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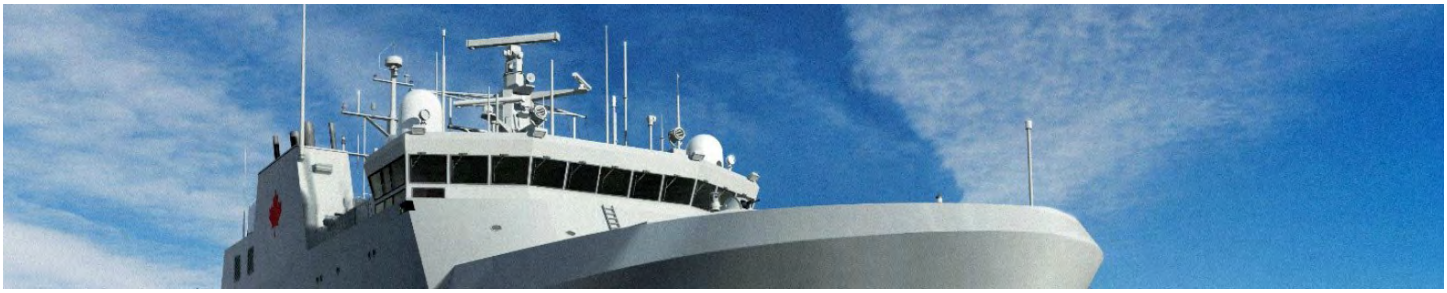

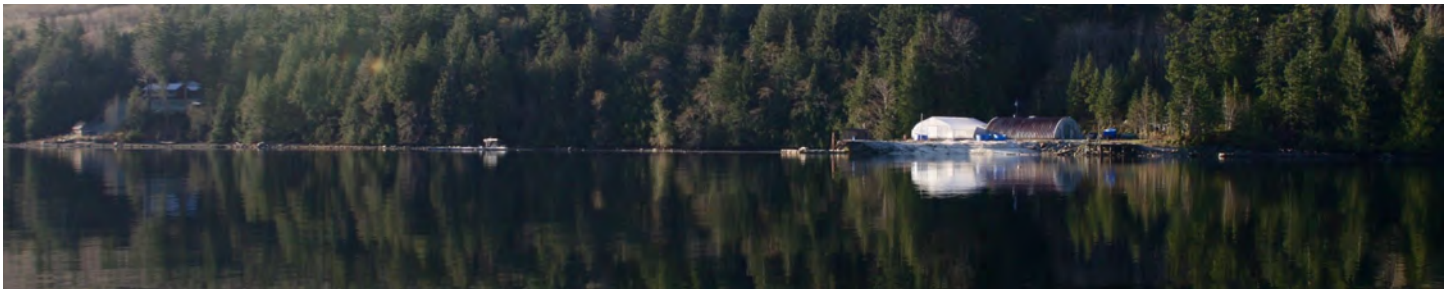

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CMOS Bulletin SCMO
"at the service of its members / au service de ses membres"

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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

The colorful collection of photographs that feature on this issue's cover are the banner images for the articles as they appear on the Bulletin's new website (http://bulletin.cmos.ca).

Top: Photograph shows a partial image of the Harry DeWolf-class offshore patrol vessel, a Government of Canada procurement project for the Royal Canadian Navy that is part of the National Shipbuilding Procurement Strategy. In the article *A New Option for At-Sea Canadian Ocean Science?* Donald Reid and Douglas Bancroft of the Canadian Scientific Submersible Facility share their involvement in promoting discussions with relevant stakeholders to facilitate access to these patrol vessels for ocean science researchers. Read more on page 10. (Image © *Irving Shipbuilding Inc.)*

Second: John G. Hollins discusses the failings of governments to take action on mitigating against global warming and warns that it is time to focus on adaptation. Read more on page 8. (Image source: https://www.pexels.com/u/kasuma/)

Third: Photograph is of a shellfish hatchery in Okeover Inlet, in Georgia Straight, British Columbia. The full article Wind-Driven Upwelling and Seawater Chemistry in British Columbia's Shellfish Aquaculture Capital by Ben Moore-Maley and colleagues, can be found on page 13. (Image source: Ben Moore-Maley)

Bottom: This image is linked to an article on the history and development of the Canadian chronometric radiosonde, by Ken Devine. See page 16. (Image source: www.pexels.com)

Les images hautes en couleur qui ornent la couverture de ce numéro servent aussi de bannières aux articles qui figurent sur le nouveau site Web du Bulletin (http://bulletin.scmo.ca).

En haut : Vue partielle du navire de patrouille de la classe Harry-DeWolf, un projet d'acquisition du gouvernement du Canada pour la Marine royale canadienne, qui fait partie de la Stratégie nationale d'approvisionnement en matière de construction navale. Dans l'article « A New Option for At-Sea Canadian Ocean Science? », Donald Reid et Douglas Bancroft de la Canadian Scientific Submersible Facility racontent comment ils s'efforcent d'encourager la discussion avec des intervenants pertinents, afin de faciliter pour les spécialistes des sciences de la mer l'accès aux navires de patrouille. Consultez la page 10. (image : © Irving Shipbuilding Inc.).

Deuxième image : John G. Hollins discute de l'incapacité des gouvernements à prendre des mesures pour atténuer le réchauffement climatique et l'adaptation. Consultez la page 8. (image: https:// www.pexels.com/u/kasuma/)

Troisième image : Photo d'une écloserie de crustacés à Okeover Inlet, dans le détroit de Georgia (Colombie-Britannique). L'intégralité de l'article « Wind-Driven Upwelling and Seawater Chemistry in British Columbia's Shellfish Aquaculture Capital » de Ben Moore-Maley et collaborateurs se trouve à la page 13. (image : Ben Moore-Maley).

En bas : Cette image illustre un article de Ken Devine sur la conception, la mise en œuvre et l'histoire de la radiosonde chronométrique canadienne. Voir page 16. (image : www.pexels.com).

Words from the President / Mot du président

Why has the Bulletin moved to an on-line format?

Dear Friends and Colleagues –

The CMOS Bulletin is embarking on a new adventure. We are no longer publishing a print version! I must confess to being sceptical about this initiative at first, but as I have settled in to being President of CMOS I have become acutely aware of the positives of bringing this idea to fruition.

As I was writing my commentary for the last Bulletin I was realizing that by the time the message was open and available to non-members, any impact of the contribution to the overall discussion of science in Canada would be months past due. Ditto for the great scientific work and commentaries that are to be found in the contributions from all CMOS members in our Bulletin. It is time to share our work and opinions of scientific issues in real time!

Member Advantages

The Bulletin is now easily available to people all over the world at http://bulletin.cmos.ca/, in a format that is widely accepted and has broad appeal. This will dramatically increase the readership, and the reach of articles published by all members.

The content will be updated on an on-going basis, ensuring that members have ready access to the latest CMOS news and events, and to articles published by your colleagues.

The Bulletin can be accessed and read in a variety of ways, to suit different needs and preferences. As well as the dynamic on-line site, once every two months members and subscribers will receive an e-newsletter of recent Bulletin stories to your inbox. Also, on a bi-monthly schedule, a downloadable PDF will be made available. So, if the preference exists for some of you to have a hard copy, then you will still be able to print one up and read it at your leisure.

All of the content of the Bulletin will now be detectable by Google. In the simple PDF format of old, all articles published in the Bulletin were virtually invisible.

The new format eases sharing of published articles, especially through social media – a link which was not previously possible.

Social Advantages

CMOS researchers are working in areas of high societal priority. In these changing times, access to factual information and informed opinions are profoundly important. All content on the new Bulletin website is searchable, supporting sharing of knowledge with educators, policy makers, researchers and community leaders around the world.

By embracing new technology such as our dynamic on-line website, social media, and an App to view congress programs, CMOS and its members can improve our relevance to society.

