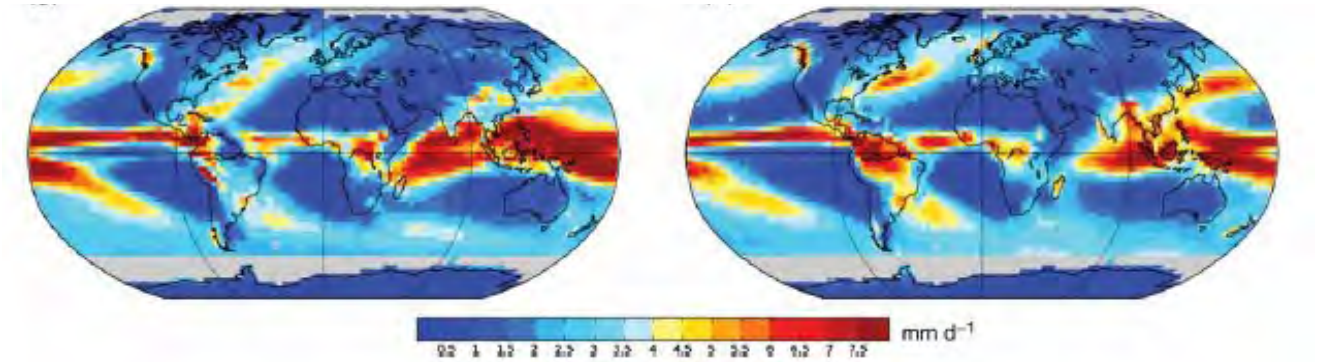
Q: What changes have been made to the ZM scheme since this work was published, 22 years ago?

The ZM scheme has continued to be used with relatively minor modifications to its basic structure in all generations of the CCCma climate models that have been developed over the last two decades. In the third generation model it was coupled to a revised closure scheme (Scinocca and McFarlane, 2004) and used in the Canadian versions, (Scinocca et al., 2008). In the fourth generation models it has been supplemented with a shallow convection scheme (von Salzen and McFarlane, 2002) to form a moist convection module that is coupled to tropospheric chemistry and aerosol modules in the operational CCCma coupled climate model (CGCM4) (von Salzen et. al.,2013) .

Guang and collaborators have developed more extensive further enhancements. A new closure linking deep convection to large-scale circulation was added to the scheme to improve the simulation of the tropical climate and and its variability (Zhang 2002, Zhang and Mu 2005a,b, Zhang and Wang 2006, Wu et al. 2007, Zhang and Song 2009). Later, entrainment dilution was incorporated in computing convective available potential energy (Neale et al. 2008). More recently, a comprehensive convective microphysics parameterization was added



Mean total cloud fraction for CanAM4 (left) and ISCCP D2 (right) during the time period January 1996 to December 2005. Only the contributions of strati-form clouds and shallow cumulus to total cloud amounts are considered for CanAM4 (von Salzen et al., 2013).



Mean precipitation for CanAM4 (left) and GPCP (right) for January 1979 to December 2007 (von Salzen et al., 2013).

to the scheme to better represent the interaction of convection with grid-scale clouds (Song and Zhang 2011, Song et al. 2012). A stochastic representation of convection has also been coupled to the ZM scheme lately to improve the simulation of intense precipitation statistics (Wang et al. 2016, Wang and Zhang 2016).

Q: Are you still working in this area, and how did this research inform your own research goals/agenda?

Norm is retired but is continuing his research on parameterizing convection as a part-time project. Guang continues to be active in this area. Convection parameterization is a very challenging scientific problem. As we gained better understanding of convection dynamics and physics through high-resolution large-eddy simulation and cloud-resolving model simulation, some of this new knowledge has been incorporated into his own research on convective parameterization. The work in turn broadened his scientific interest in the role of moist convection in convection, cloud and climate interaction.

Q: What are your research plans for the future?

As the resolution of global climate models increases, it's not clear to what extent the current convection parameterization is still valid in high-resolution GCMs. In the near future, Guang plans to work on making convective parameterization schemes suitable for high-resolution GCMs.

Q: Climate change is an environmental focal point of this century. What is your opinion on what research is required to further our ability to predict changes, and to understand the possible impacts?

The uncertainty in future climate change is largely rooted in the lack of accurate representation of atmospheric moist processes including convection, clouds and their interaction in Earth system models. A better understanding of these processes through observations and process-level modeling will be key to advancing their parameterization in global models.

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About Guang

Guang Zhang obtained his Ph.D. from University of Toronto in 1989. After spending three years at the Canadian Climate Centre in Downsview, Ontario for his postdoctoral work, he accepted a position as an Assistant Research Meteorologist at Scripps Institution of Oceanography and has been there since. He is currently a Research Meteorologist. His current research interests include convection parameterization development, interaction of convection, clouds and climate, tropical meteorology and global climate simulation.

About Norm

Norman McFarlane retired in 2004 as a Senior Scientist within Environment Canada. Prior to retirement he was the leader of the atmospheric model development group in the Canadian Centre for Climate Modelling and Analysis (CCCma). From August 2004 to February 2011 he was the Director of the International Project Office for the SPARC (Stratospheric Processes and their Role in Climate) Core project of the World Climate Research Programme. Currently he holds an adjunct faculty appointment in the School of Earth and Ocean Sciences, University of Victoria and remains involved in collaborative model development and research activities within the CCCma.

Paper Summary

***Sensitivity of Climate Simulations to the Parameterization of Cumulus Convection in the Canadian Climate Center General-Circulation Model*. Zhang, G.J. and McFarlane, N.A. 1995.**

The authors document a parameterization scheme utilizing the entraining plume conceptual framework pioneered by Arakawa and Schubert in 1974 (AS) to represent the effects of deep moist convection on the larger scale circulation in global models. A major simplification from the original AS formulation was the adoption of a spectrum of convective elements whose cloud-base mass fluxes are uniformly distributed as a function of their fractional entrainment rates. The “Zhang-McFarlane” (ZM) cumulus parameterization has been adopted in a wide range of modeling applications including the operational global climate models of the Canadian Centre for Climate Modelling and Analysis (CCCma), the Community Atmospheric Model of the National Centre for Atmospheric Research (NCAR CAM), and a number of global climate models in use within the international climate research community. Since publication of this paper, Dr. Guang Zhang has developed additional refinements, linking onset of convection and cloud-base mass flux to production of convective instability by large-scale flow. A comprehensive microphysics parameterization has also been incorporated into the ZM scheme recently to better describe the microphysical processes inside convection. These changes have substantially improved the performance of the ZM scheme.

In Brief: Our Common Atmosphere

Our Common Atmosphere: Lawnmowers and Cow Wind

Dr. Jim Young (extracts from his blog "Our Common Atmosphere")

In 1990, air pollution emissions from cutting your grass for an hour with a gasoline-powered lawn mower were about the same as the emissions from a 150 kilometre trip by car.

One important pollutant found in lawnmower exhaust was polycyclic aromatic hydrocarbons (PAHs) which have been measured as high as 4000 millionths of a gram per hour with unleaded fuel. Just like cars, this can be reduced to about 800 (on average) if a catalytic converter is used. According to a U.S. Environmental Protection Agency study completed in 1990, small engines from lawn and garden equipment made up nearly 9% of the total air pollution emissions. The 1990 Swedish study used unleaded fuel in a 4-stroke, 4 horsepower lawn mower and found PAH emissions after an hour to be equivalent to a gasoline-powered car driving 150 kilometres. A typical push-type lawn mower is run for approximately 25 hours per year according to the Outdoor Power Equipment Institute.