Environmental Advantages

In the previous format, the Bulletin was mailed out six times a year, to those CMOS members that had requested the service. At an average of 40 pages per issue, this amounted to approximately 100,000 printed pages every year. The carbon footprint associated with the paper, ink, production, and distribution to addresses across the county is now one footprint that the Society and its members will be erasing.

Financial Advantages

The environmental savings lead to a financial savings, since production and delivery costs are eliminated. This is an important move for a non-profit society.

The on-line format will also be more enticing for corporate advertisers, thus increasing the potential for generating advertising revenue.

Words from the President / Mot du président

CMOS Advantages

Apart from all of those advantages already mentioned, it is my hope that the Bulletin will now have a number of other benefits to the Society, including improving appeal and loyalty from old, young and new membership. The dramatic improvement in the reach of content that is both searchable and highly shareable will support an improvement of the national and international visibility of the Society.

It is also my hope that the modern and dynamic layout, as well as the renewed focus on content that is both highly readable and relevant, will attract a greater number of high quality submissions to the Bulletin from you, our CMOS members.

The bulk of the work to bring our CMOS Bulletin into a fully on-line format has fallen to our new editor Sarah Knight. Sarah has done a remarkable job to honour the long-term quality of the Bulletin, while bringing it into a modern format whereby CMOS can become a much more influential and informative volunteer organization, with a clear role in shaping science activities, funding and policies in our areas of knowledge and expertise. We should be able to reach a much broader, general audience with our new Bulletin format. The combination of our Bulletin with our focused, scientific, Atmosphere-Ocean Journal, and our annual CMOS Congress, will enable CMOS members to share our scientific expertise and informed advice as we work together towards resolving increasingly worrisome local, regional and planetary issues.

Wayne Richardson, P.Eng.
CMOS President

Pourquoi le *Bulletin de la SCMO* a-t-il migré vers un format en ligne?

Chers amis et collègues,

Le Bulletin de la SCMO se lance dans une nouvelle aventure. La version imprimée ne paraîtra plus! J'avoue qu'au départ je doutais de la pertinence d'une telle initiative, mais les quelques mois passés au poste de président de la SCMO m'ont convaincu du bien-fondé de cette démarche.

Tandis que j'écrivais le message destiné au dernier Bulletin, je me suis rendu compte qu'à sa publication pour accès général aux non-membres, tout impact de la contribution à la discussion sur la science au Canada accuserait un retard de quelques mois. Ce serait aussi le cas des travaux scientifiques et des commentaires pertinents auxquels ont contribué tous les membres de la SCMO dans les pages du Bulletin. Le temps est venu de partager en temps réel nos réalisations et nos opinions en matière d'enjeux scientifiques!

Les avantages pour les membres

Le Bulletin se consulte maintenant facilement par tous et partout dans le monde sur le site http://bulletin.scmo.ca, dans un format qui est largement accepté et d'attrait général. Ce format augmentera substantiellement notre lectorat et la portée des articles que rédigent nos membres.

Le contenu sera actualisé en continu, afin d'assurer aux membres un accès rapide aux dernières nouvelles et au calendrier d'événements de la SCMO, ainsi qu'aux articles que soumettent vos collègues.

Vous pouvez accéder au Bulletin de différentes façons et le lire selon vos besoins et vos préférences. En plus de pouvoir accéder aux dernières nouvelles en ligne, les membres et les abonnés recevront une fois tous les deux mois, par courriel, une lettre de nouvelles contenant les articles récents du Bulletin. Il sera aussi possible, tous les deux mois, de télécharger une version PDF de cette publication. Ainsi, si vous préférez posséder un exemplaire papier, il vous sera facile d'imprimer le fichier et de le lire à votre convenance.

Le moteur de recherche Google™ pourra maintenant détecter le contenu entier du Bulletin. Les articles publiés uniquement en version PDF restaient virtuellement invisibles.

Cette nouvelle approche facilite le partage des articles, notamment dans les médias sociaux, ce qui s'avérait impossible auparavant.

Les avantages pour la société

Les chercheurs de la SCMO travaillent dans des domaines de haute importance pour la société. E n ces temps de changements, l'accès à des informations factuelles et à des opinions éclairées revêt une importance indubitable. Tout le contenu du site Web du nouveau Bulletin est interrogeable. Ce qui permet le partage des connaissances avec les enseignants, les décideurs, les chercheurs et les leaders de communautés partout dans le monde.

En profitant des nouvelles technologies, comme notre site Web dynamique, les médias sociaux et l'application mobile pour consulter le programme du congrès, la SCMO et ses membres renforcent leur pertinence auprès de la société.

Les avantages pour l'environnement

Auparavant, nous postions le Bulletin six fois par année aux membres de la SCMO qui en formulaient la demande. En comptant en moyenne 40 pages par numéro, nous arrivons à un total de 100 000 pages imprimées par année. L'empreinte de carbone associée au papier, à l'encre, à la production et à la distribution partout au pays sera chose du passé pour la SCMO et ses membres.

Les avantages financiers

Ces mesures environnementales entraînent des économies financières, puisque nous avons éliminé les coûts de production et de livraison. Un pas important pour un organisme sans but lucratif.

Le format en ligne plaira davantage aux annonceurs, d'où une augmentation éventuelle de revenus de publicité.

Les avantages pour la SCMO

Au-delà du bilan positif déjà mentionné, j'espère que le Bulletin procurera d'autres avantages à la Société, y compris un attrait accru auprès des anciens, des jeunes et des nouveaux membres, ainsi qu'une loyauté renforcée. L'élargissement extraordinaire de la portée du contenu, à la fois interrogeable et facilement partageable, permettra de maximiser la visibilité de la SCMO au pays et à l'étranger.

Nous espérons aussi que l'allure moderne et dynamique du Bulletin, tout comme les efforts visant à obtenir un contenu à la fois lisible et pertinent, encouragera un nombre grandissant de membres à soumettre du contenu de grande qualité.

L'essentiel du travail ayant permis d'arriver à un Bulletin de la SCMO en ligne a reposé sur les épaules de notre nouvelle réditrice en chef, Sarah Knight. Sarah a sans contredit réussi à respecter la qualité de longue date du Bulletin, tout en lui appliquant un format moderne, qui contribuera à transformer la SCMO en une organisation bénévole des plus influentes et informatives. Une organisation qui avance vers un but précis en matière d'activités scientifiques, de subventions et de politiques, relativement à nos domaines d'expertise. Le nouveau format du Bulletin nous permettra d'atteindre un lectorat général élargi. Notre bulletin, la revue scientifique de pointe Atmosphere-Ocean et notre congrès annuel donneront aux membres l'occasion de partager leur expertise scientifique et leurs conseils éclairés, tandis que nous travaillons à résoudre des enjeux locaux, régionaux et planétaires de plus en plus préoccupants.

Wayne Richardson, P.Eng.
président, SCMO

Article: Adaptation to Global Warming

Adaptation to Global Warming: Inevitable, Prepare Now*

John Hollins

Attention by civil society and governments to global warming in the 1990's was a sequel to action on both acidic precipitation and depletion of the stratospheric ozone layer. The latter issues had been addressed, with some success, by adopting the strategy of reducing the emissions of the limited number of industries that caused the problems. The same approach was applied to global warming. This was a mistake because a vastly larger number of players would have to be engaged — not just a few industries, but for starters all users of fossil fuels.

Effective attention to global warming required a broader strategy and a wider range of actions. It still does, with much higher stakes than those of the 1990's. The globe has already warmed by 1ºC since the nineteenth century, and northern Canada by 2.5ºC. Dispassionate prognosis, for example, by the Harvard Project on Climate Agreements, suggests that under the Paris Agreement there is a 50% probability of warming being limited to 2.7ºC — and a 50% probability of warming going above 2.7ºC, even if all the commitments are met. Compare that with the Paris target of 2ºC and the politically popular illusion of 1.5ºC!

There are two fundamental considerations:

- There is a moral obligation by current generations to future generations;
- Effective attention to adaptation would add a powerful political argument to the case for mitigation of emissions.

Canada played a significant role in putting global warming on the international agenda. The Canadian government also engaged with provincial and territorial governments, and with non-governmental organizations and one business sector, the insurance industry. For example, in 1994, the Canadian Council of Ministers of the Environment reaffirmed its commitment to stabilize greenhouse gas emissions by the year 2000 and to develop sustainable options to achieve further progress in the reduction of emissions by the year 2005.

The governments and citizens of Canada failed to meet this commitment and every subsequent one; emissions have continued to rise. If Canada, with political will for two of the past three decades has failed and is likely to continue to fail, the prospects for the Paris Agreement are poor — reason enough to pay at least the same attention to adaptation as to mitigation. There is a lot of room: in Canada, we are talking a little, but doing almost nothing.

Mitigation has an effect on the scale of the globe, whereas adaptation is essentially local. Investors in adaptation are more obviously the beneficiaries than investors in mitigation, where benefits may be greater in faraway places. For government and business, adaptation is just sane, knowledgeable risk management, consistent with modern management approaches. Furthermore, the foundation for adaptation was built some 15 years ago with studies in many countries, including Canada. Consequently, a starting place already exists.

Island states, in particular, are already taking action. An example: construction of a two-story mosque in the Maldives where the upper floor provides a safe place for the entire population of an island during a storm surge or a tsunami, a solution that provides a benefit in both the short and long terms. (photo: Dr. Edward Manning, Tourisk, Inc.)

Article: Adaptation to Global Warming

The financial industry in general, not just insurers, is now paying attention to global warming. Central banks, traditionally conservative institutions, are clear. Mr. Timothy Lane, a Deputy Governor of the Bank of Canada, referred to direct economic costs by 2050 of 20 – 40 billion dollars, not counting ecological and social costs. At the other end of the scale, the proportion of Canadian homeowners purchasing overland flood insurance is climbing rapidly. So, some of us get it!

It is high time for the federal, provincial and territorial governments to change their desultory approach to advisory bodies on adaptation and to put some flesh on the bones. If the federal government were looking to really make a difference, an obvious place to start would be to take the substantial subsidies still paid to the fossil-fuel industry and apply them instead to adaptation, for the benefit of Canadians living now who will have to cope with the inevitable consequences of global warming and for the generations to come.

** This comment is based on a workshop held by the Canadian Association for the Club of Rome. The panelists were J-C Amado, PwC; Ian Burton, University of Toronto; Ted Manning, Tourisk, Inc. John Hollins is Chair of CACOR.*

About the Author: John Hollins

John Hollins (B.Sc. Physics, Ph.D. Biophysics) has been active in community affairs for some 40 years. During his career, he was Executive Director of the Energy Council of Canada and Director of the Energy Branch and Science Advisor at Environment Canada. For 15 years he represented Canada at, and served as Chair of both, the OECD Group on Energy and the Environment, and the International Energy Agency's Programme of Energy Technology Systems Analysis. He is currently Chair of the Canadian Association for the Club of Rome.

Article: At Sea Canadian Ocean Science

A New Option for at Sea Canadian Ocean Science

Donald Reid and Douglas Bancroft, Canadian Scientific Submersible Facility (CSSF)

Introduction

Increasingly limited access to ship time for Canadian Ocean Science has created difficulties for many years, but is now becoming even more problematic. Most ship time has been provided aboard Canadian Coast Guard (CCG) vessels, which attempts to fulfill its mandate while dealing with the maintenance and coordination problems of operating an aging fleet. Capacity is eroding before replacement. Ships are not being replaced one-for-one. These problems are affecting all three coasts, but are especially notable, and potentially critical, in the Arctic. Reduced availability of CCG ships is a threat to all Canadian Ocean Science researchers who rely on this sea time.

It is suggested that a significant contribution to Canadian Ocean Science could be made by the Royal Canadian Navy (RCN) supporting science missions with ship time and facilities aboard the soon to be launched HARRY DEWOLF-Class Arctic/Offshore Patrol Ships (AOPSs) with delivery of up to six vessels scheduled to begin in 2018.

We hope that government leadership in ocean science, specifically Fisheries and Oceans Canada (DFO) ADM Science, and Natural Resources Canada (NRCan) ADM Lands and Minerals, will be convinced that this is a sound idea worth evaluating with a pilot project conducted in the summer of 2019. The potential availability of time and facilities aboard these ships will hopefully lead to Canadian Ocean Science academics developing collaborations with DFO and NRCan scientists to take advantage of any available ship time.

HARRY DEWOLF-Class Arctic/Offshore Patrol Ship © Irving Shipbuilding Inc.

The Problem

Access to reliable CCG ship time for ocean scientists has been steadily declining for years. There are several key causes; a science support fleet that has been aging for decades, DFO Ocean Science structural deficits, and slowly declining Natural Sciences and Engineering Research Council (NSERC) Ship Time Allocation Committee (STAC) funding. These problems have recently begun to accelerate on all three coasts.

Concurrently, demand for ocean science support has been increasing and is likely to continue to do so. For instance, growing pressure to establish new Marine Protected Areas on all coasts will require extensive ocean science studies to identify optimum locations. Once established, longer-term monitoring programs will be required to demonstrate and ensure their levels of effectiveness.

While new science-capable ships are currently being constructed for the CCG, there will be significant loss of capacity in the interim, until all the required replacement vessels are in service. It should also be noted that any CCG ships assigned to science missions are periodically re-assigned to real world Search and Rescue and other tasking, displacing science missions. Current challenges by region include:

Atlantic: CCG ships that support science have been retired, or are close to retiring, and are increasingly not available for ocean science service. Examples include:

- CCGS ALFRED NEEDLER – 35 years old, suffered a significant engine room fire in 2003;
- CCGS WILFRED TEMPLEMAN – in service for 27 years, removed from service in 2008; and
- CCGS HUDSON – 54 years old, first Canadian purpose-built ocean research ship, in refit since December 2016.

Pacific: One key CCG ship that has supported ocean science has just retired, leaving little other capability, especially for fisheries science. Examples include:

- CCGS W. E. RICKER – 39 years old (31 years in government service) and no longer sea worthy, removed from service in March 2017; and

- CCGS TULLY – 33 years old, entering a life extension refit creating some uncertainty as there is little alternative west coast science capacity.

Arctic: Activity in the Arctic is increasing and expanding our ocean science presence is crucial. CCG ships include:

- CCGS AMUNDSEN has been key. A capable ship but greatly oversubscribed and limited to deploying a relatively small Remotely Operated Vehicle (ROV) by her "moon pool", and limited available deck space. She is 39 years old and approaching a refit (originally refitted to support Arctic science in 2003, service refit in 2012);
- CCGS LOUIS ST-LAURENT is 51 years old, conducted sea -floor mapping in 2016;
- CCGS SIR WILFRED LAURIER is 32 years old, involved in the search that found Franklin's HMS EREBUS in 2014, limited science capacity.

CCGS AMUNDSEN © Martin Fortier-ArcticNet

Potential Opportunity: Arctic and Offshore Patrol Vessels

With the RCN taking delivery of up to six ice-capable AOPSs (or Arctic and Offshore Patrol Vessels; AOPVs) starting in 2018, new ocean science platforms may become available. The AOPS's mandate will include:

- conducting armed sea-borne surveillance of all three of our coasts;
- providing situational awareness of activities and events; and
- cooperating with other government departments in supporting their mandates, as required.

The last statement means that if DFO and NRCan (and other departments) request support from the RCN for ocean science, this could be made available "as opportunity allows". In addition, they could also support academic ocean science missions if those scientists were in collaboration with DFO (possibly through their Partnership Program) and/or NRCan researchers.