Now, each weekend in a typical spring, summer and fall about 54 million Americans mow their lawns, using 800 million gallons of gasoline per year and producing carbon monoxide, volatile organic compounds (VOCs) and nitrogen oxides – about 5% of the USA's air pollution. According to an EPA study, a traditional gas-powered lawn mower produces as much pollution as 43 new cars each being driven 19,300 kilometres. And 17 million gallons of gasoline were spilled each year while refuelling lawn mowers – that's more than all the oil spilled by the Exxon Valdez in the Gulf of Alaska.

Gas mowers emit hydrocarbons (principle components of smog), particulate matter (which can damage the respiratory system), carbon monoxide (a gas that can suffocate you in a confined space) and carbon dioxide (contributes to global warming). It is more efficient to use an electric mower - but only reel mowers have a zero carbon footprint.

[source: https://www.linkedin.com/pulse/our-common-atmosphere-lawnmowers-james-young]

Governments are trying to figure out how to control cow burping, and farting, which is a significant factor in global warming.

More and more "cow power" is being generated these days because it is a source of green energy. By collecting cow and sheep manure and storing it in huge tanks – anaerobic digesters – with no oxygen and keeping it warm (35-40 degrees C), the bacteria produce lots of biogas. This gas, which is about 90% methane, is piped to an engine which burns the gas to generate electricity. The leftover manure is used as a fertilizer and bedding and compost.

Cow burps can't be easily caught and just float up into the atmosphere. Each cow burps about 280 litres (140 2-litre pop bottles) per day. Worldwide this translates into 80 million metric tons of methane gas per year – about 22% of all man-made methane. Methane is a greenhouse gas and is 21 times better at trapping heat in the atmosphere than carbon dioxide. But why do cows burp methane? Well, there are millions of bacteria in a cow's rumen (the first of its four stomachs). These are the same bacteria that are in the anaerobic digester. These bacteria break down the grass and hay in a process called enteric fermentation. These bacteria help cows digest but give off methane as a by-product. The cows get rid of it by burping. Global warming is a major problem, but we need our cows, and sheep, and they need to burp and fart. What are we to do?

By using the manure in digesters, farmers and others are transforming a problematic waste into new useable commodities – electricity, compost and fertilizer. And there is research work going on to see if changing their food can make their gas less potent.

We all release methane gas – it is part of our nature. It's part of our earth, from bogs, coal mines, gas drilling and plants and trees.

[source: https://www.linkedin.com/pulse/our-common-atmosphere-cow-wind-james-young]

About Jim

Jim has over 40 years of experience in weather and air quality studies and continues to provide services in these areas at RWDI consulting engineers and scientists He welcomes feedback on his blogs as well as requests and suggestions for future topics.

51st CMOS Congress Podcast

Ep 1 Dr. Jim Young - Climate Change Resiliency & Teacher's Day

Dr. Jim Young, an atmospheric scientist with 41 years of experience, discusses climate change resiliency, and what it means for Canadians as we look to the future in a changing climate. He also answers questions on the annual "Teacher's Day" that CMOS is holding at the congress, and explains what educators can expect to get out of this event to share with their students: our scientists of the future.

Ep 2 Dr. Francis Zwiers - Changing Weather Extremes

Dr. Francis Zwiers, Director of the Pacific Climate Impacts Consortium and IPCC coordinating lead author of the Fourth Assessment Report, discusses "changing weather extremes" – a topic that is also the title of his free public lecture at the CMOS congress on June 6th. His very well-informed thoughts on how the climate is changing, what weather extremes we might expect in Canada as a result, some of what brought us to this point, and what the future looks to hold, are crucial messages that we all need to hear and take action on.

Ep 3 Dr. Susan Allen - Ocean Modelling

Physical Oceanographer Dr. Susan Allen explains ocean modelling and its applications - from predicting tomorrow's storm surges to the next decade's warming and sea level rise. She answers questions about some of the problems the oceans are facing, including ocean acidification and changing ocean current regimes, as the earth continues to warm, and how ocean scientists across the globe are working together.