Key AOPS technical factors:

- Length: 103 metres. Beam: 19 metres. Crew: 65;
- Displacement: 6,440 tonnes;
- Dozens of empty bunks (for soldiers, special forces, etc.);
- Considerable upper deck space for six 20-foot containers, space on the flight deck for ROVs and/or Autonomous Underwater Vehicles (AUVs, including gliders);
- A 20-tonne crane to self-load/unload payloads, instruments, ROVs, etc.;
- Helicopter and drone capability;
- Two 4.5-megawatt main engines, powered by four 3.6 megawatt generators; and
- Bow thrusters for dynamic positioning.

Highly versatile, AOPSs could become outstanding ocean science vessels of opportunity. This belief could be easily tested in a four-week trial deployment in 2019. As an example, the following could be readily embarked:

- Up to two dozen scientists and support staff;
- Containerised labs and equipment;
- The ROV Remotely Operated Platform for Ocean Science (ROPOS; Canadian Scientific Submersible Facility (CSSF));
- HUGIN AUV (ULaval); and
- AUV Gliders (Dalhousie, UBC).

Benefits for the RCN/Canadian Forces

These ships, outfitted with appropriate research equipment including state-of-the-art ROVs and/or AUVs, could also provide a comprehensive deep seabed intervention capability for the RCN that has been lacking for decades, as well as the opportunity to maintain continuing experience in this and related fields. It would restore RCN expertise and develop experience with deep seabed intervention operations.

This opportunity could also be used to restore RCN experience with deep sea Search and Recovery, and provide a contingency seabed intervention capability. While supporting DFO and NRCan ocean science, Defence Research and Development Canada (DRDC) could also exploit this capability to install experimental moored arrays and other RD projects in direct support of RCN capability improvement.

Next Steps

CSSF has been supporting this initiative in discussions at all levels of DFO, NRCan, and RCN; as well as with academic scientists, NSERC and DRDC, and will continue to do so. A current priority is the development of a four -week ocean science demonstration trial aboard an AOPS operating out of Halifax, NS as soon as possible after the completion of ship trials.

This entire process could be initiated if the DFO ADM Science and NRCan ADM Lands and Minerals were able to meet with The Commander of the RCN to develop and sign a formal Memorandum of Understanding among the three groups. DFO and NRCan would then be able to have their scientists assemble consortia of ocean science research groups that would include university academics, NSERC and DRDC.

Led by DFO and NRCan, these groups could then work together to develop a five-year proposed Canadian Ocean Science plan with full participation by academics, DRDC, and interested NGOs. Recognised Networks of Centres of Excellence (NCEs) and related entities including the Marine Environmental Observation Prediction and Response Network (MEOPAR), Ocean Networks Canada, Takuvik, ArcticNet and the Ocean Frontier Institute should also be engaged and may in fact wish to play a key science leadership role. Participation of the DFO Partnership Fund and NSERC STAC would be critical for the funding of mission-related incremental costs.

CSSF is not alone in recognizing this problem and envisioning solutions. Of note, a team of academics led by MEOPAR Scientific Director Douglas Wallace have developed a concept known as Modular Ocean Research Vessels (MORV). MORV will use existing, non-specialized vessels to embark science teams with containerised labs and support modules. They have identified several candidate ships in Halifax and St John's and are working to further develop this concept, with a trial expedition, using a platform supply vessel, as early as August/ September 2018 to test both MORV and AOPS concept of operations while conducting quality ocean science. Science would include various water column and seafloor biogeochemistry and monitoring studies with a ROPOS mission focusing on deep ocean microbiology studying hydrocarbon-degrading microbes.

Conclusion

The ability of the CCG to support Canadian Ocean Science is continuing to decline and significant shortfalls will still occur after delivery of the new science ships. Any ship time "as opportunity allows" that may become available aboard an RCN AOPS could and should to be fully exploited to achieve their full mandate while promoting all possible aspects of Canadian Ocean Science. The future is what we make it.

References:

AOPS: http://www.navy-marine.forces.gc.ca/en/fleet-units/aops-home.page
CSSF ROPOS: http://www.ropos.com

About the Authors: Douglas Bancroft and Donald Reid

Douglas Bancroft is a former Commanding Officer of several RCN ships, who has also enjoyed three decades in senior leadership positions in DFO, Environment Canada (EC) and NRCan science. He is currently President and CEO of the Canadian Scientific Submersible Facility (CSSF). He has observed first hand the alarming and accelerating decline of CGG capacity to support Canadian ocean science over the last decade, and developed this concept as an option to substantially mitigate this situation.

Donald Reid has worked in ocean sciences for more than four decades as a marine/aquatic biologist studying coral reefs, crustacean reproduction, fisheries management, and the transport and control of aquatic invasive species. He has been a co-ordinator/advisor for various programs and projects with EC, DFO and TC, including the CCG.

Wind-Driven Upwelling and Seawater Chemistry in British Columbia's Shellfish Aquaculture Capital

Ben Moore-Maley(1), Debby Ianson(2), Susan Allen(1); 1: Department of Earth, Ocean and Atmospheric Sciences, University of British Columbia; 2: Institute of Ocean Sciences, Department of Fisheries and Oceans Canada

On the southern British Columbia coast, the protected waterways of the Strait of Georgia host over 80% of the 400+ shellfish farm leases in Pacific Canada [DFO Aquaculture Management Division, 2016]. The shallow, tidally flushed shorelines and passages, particularly in the northern Strait, provide often ideal conditions for raising several shellfish varieties including oysters, clams, and mussels. Since 1998, a steady expansion of the number of farm leases in and around the Strait has been underway [Silver, 2014]. However, despite a 2015 harvest of 11,000 tonnes and over $57 million in wholesale value [BC Ministry of Agriculture, 2016], these numbers fall nearly 50% short of the provincial government's 1997 projections when the initial lease expansion began [Silver, 2014].

While a variety of ecological mechanisms attenuating shellfish farm productivity may arise from increased farming density [Bendell-Young and Ydenberg, 2001], changes in the seawater carbonate chemistry of the Strait of Georgia habitat may also play a role. Rising ocean dissolved inorganic carbon (DIC) due to increased CO2 uptake from the atmosphere is causing ocean pH to decline (ocean acidification, [Byrne et al., 2010]), and the negative effects of this decline on marine organisms and ecosystems have been increasingly explored over the past decade [Haigh et al., 2015]. Shellfish are particularly vulnerable to this decline because rising DIC also lowers the saturation state of aragonite, a mineral form of calcium carbonate used especially in juvenile shellfish [Waldbusser et al., 2015].

For the Strait of Georgia, it is unclear whether ocean acidification is affecting farmed shellfish habitats or not. In fact, DIC is higher in the deep Strait of Georgia, due to local carbon retention, than in the northeastern Pacific Ocean water that annually flushes the Strait [Ianson et al., 2016]. However, this same local carbon retention produces low pH (< 8.0), aragonite-undersaturated waters below a strong, shallow (20 m) gradient throughout the spring, summer and fall [Moore-Maley et al., 2016]. These waters could be a source of environmental stress for, and potentially corrosive to, shellfish if they flow through farmed areas.

Figure 1: An oyster farm in Deep Bay toward the south of Baynes Sound. Photo: Eleanor Simpson, Simon Fraser University.

Figure 2: An oyster farm in Okeover Inlet near the Discovery Islands.

In lakes of comparable scale and dimension to the Strait of Georgia, wind-driven upwelling is capable of displacing water masses near the shore by 20 m both along basin sides (e.g., Lake Ontario, [Csanady and Scott, 1974]) and at basin ends (e.g., Kootenay Lake, BC, [Stevens and Lawrence, 1997]). However, increased stratification and tides make characterizing the wind-driven upwelling in the Strait more complicated than in lakes. Furthermore, the overwhelming majority (80%, [DFO Aquaculture Management Division, 2016]) of farm leases in the Strait of Georgia are concentrated in Baynes Sound (like the site shown in Figure 1) along the central eastern coastline of Vancouver Island, and in or near the Discovery Islands (like the site shown in Figure 2) at the northern end of the Strait (Figure 3), both of which are topographically isolated zones of significant tidal influence.

The Mesoscale Ocean and Atmospheric Dynamics (MOAD) group at the University of British Columbia is investigating the link between wind-driven upwelling and nearshore carbonate chemistry in the Strait of Georgia using the recently developed SalishSeaCast marine forecast model (https://salishsea.eos.ubc.ca/nemo, Figure 3). The project is part of the Integrated Coastal Acidification Program (I-CAP) supported by the Marine Environmental Observation, Prediction And Response (MEOPAR) Network of Centres of Excellence of Canada. SalishSeaCast is built on the NEMO 3.6 ocean model [Madec, 2016] and was first deployed as a MEOPAR-funded, storm surge forecast model for low lying municipalities in the southern Strait [Soontiens et al., 2016]. The project has since grown into a 3+ year hourly record archived by the MOAD team (https://salishsea.eos.ubc.ca/erddap).

The SalishSeaCast model is forced by tidal sea surface heights at the north and southwestern open boundaries (Figure 3), at the surface by 2.5 km resolution surface wind velocities from Environment and Climate Change Canada's (ECCC) High Resolution Deterministic Prediction System (HRDPS) atmospheric forecast model [Milbrandt et al., 2016], and at approximately 150 river mouths using a watershed climatology [Morrison et al., 2012] and Fraser River gauge data from ECCC. The combination of high resolution wind forcing, river forcing, and tuned tidal amplitudes and mixing throughout the model domain [Soontiens and Allen, 2017] provides SalishSeaCast with the skill to accurately reproduce upwelling events near the Baynes Sound and Discovery Islands shellfish farming areas.

Figure 3: Map of the Salish Sea. The SalishSeaCast model domain is shown in gray and the model bathymetry is contoured in blue. Model horizontal resolution is approximately 500 m with 40 vertical layers of thickness 1 m near the surface to 27 m at depth. Baynes Sound and the Discovery Islands are highlighted by the red boxes and contain approximately 35% and 45%, respectively, of the total shellfish farm leases in the Strait of Georgia.

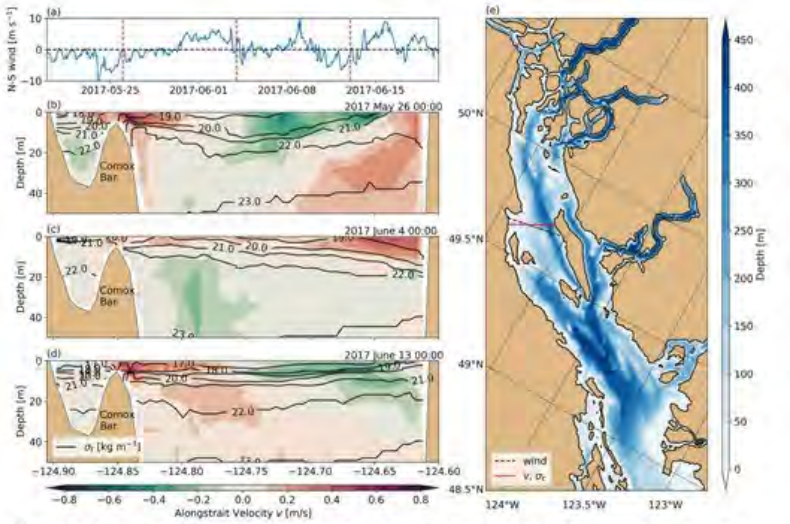

Figure 4: Along-strait wind speed and cross-strait density and velocity structure near Baynes Sound between 20 May and 20 June 2017. Wind speed (a) is positive from the south and averaged along the dotted black transect shown in (e). Density (black contours, σt = density – 1000 kg m-3) and along-strait velocity (color contours, positive north) cross-sections are taken from the red transect shown in (e) on (b) 26 May, (c) 4 June and (d) 13 June at midnight UTC. The 4 June cross-section (c) follows a 4 day south wind event, and upwelling is evident by the shoaling isopycnals on the west side of the basin.

The Strait of Georgia is wide enough for rotational dynamics to affect the water column response to wind forcing. Thus for along-strait winds blowing from the south, there is a cross-strait tilt in the near-surface pycnocline and upwelling along the Vancouver Island coastline. One such wind event occurred in the SalishSeaCast record near Baynes Sound at the beginning of June 2017 (Figure 4). In late May and mid June, the 1022 kg m-3 cross-strait density surface, corresponding approximately to the 20 m isobath, was nearly flat (Figure 4b, d). Based on recent observations [Ianson et al., 2016] and modelling [Moore-Maley et al., 2016], the 20 m isobath roughly corresponds to the strong chemical gradient separating the surface from the low pH (< 8.0), aragonite-undersaturated water below. On June 4 following a 4 day wind event from the south (Figure 4a), the cross-strait pycnocline tilted significantly and the 1022 kg m-3 density surface appeared to begin spilling over Comox Bar into northern Baynes Sound, as evidenced by the shoaling isopycnals on the western side of Comox Bar (Figure 4c).

Such wind events originating from the south are more characteristic of winter than summer. Shellfish stocks may be more resilient to winter disturbances since the primary growing season for juveniles is spring and summer. However, as the June 2017 example illustrates, these south wind events are not isolated to winter and can occur during any season. What remains to be determined is how frequently and how significantly these types of events

influence the water properties of regions like Baynes Sound and the Discovery Islands. These areas may turn out to be protected from upwelling by tides, bottom topography, or nearby rivers. Alternatively, they may turn out to be hotspots for upwelling sensitivity, which could explain some of the deficit in projected industry growth. Either way, if wind driven upwelling does turn out to be a source of environmental stress for farmed shellfish, forecast models like SalishSeaCast may be able to provide a solution for shellfish farmers to avoid putting their stock in harm's way. The MOAD Salish Sea team is currently developing a carbonate chemistry model coupled to SalishSeaCast for the purpose of forecasting pH and aragonite saturation state in areas like Baynes Sound and the Discovery Islands.

Acknowledgements: *This work is funded by MEOPAR and an NSERC Discovery Grant. We would like to acknowledge the contributions and ongoing work of recent MOAD Salish Sea team members, especially Doug Latornell for implementing the automation, forecasting, collaboration, and software development frameworks, Michael Dunphy, Nancy Soontiens and Jie Liu for their roles in developing the model physics, Vicky Do for her ongoing upwelling simulations, Elise Olson for her development and evaluation of the biology model, and Tereza Jarníková for her ongoing development of the carbonate chemistry model. We would also like to thank our partners in the shellfish industry: Keith Reid of Stellar Bay Shellfish, Yves Perrault of Little Wing Oysters, Andre Comeau of Okeover Organic Oysters and Andrew Dryden of Evening Cove Oysters.*

References

BC Ministry of Agriculture (2016), British Columbia Seafood Industry: Year in Review 2015, Retrieved from https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/statistics/industry-and-sector-profiles

Bendell-Young, L. I., and R. Ydenberg (2001), Ecological implications of the shellfishery: a case study on the west coast of British Columbia, Canada, in Waters in Peril, edited by L. I. Bendell-Young and P. Gallaugher, pp. 57-70, Springer, doi:10.1007/978-1-4615-1493-0.

Byrne, R. H., S. Mecking, R. A. Feely, and X. Liu (2010), Direct observations of basin-wide acidification of the North Pacific Ocean, Geophy. Res. Lett., 37(2), L02601, doi:10.1029/2009GL040999.

Csanady, G. T., and J. T. Scott (1974), Baroclinic coastal jets in Lake Ontario during IFYGL, J. Phys. Oceanogr., 4(4), 524-541, doi:10.1175/1520-0485(1974)004<0524:BCJILO>2.0.CO;2.

DFO Aquaculture Management Division (2016), 2016 Shellfish Aquaculture Facilities in BC (Map), Retrieved from http://www.pac.dfo-mpo.gc.ca/aquaculture/maps-cartes-eng.html.