Ep 4 Dr. Gordon McBean - Future Earth

Dr. Gordon McBean, IPCC contributor and current President of the International Council for Science, is a climatologist with a long and strong career in national and international climate research and policy. Here, he shares his insights on some of the threats that we will face as the climate changes and how we can better become a more resilient society.

Ep 5 Dr. Andrew Weaver - Science & Politics

Interview with BC Green Party leader Dr. Andrew Weaver, in the wake of the May 9th election that left the Green Party in a powerful position. Dr. Weaver offers his thoughts on the role of science in politics, his stance on climate change and intergenerational equity, his strong feelings about the importance of climate scientists communicating their work, his suggestions for citizen action for positive environmental change, and more.

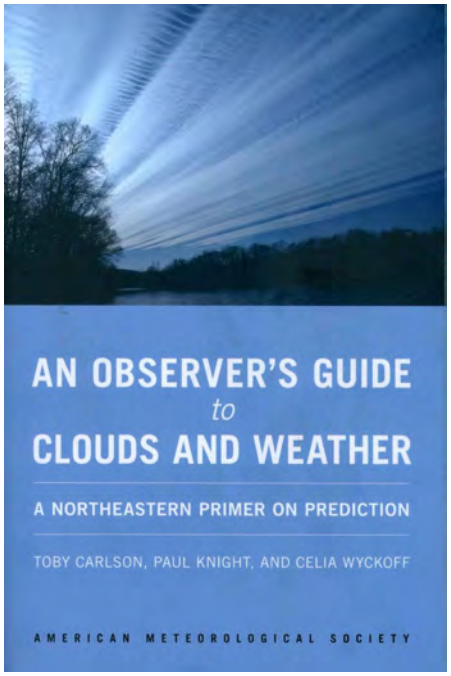
Ep 6 Dr. Paul Kushner - Changing Snow & Sea Ice Cover

Dr. Paul Kushner, principal investigator of the Canadian Sea Ice and Snow Evolution Network (CanSISE), talks about how snow and sea ice cover are changing in the Canadian north, what the 1.5 degree Celsius climate target means and how we are on a trajectory for much more warming than that, why the Arctic is warming faster than any other place on the planet, and how the ability to communicate scientific findings in a meaningful way is crucial for moving forward.

Ep 7 Dr. Kim Strong - Our Atmosphere

Dr. Kimberly Strong is an experimental atmospheric physicist involved in measuring and monitoring a variety of compounds in the atmosphere that are involved in processes such as ozone depletion, climate change, and pollution. She discusses these, and also answers questions specific to the Arctic atmosphere, on what the concerns are and why it is changing so quickly.

Book Review



An Observer's Guide to Clouds and Weather, A Northeastern Primer on Prediction

By Toby Carlson, Paul Knight and Celia Wyckoff

Published by American Meteorological Society, Boston
Paperback 224 pages ISBN 978-1-935704-58-4 $30 US

Book Reviewed by Kenneth A. Devine[1]

While focusing on the northeastern portion of the United States, the authors have presented a descriptive approach to explaining the classical weather systems and how they manifest themselves for ground level observers. With no mathematics this book was not intended for professional meteorologists but with rather careful explanations it takes the reader through gradually more difficult situations. The physics related to meteorological systems is explained for the nonscientific observer. The clear line drawings with the relevant photographs allow the observer to understand the large scale weather situation which they are experiencing.

Starting with a description of the basic processes in which the physics is graphically explained, the authors move on to a detailed description of the classical weather systems with many diagrams. The manifestations of these weather systems at the surface are clarified with cloud pictures. The authors follow with the local effects caused by topography and moisture sources such as the lake effect snow showers. The procedures used in the productions of public forecasts are explained. In the final chapter a number of examples of weather systems are described in detail and the methods for taking local observations are explained. Sources for weather information on the Internet are listed before the index but there are no references.

Using the classic Norwegian model as a basis, the stages in the development and demise of a low pressure system are illustrated with three dimensional line drawings. Variants such as the Alberta Clipper and the back door cold front are carefully described. The lengthy figure descriptions could be reduced as the same information is covered in the text. While the cloud pictures in this paperback book are mostly quite good, occasionally they fall short of properly illustrating the clouds being depicted.

The authors fill the book with many small items such as rules of thumb used by forecasters and weather sayings with their explanations. The chapter explaining how forecasts are produced is excellent and includes the reasons for uncertainty in the forecasts. The best way to use published forecasts is also described. The authors have moved beyond linking everything to the jet stream to explaining the use of upper air charts such as the 850 and 500 millibar levels. This is an excellent book which is aimed at the advanced amateur observer.

[1] *Meteorological Instrument Consultant*

Book Review

Canadian Aviation Weather*

By Captain Doug Morris

Published by Lulu.com
Paperback 352 pages ISBN 978-1329431393, $69.95

Book Reviewed by Steve Ricketts[1]

*Available through Amazon or http://www.canadianaviationweather.ca

There are a few books that cover aviation weather and are aimed at pilots and weather enthusiasts, including those in Canada, but they're rather dated. Doug Morris's book (Canadian Aviation Weather) has arrived on the scene and it fills a need.

When writing about weather, it can be challenging to strike the right balance. People in aviation need to know more about weather than the guy on the street; they need to know more about meteorological processes in order to make wise decisions while flying; the challenge is how to do this without overwhelming them with overly complex descriptions.

Doug strikes a good balance. He describes, in a relatively easy-to-understand fashion, how atmospheric processes work, and follows it up with real-life examples and stories, which often are based on his extensive flying career. This includes flying into hordes of fish flies while landing in Gimli, MB and landing at Toronto Pearson in fog conditions… as well as skiers encountering rime icing, and condensation in the shower.

His is a casual, light-hearted writing style, similar to the "<x> for Dummies" series of books and which, in my view, is quite appropriate when writing about a topic that can be very dry.

Doug proceeds logically through the various topics, starting with the essential building blocks (e.g. the atmosphere, clouds, pressure, temperature, moisture), then moving on to features (air masses, fronts) and then on to weather parameters that are the most important to aviation (icing, turbulence, thunderstorms). He provides clues for pilots regarding what to look out for.

There are several chapters on aviation weather products, ranging from METARs to TAFs and the GFA, SIGMETs and AIRMETs, and charts. Doug is careful to point out differences between Canadian and American products and rules. He has added and/or updated chapters on new products and technologies; e.g. weather radar, satellite imagery, space weather, and numerical weather modelling.

Each chapter finishes with a list of its most essential points; this is handy for people preparing for a test.

It's a thorough and relatively easy-to-follow (for the layman) explanation of weather and atmospheric processes, and focused on how they affect flying, and why pilots need to be aware of them.

The book would have benefited by having at least some of its diagrams and images in colour, but this would have driven up the cost significantly. It also lacks an index; perhaps something for the 2nd edition?

The book touches on automated weather observations, but as these are growing in number and becoming a greater part of the pilot's world, I would have liked to have seen more details regarding their strengths and limitations and how to interpret their data.

Also, I think a chapter describing the various players in aviation weather would benefit the reader; i.e. the role that ICAO and WMO play in setting standards, that Transport Canada plays in setting and enforcing regulations, that NAV CANADA plays as the ANS provider (that's responsible for the provision of aviation weather info, both observations and forecasts), and that the MSC plays in providing weather forecasts, under an agreement with NC.

Pilots might also be interested to see more detail of the forecast production process, starting with how weather observations are used, both by forecasters and numerical weather models, to create predictions of various aviation weather parameters. And how forecasters go about creating forecasts, and what they are attempting to emphasize, the degree of confidence and uncertainty that is inherent in forecasting and, most importantly, how pilots should interpret and use forecasts.