Haigh, R., D. Ianson, C. A. Holt, H. E. Neate, and A. M. Edwards (2015), Effects of ocean acidification on temperate coastal marine ecosystems and fisheries in the Northeast Pacific, PLoS ONE, 10(2), e0117533, doi:10.1371/journal.pone.0117533.

Ianson, D., S. E. Allen, B. L. Moore-Maley, S. C. Johannessen, and R. W. Macdonald (2016), Vulnerability of a semi-enclosed estuarine sea to ocean acidification in contrast with hypoxia, Geophys. Res. Lett., 43(11), 5793-5801, doi:10.1002/2016GL068996.

Madec, G. (2016), NEMO Ocean Engine, Note du Pôle de modélisation de l'Institut Pierre-Simon Laplace No. 27, France.

Milbrandt, J. A., S. Bélair, M. Faucher, M. Vallée, M. L. Carrera, and A. Glazer (2016), The pan-Canadian high resolution (2.5 km) deterministic prediction system, Weather Forecast., 31(6), 1791-1816, doi:10.1175/WAF-D-16-0035.1.

Moore-Maley, B. L., S. E. Allen, and D. Ianson (2016), Locally-driven interannual variability of near-surface pH and ΩA in the Strait of Georgia, J. Geophys. Res. Oceans, 121(3), 1600-1625, doi:10.1002/2015JC011118.

Morrison, J., M. G. G. Foreman, and D. Masson (2012), A method for estimating the monthly freshwater discharge affecting British Columbia coastal waters, Atmos. Ocean, 50(1), 1-8, doi:10.1080/07055900.2011.637667.

Silver, J. J. (2014), Shellfish and coastal change: Pacific oysters and Manila clams in BC waters, BC Studies, 181, 83-103.

Soontiens, N., and S. E. Allen (2017), Modelling sensitivities to mixing and advection in a sill-basin estuarine system, Ocean Modelling, 112, 17-32, doi:10.1016/j.ocemod.2017.02.008.

Soontiens, N., S. E. Allen, D. Latornell, K. Le Souëf, I. Machuca, J.-P. Paquin, Y. Lu, K. Thompson, and V. Korabel (2016), Storm surges in the Strait of Georgia simulated with a regional model, Atmos. Ocean, 54(1), 1-21.

Stevens, C. L., and G. A. Lawrence (1997), Estimation of wind-forced internal seiche amplitudes in lakes and reservoirs, with data from British Columbia, Canada, Aquat. Sci., 59, 115-134, doi:10.1007/BF02523176.

Waldbusser, G. G., B. Hales, C. J. Langdon, B. A. Haley, P. Schrader, E. L. Brunner, M. W. Gray, C. A. Miller, and I. Gimenez (2015), Saturation-state sensitivity of marine bivalve larvae to ocean acidification, Nat. Clim. Change, 5, 273-280, doi:10.1038/nclimate2479.

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Ben is a PhD candidate with the MOAD Salish Sea team at the University of British Columbia. He is using the SalishSeaCast model to study how wind-driven currents and upwelling in the Strait of Georgia impact seawater carbonate chemistry and oil spill trajectories.

The Canadian Chronometric Radiosonde

Kenneth A. Devine

While temperature profiles to the tropopause had been conducted in Canada for research purposes starting in 1911 (Devine & Strong, 2009), operational upper air systems did not become available until 1929 with the introduction of the radiosonde which had a built in radio transmitter. The radiosonde gave the meteorologist a three dimensional view in real time of the atmosphere which remains the critical element for forecasting. The first operational upper air station of the Meteorological Service of Canada (MSC) was opened in Gander, Newfoundland in 1941 (Thomas, 2001) using the Canadian radiosonde system. Eventually only eight stations – Aklavik, Baker Lake, Coppermine, Fort Smith, Port Hardy, Sable Island, The Pas and the Pacific Weather Ship (PAPA) – used these Canadian designed radiosondes (Bindon, 1953). The other upper air stations in Canada used the American audio modulated radiosonde system.

The Canadian radiosonde (Figure 1) was a chronometric radiosonde (Middleton & Sphilaus, 1953) which depended upon an accurate motor speed since the value of each measurement was determined by timing. The 1500 rotations per minute (rpm) motor was geared down by a ratio of 1:343 to slowly rotate an anodized aluminum disk which had a spiral slot impressed upon it. Above the rotating spiral disk were four contactors for: pressure (right, off the picture), temperature (upper left), humidity (left), and reference (center bottom). A single aneroid cell moved the pressure contactor arm. The temperature arm was deflected by a short bimetal sensor made of nickel steel and Invar. Initially, the humidity arm had used a human hair sensor but by 1947 a goldbeater skin (intestine) was being used, as it was more sensitive and responsive at cold temperatures. During the preflight calibration, which is called the baseline check, the humidity sensor had to be exercised by breathing on it until the recorder indicated 100% (MSC, 1946).

The fixed reference arm marked the beginning and end of each half rotation of the disk. The reference signals were manually synchronized with the base station recorder (Figure 2) speed in order to compensate for any gradual change in the motor speed during the flight.

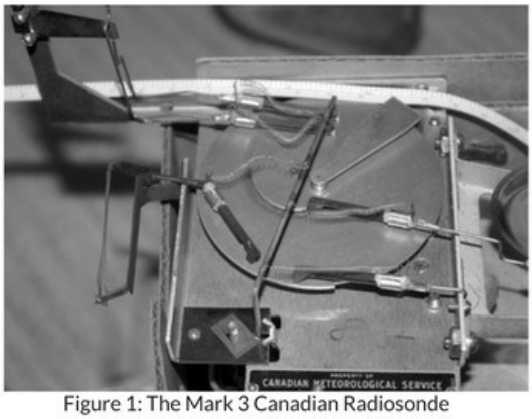

Figure 1: The Mark 3 Canadian Radiosonde (CMST, #910075)

Figure 2: Base Station FM Receiver and Recorder (Devine, 1961)

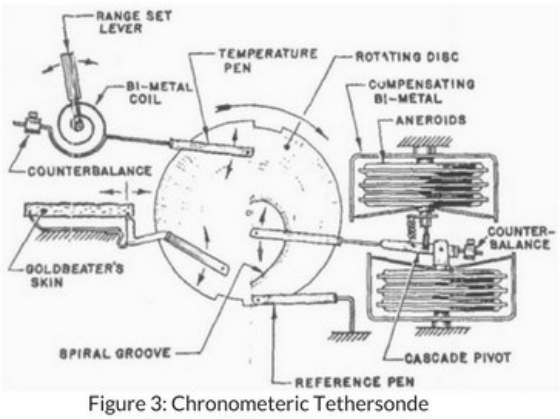

Figure 3: Chronometeric Tethersonde (Bourke & Klein, 1967)

The published limits of the sensor accuracy was ±0.2°C for temperature (+35 to -75°C), ±1% for humidity, and ±2 hPa for pressure (Latimer & Dickson, 1957). The 1957 Mark 3 version of the radiosonde (Figure 1) had two temperature elements: one was nickel plated and the other was black. This was changed in the 1958 Mark 3(S) to a single bimetal element in a shielded duct for which solar radiation corrections were applied (MSC, 1958).

The radiosonde motor was developed by Ratje Jacobsen who modified a commercial midget direct current motor in 1937 (Jacobsen, 1939). A vibrator controlled the rotation rate of a magnet on the motor shaft by alternately switching off and on the battery voltage to a fixed coil as the shaft rotated. Once started, the magnet on the motor shaft continued to rotate at a rate of about 1500 rpm. This “hit-and-miss” motor, which rotated the spiral via the gearing, dates from the time of Michael Faraday. Jacobsen weighted the phosphor bronze vibrator so that it oscillated at a very constant rate like a watch. As a result the motor speed was quite accurate and the disk rotated at a constant rate in about fourteen seconds.