This book covers all the essential topics that aviation weather users need to know. I wholeheartedly recommend it to students in aviation, budding meteorologists and also the casual weather enthusiast.

[1] *SCR Consulting Services and leader of CMOS' Aviation Special Interest Group*

Celebrating Success

Breakthrough Election Results for Andrew Weaver and the BC Green Party

Dr. Andrew Weaver, leader of the BC Green Party, was one of three Green Party members to secure a seat in the legislature in the BC elections on May 9th, when he was re-elected to the riding of Oak Bay-Gordon Head. With the Liberals securing 43 seats and the NDPs securing 41, the Green Party's 3-seat win left them in a strong political position. At the time of writing, the BC Greens had had just announced that they would be supporting the NDP in the legislature.

Andrew is a prominent climate scientist, and was a professor at the University of Victoria for 20 years before moving in to politics. He is a CMOS member, and has been with the Society for 32 years. He has probably attained the highest political level of any CMOS member.

On behalf of CMOS, congratulations Andrew!

Listen to Andrew's recent interview with CMOS Bulletin Editor Sarah Knight, on the 51st CMOS Congress podcast channel (http://www.hipcast.com/podcast/HYQcpQ6Q), or read extracts from this interview on page 13.

Professor Gordon McBean announced as Winner of the 62nd International Meteorological Organization (IMO) Prize by the World Meteorological Organization

The World Meteorological Organization, the United Nations' authoritative voice on weather, climate and water, has announced that Professor Gordon McBean, longstanding member of CMOS, is the winner of the 62nd International Meteorological Organization (IMO) Prize. He will receive his award in 2018.

Established in 1955, the IMO Prize is the most important award in meteorology and is named after WMO's predecessor organization the International Meteorological Organization. It is awarded annually to scientists that have made outstanding contributions to meteorology, hydrology and geophysical sciences, and this is only the fourth time that it has ever been awarded to a Canadian scientist.

More at https://public.wmo.int/en/media/news/imo-prize

On behalf of CMOS, congratulations Gordon!

Listen to Gordon's recent interview on the 51st CMOS Congress podcast channel (http://www.hipcast.com/podcast/HqY9bCgQ).

In Memoriam

Brian Joseph Paruk (1953 - 2017)

Brian graduated from the University of Alberta with a BSc in Physics in 1974, and promptly began his meteorological career with the Atmospheric Environment Service of Environment Canada on Course Number 31. Brian's passion for operational meteorology was evident throughout his career, most of which was spent in Edmonton at the Alberta Weather Centre. Like many in the Meteorological Service, he spent his early years as an operational forecaster.

As his career matured, his interests focused on operational development, implementation and training. Brian published several articles over his career, focused on storms, flooding events, and summer severe weather. He is remembered by his colleagues as the quiet, smart guy, who had a dry sense of humour, and who enjoyed passing his love of meteorology on to young meteorologists, and he was well-known for his "Friday smile" emails. When Brian became excited about discovering something, he could barely stand still, his words spilling out uncontrollably in his attempt to share. Always the consummate professional, you could count on Brian, no matter the challenge.

Brian was an active member of CMOS throughout his career, and remained active in his retirement. He was the Chair of the Local Arrangements Committee for the 2004 CMOS Congress in Edmonton and the photo shows him at the podium during that Congress. Brian's contributions to CMOS are gratefully acknowledged.

Brian died in Edmonton AB on April 6, 2017 at the age of 64 years.

-Alton Wallace

From the CMOS archives: Brian (back row, third from left) in 1975, at the Meteorologist (BSc) course in Winnipeg. [Back row (l To r): Rob K Cross, Al F Wallace, Brian J Paruk, Roger B Street, Peter Chen, Bill Richards, C Hal Ritchie. Front Row: Serge Dupuis, Colin di Cenzo, Christiane Beaudoin, Leslie Taylor (Malone), David L Waugh, Bruno de Lorenzis].