Based on this radiosonde, a tethersonde was developed for profiling the first 500 metres of the atmosphere for research purposes (Figure 3). The tethersonde was lifted by a small helium filled balloon (kytoon) which was shaped like a dirigible whose speed of ascent was controlled by a winch on the ground. This sonde was virtually identical to the operational radiosondes used to measure profiles up into the stratosphere. The main change was the use of six rather than a single aneroid cell to handle the smaller pressure changes near the surface. The temperature sensor was also changed from a short bimetal strip to a bimetal coil, again to handle the minute changes within the first 500 metres. The motor, disk and humidity sensor were not changed. A special audio modulated version of the tethersonde was developed by MSC in the later 1960s.

This chronometric radiosonde was typical of the radiosondes developed during the 1930s, and while ingenious they were mostly mechanical. Remnants of these mechanical subsystems would remain in radiosondes worldwide until the 1990's. The Canadian radiosonde was last used operationally on Ocean Station PAPA in 1963. As many as one hundred thousand of these radiosondes may have been used during its twenty-two year operational life.

References:

Bindon, H.H., 1953, Developments in the Canadian Radiosonde, Royal Meteorological Society – Canadian Branch, Volume 4

Bourke, R.S., and Klein, G.L., 1967, The Chronometric Tethersonde, Description and Operation, J.App.Met, p419, Vol.6

CMST, #910075, Canadian Museum of Science and Technology, Canadian radiosonde: archive number 910075

Devine, K.A. and Strong, G.S., 2009, The First Tropospheric Temperature Profile in Canada, CMOS Bulletin, Vol.37, No.5, October

Jacobsen R.C., 1939, A Speed – Governed Midget Electric Motor, Review of Scientific Instruments, page 315, Volume 10, October

Latimer, J.R. & Dickson, J.S., 1957, The Canadian Radiosonde and Rawinsonde System, Meteorological Service of Canada, Instrument Manual 91, MSC Circular 2877, Toronto

Middleton, W.E. Knowles and Spilhaus, Athelstan F., 1953, Meteorological Instruments, University of Toronto Press, Third Edition, Toronto

MSC, 1946, The MSC Radiosonde (and how to use it), Radiosonde Circular 2, MSC Circular 892, Meteorological Branch (MSC), Toronto

MSC, 1958, Summary of Radiosonde Observation in Canada

Thomas, Morley, 2001, Metmen in Wartime – Meteorology in Canada 1939-1945, CW Press, Toronto

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Ken began his career as an observer and Officer-in-Charge at remote upper air stations. Later he worked three years as a senior electronics technician which included installing the first operational weather stations in Canada. After obtaining his degree and completing the meteorologist training in 1971, he spent four years forecasting on the east coast before moving to headquarters. In Toronto he worked in instrument development, project management, Field Services and finally as Superintendent of Climate Standards. After retiring in 1998 he has been researching and writing articles on the history of meteorological instruments in Canada.

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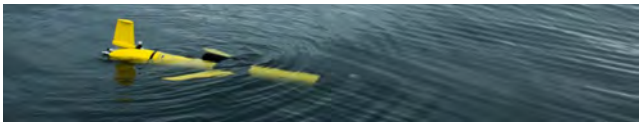

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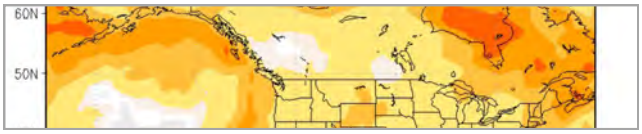

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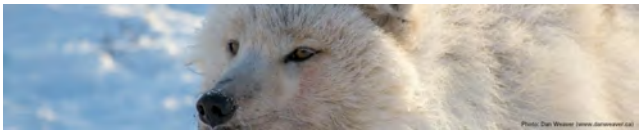

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Maury Project 2017

Aditi Garg, Centennial Collegiate, Saskatoon, SK

This summer I had the distinct pleasure of representing Canada at the annual two week Project Maury teacher peer-trainer program hosted at the United States Naval Academy (USNA) with the American Meteorological Society (AMS). My position was funded by the Canadian Meteorological and Oceanographic Society and the Canadian National Committee for SCOR. I am thankful that they continue to support teacher professional development.

The course is a wonderful opportunity to meet highly engaging and masterful educators from across the border. It is rare for me to get the opportunity to meet American teachers and this was perhaps the most appreciated part of Project Maury. I was also the most junior teacher on the course, so I was thrilled to get to soak up the good ideas from my 'elders'.

The course is a well-oiled machine. The program organizers have been doing this for over twenty years and their proficiency is incomparable. Although the program has spanned three decades, they are still able to draw on the cutting-edge research of USNA, NASA and NOAA colleagues, former students and friends that make the program relevant and meaningful. It's a completely overwhelming, absorbing two weeks for participants. For the organizers, they started planning the next year before we even finished this one.

The content of the program is broken into a series of modules. They range from very general to more specific content, however each one could fit within my provincial curriculum at multiple levels. The topics covered include: waves and tides, density and wind driven circulations, sea-air interactions, physical factors impacting ocean life, changing climate, sea levels and coastlines, ocean reservoir capacity, sea level measurement, direct and remote sensing, El Niño and La Niña, and winds, storms, hurricanes, and storm surges.

The activities are designed to use material 'from the recycling bin' and few extra resources. It is nice that they are not elaborate or costly thus accessible regardless of school resources. Very few of the activities require Internet. It's a nice reminder that students don't need the latest tech to have effective learning. Additionally, one of the best parts of the program was that although the organizers showed these traditional demonstrations, they allowed plenty of time for teachers to discuss adaptations or modernizations. Which videos and websites would supplement or enhance the cardboard paper tube demonstration? Which apps could make recording data from this density lab more precise or easier to interpret? The flexibility of learning was awesome.

The downtime each day was spent exploring Annapolis, learning about the history of the Chesapeake Bay and enjoying the multiple pubs and restaurants of the area. We also spent a day in Baltimore at the National Aquarium, a half day at the NOAA headquarters and another half day at the NASA Goddard Centre.

Upon my return to Canada, I facilitated a workshop for my colleagues focused on one specific lab about density-driven ocean circulation. The teachers' evaluation of the workshop was positive and they were interested to get more information about the other labs, specifically those related to waves as it is a significant portion of our physics courses.

I am grateful to the CMOS award coordinators for selecting me and the AMS's gracious welcome of a Canadian. These kinds of cross-border connections are rare. Special thanks to David Smith and Don McManus (Maury Project), Wendy Abshire (AMS), and Denis Bourque (CMOS). Thank you also to William Swick, Shawn Gallaher and Joe Smith at the USNA. Their professionalism, respect and sensibility blew me away – they were great mentors and a positive reminder that there is meaningful work being done by the American government and military.

Taking the temperature of Chesapeake Bay bottom water the analog way. Aditi is on the left.

Comparing tide heights using sticky notes.

At the end of a good day surveying coastal landscape and seine netting the littoral zone.

Project Atmosphere 2017

Maria Nickel, Winnipeg, MA

In late May, I found out that I had been selected by the Canadian Meteorological and Oceanographic Society and Canadian Geographic Education as the Canadian participant at Project Atmosphere. Project Atmosphere is a Summer Teacher's Workshop offered by the American Meteorological Society at the National Weather Service Training Center in Kansas City, Missouri for K-to-12 teachers in the USA. For 2 weeks in JULY, 20 teachers from all over the US, one from Egypt, and I participated in a very intensive professional development course designed to teach atmospheric content.

The location for our workshop was the National Weather Service Training Center (NWSTC). The workshop location was primarily at the meteorological training facility as well as at a Weather Balloon launching station. Both locations provided all participants with tremendous access to working personnel at the office to learn and see the day-to-day operations of weather forecasting on a daily basis. There were computerized models displays on forecasting and question and answer sessions with the workers in the field. This access gave us all insight in the daily challenges weather forecasters face in predicting complex moving weather patterns around the US, Canada and around the world. Our primary focus was the US during our stay there with a few Canadian references thrown in.