Other CMOS News

CMOS one of 33 organizations to endorse Collective Global Climate Statement

A Collective Global Climate Statement was released on Earth Day - 22nd April, 2017. The Statement was initiated and coordinated by the Royal Meteorological Society, endorsed by an international coalition of 33 meteorological and climate societies and institutions.

The Statement acknowledges the overwhelming scientific evidence that our planet is warming, largely due to emissions of greenhouse gases from human activities and calls for prompt, sustained, global, collaborative, evidence-based action to avoid the largest impacts of climate change.

It urges governments to fully and urgently implement the commitments made in Paris in 2015 to ensure the future global temperature increase is limited to well below 2°C above the pre-industrial levels, to pursue efforts to limit the increase to 1.5°C and to cut greenhouse gas emissions to net zero in the second half of this century.

The essential role of meteorological and climate services in developing effective tools and systems for use by decision makers is highlighted, and cooperation and collaboration across countries, business sectors, society, and science, including education, research and innovation, is emphasised.

The full statement can be found on https://www.rmets.org/sites/default/files/resources/Collective-Global-Climate-Statement.pdf.

NEW CMOS Strategic Plan 2018-2020

"The world is changing rapidly in many ways that implicate the Canadian Meteorological and Oceanographic Society (CMOS). Science, technology, the way people communicate and the policies and priorities of governments world-wide are going through a period of extraordinary advancement, evolution and upheaval; these, and the changing climate are of primary interest to the Society. CMOS has accomplished much in its 50-year history, largely due to the passion and hard work of its members. However, CMOS itself is also changing – changing in the composition of its membership, changing in the way its revenue is raised and spent and changing in the way it communicates with its members and Canadian society."

Available now through the CMOS website (cmos.ca) for consultation until August 31st, 2017.

Books in search of a Reviewer*:

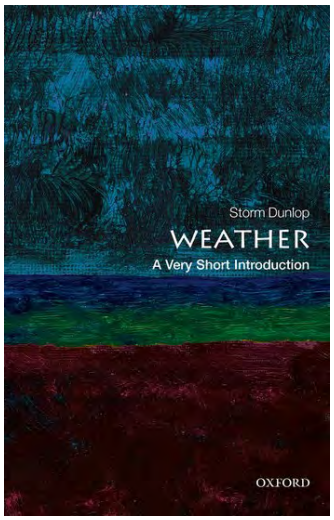
(2015-4) *Thermodynamics, Kinetics, and Microphysics of Clouds*, 2015. By Vitaly I. Khvorostyanov and Judith A. Curry, Cambridge University Press, ISBN 978-1-107-01603-3, Hardback, 782 pages, $108.95.

(2016-2) *Heliophysics: Active Stars, their Astrospheres, and Impacts on Planetary Environments*, 2016.
Edited by Carolus J. Schrijver, Frances Bagenal, and Jan J. Sojka, Cambridge University Press, ISBN 978-1-107-09047-7, Hardback, 406 pages, $68.95

(2017-1) *Weather: A Very Short Introduction*, 2017. By Storm Dunlop, Oxford University Press, ISBN 978-0-19-957131-4, Paperback, 152 pages, $11.95

(2017-3) *Eustasy, High-Frequency Sea-Level Cycles and Habitat Heterogeneity*, 2017. By Mu Ramkumar and David Menier, Elsevier Inc, ISBN 978-0-12-812720-9, Paperback, 102 pages, $60 US

You review it, yours to keep!



Other CMOS News

Canada is the host country for this year's UN World Environment Day, June 5th

World Environment Day provides us with an opportunity to broaden the basis for an enlightened opinion and responsible conduct by individuals, enterprises and communities in preserving and enhancing the environment. Since it began in 1974, it has grown to become a global platform for public outreach that is widely celebrated all over the world.

Connecting People to Nature: A summer evening's paddle on Lake Ontario

Each World Environment Day is organized around a theme that focuses attention on a particularly pressing environmental concern. The theme for 2017, 'Connecting People to Nature', urges us to get outdoors and into nature, to appreciate its beauty and to think about how we are part of nature and how intimately we depend on it. It challenges us to find fun and exciting ways to experience and cherish this vital relationship.

Every World Environment Day has a different global host country, where the official celebrations take place. This year it is Canada. Its rich and spectacular natural heritage is a source of pride and identity for Canadians. Abundant natural resources also support the country's economic prosperity – through tourism as well as sustainable use – and the health and well-being of its 36 million inhabitants.

Source: http://www.un.org/en/events/environmentday/

50 years on, can we do it?

This photo was taken at the very first annual congress of the Canadian Meteorological Society in 1967. Fifty years later, membership has most certainly grown, and the demographics of the Society have most certainly changed!

To celebrate both the occasion of our 50th birthday, and the much improved gender and racial diversity of the Society, we are going to attempt to gather 400+ Toronto Congress attendees for a group shot.

Can we do it? Watch this space!

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

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

Ocean articles, news and more in the May issue of the Canadian Ocean Sciences Newsletter *(see http://cncscor.ca/site/canadianprogram/newsletter)*, **including:**

A Report on a MEOPAR Ocean Acidification Workshop, 23-24 March 2017

by Ken Denman, Maurice Levasseur, Denise Joy, Ron Pelot, and Doug Wallace

"Canada has the longest coastline in the world; our Exclusive Economic Zone (EEZ) including territorial waters for all three of our oceans encompasses 6 million km2 , equivalent to 60% of our land area. As a result of increasing CO2 in the atmosphere and a changing climate, we expect Canada's oceans to become warmer, fresher, more acidic, and, below the surface ocean, to become less oxygenated. Observations and models indicate that acidification will proceed more rapidly and more strongly at high latitudes. During the last three years, the MEOPAR Network of Centres of Excellence supported research projects and two workshops aiming at understanding the causes and the consequences of the ongoing acidification of Canadian Coastal waters…."

Council / Conseil d'administration

Next Issue of the CMOS Bulletin SCMO

The CMOS Bulletin is moving on-line to http://bulletin.cmos.ca. It is expected that the new Bulletin website will be live by July 2017. Please send articles, notes, workshop reports and news items to bulletin@cmos.ca. We will be accepting, reviewing, and publishing content on an on-going basis.

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

Prochain numéro du CMOS Bulletin SCMO

Le bulletin SCMO sera publié virtuellement sur http://bulletin.cmos.ca. On s'attend à ce que le nouveau site soit prêt d'ici juillet. Veuillez envoyer des articles, des notes, des rapports d'atelier et des nouvelles à bulletin@cmos.ca. Nous examinerons et publierons le contenu sur une base continue.

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

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

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51st CMOS Congress | 51e Congrès de la SCMO

Future Earth

Weather, Oceans, Climate

La Terre de l'avenir

Météo, océans, climat

Canadian Meteorological and Oceanographic Society
La Société Canadienne de Météorologie et d'Océanographie

CANADA 150

June 4 - 8th | 4 au 8 juin

2017 TORONTO

Hilton Toronto Downtown | Hilton Toronto, centre-ville

Art & Design: Alicja Parlak, Toronto, ON

It's in our nature.

Watershed management advisors make crucial decisions based on snow and water data. When spring arrives, deciding when to open or close sluice gates could mean the difference between a flood and responsible resource management during a drought. Campbell Scientific has been providing real-time, automatic snow and water monitoring systems in Canada for over 35 years and we understand the challenges of measuring these resources. When you need reliable, accurate data, you can rely on our systems and the expertise of our Measurement Consultants. We'll help you make the best possible measurements, so you can make the best possible decisions.

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