During this intensive two weeks, we learned from various experts, including National Weather Service head Dr. Louis Uccellini (on left) who makes it a point every year in his busy schedule to spend time with all of the participant and talk to us about the National Oceanic and Atmospheric Administration (NOAA), how they are trying to make the US a Weather-Ready Nation, the importance of weather and the value of teachers in educating the next generation of forecasters. The workshop was essentially an 8-week grad course from Cal U Pennsylvania compressed into 2 weeks. It was a huge learning challenge for me and all participants but we persevered and completed it.

Once done the workshop, the expectation is to hold two workshops to other teachers to help provide them with some of the same learning materials we did in our two weeks in Kansas City, MO. The goal is to help educate more teachers in weather concepts and help teach our students to be weather aware and how challenging it is to forecast weather. As well, once we complete this task, we will receive a grad credit for a meteorology course. All for free! I can honestly say after having done this workshop, I have newfound respect for what weather forecasters do to help keep us safe and warn us of potential disasters so we can prepare for them to get out alive.

We also gained knowledge from across the USA, from meteorological experts in the field, such as Space weather, hurricanes, tornadoes, weather bombs, snow and ice storms and more. Instruction also came from professors at Cal U, and we were given modules with student activities to apply the weather knowledge in the classroom. One particularly hot and humid evening, we had a field trip to the National Weather Service (NWS) Topeka, Kansas weather station to launch a weather balloon and learn from the front line workers there how the balloons play an intricate role in daily forecasting. Everyday at 6:00 pm a balloon is launched to gather data that is used to make their forecasts. It was a tremendous learning experience, since I have never viewed a weather balloon launch before. The next day we used the raw data collected by the balloon and analyzed it with our professors to see what could be on the horizon.

Huge highlights for me were Bob Rutledge from Boulder, Colorado, session on Space Weather and Impacts on Critical Structures on Earth and in space and Barbara Mayes Boustead, Climate program manager at NWS

forecast office Nebraska, dissertation on the historical accuracy of the weather in Laura Ingalls Wilder's book "The Long Winter"; these showed me that we could do cross curricular tie ins with other subjects and not just learning about weather in science, as we demonstrated during the peer-led learning where our teams showcased a variety of take-home suggested activities for our classrooms.

Each day we had a weather briefing with Jerry Griffin, in the Forecast Operations Programs, at the NWSTC. Each afternoon began with "How's the Weather today Jerry?" and we would get into our 45-minute discussions on what took place that day and the night before. In these briefs, we observed radar and satellite imagery and learned to interpret surface station data and 500-millibar charts. We also followed storm systems, esp. hurricane tracking as they moved through the Pacific as it was the start of the season. He also gave us many useful and wonderful online resources on the NWS site that we could use to forecast weather with our students.

Although I am not a high school teacher, I was able to gain an understanding of some of the concepts my junior high students will be learning as they leave me and move on. It gave me an appreciation on how to prepare them for their journey to high school. The best was seeing the new GOES-16 Satellite that was not fully operational yet, but being slowly used in forecasting. The clarity of showing the different fronts and their temperatures was so stunningly clearer compared to current satellites being use, a real game changer for forecasters in being able to better predict weather phenomenon.

I loved being able to showcase the Canadian Education system and our practices and, as well, meeting so many fascinating educators. I gained new friends after the two-week stay and we continue to stay in touch and collaborate on our group Facebook page. I also enjoyed having the weekend off between the two weeks to explore Kansas City with some of the participants. I was able to see the Farmers Market and get great food to cook and share with other participants while I was there, see the National WWI Museum, and I went to a Kansas City Royals baseball game and now add that to my list of MLB fields I have watched games in (my goal is to say I have seen a game in all the stadiums in MLB. So far I am at 8!)

I am looking forward to using the new skills and resources obtained during this workshop to create new professional development opportunities for teachers as well as better integrate atmospheric content into class-room projects I develop with teachers. In the end, we learned how to be READY, RESPONSIVE & RESILIENT. The modules presented are engaging and meaningful activities that I will be able to share with teachers as well.

I would like to thank the workshop faculty for all their help over the two weeks. As well as, Wendy Abshire, Abby Stimach, Jerry Griffin, Bob Weinbeck and Chad Kauffman who did super job of taking care of us, sharing their knowledge with us, being light hearted, keeping us on task, organized and getting us prepared to share what we've learned with other teachers when we get home. Also, HUGE BIG HIGH 5 and THANK YOU to the Canadian Meteorological and Oceanographic Society and Canadian Geographic Education, the educational committee of The Royal Canadian Geographical Society, for continuing to support Canadian participation at these workshops.

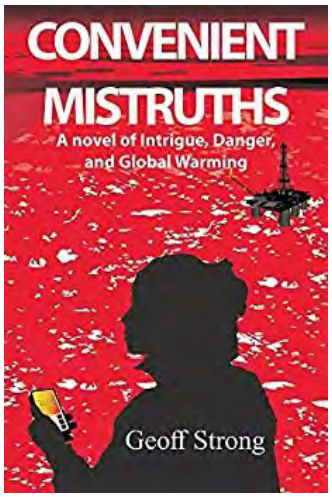
Maria teaching about the Canadian education system, space learning and weather.

Jerry Griffin teaching about GOES 16.

Book Review: Convenient Mistruths

Convenient Mistruths: A Novel of Intrigue, Danger, and Global Warming

Review by Edward Lozowski, Professor Emeritus, Earth and Atmospheric Sciences, University of Alberta



Book by Geoff Strong
Published by Geoff Strong
Paperback 246 pages ISBN 978-0-9952883-0-0, $19.99

Convenient Mistruths is a semi-fictional thriller, based on the very real possibility that offshore drilling in the Arctic could release large volumes of stored methane in the form of methane clathrates.

If enhanced atmospheric methane concentrations push the climate system over a "tipping point", it could be a disaster never seen before. Anticipating and averting this potential disaster provides an immediate sense of urgency to the action in this novel.

This novel is neither polemical nor dull. The author has set out to entertain the reader, while making him or her aware of some of the serious scientific, moral and ethical issue that we face collectively in the guise of climate change. And this he does with exceptional brilliance and a flare for page-turning writing.

The novel begins with a prologue, consisting of a series of five seemingly unconnected mini-stories, set in various locations around the world. Some take place in the past and exemplify the immediate human impacts of a changing climate, while others move the reader into a plausible but frightening future.

Chapter 1 engages the reader's interest and introduces two of the main characters, who are good friends, scientific colleagues and members of the International Panel on Climate Change (IPCC). Political boundaries are no constraint for these scientists, who share data on local atmospheric methane concentrations. Unusually and unexpectedly high concentrations of methane in the Russian Arctic near an oil and gas drilling site set off a chain of events that informs the rest of the action in this exciting novel. It involves rogue scientists, commercial avarice, international intrigue, hired villains with guns and unpredictable twists and turns.

The author's style is neither pedantic nor self-serving. He presumes an interested and intelligent reader, but he does not feel the need to explain every detail of the science. Nevertheless, he is not afraid to introduce important scientific concepts such as sea-level rise due to thermal expansion and ocean acidification due to dissolution of carbon dioxide. But this is not a pedagogical tome. In this novel, the science serves the development of the plot. And it is not hard to follow.

The title of the novel reminds me of Al Gore's 2006 film "An Inconvenient Truth". And, like the film, the author's stated objective is "to inform the public about the present and potential future disastrous impacts of global warming, and to refute those who continue to deny the reality of anthropogenic climate change …"

Convenient Mistruths is a compelling first novel by a former meteorologist and research scientist, now a climate change lecturer and advocate for protecting "planet Earth, the only planet available to us." The transformation of the author from scientist into novelist is both remarkable and gratifying. I highly recommend this novel. It is a good read, exciting, gratifying and challenging. No technical background is required. It is accessible and enjoyable by all.

CMOS Founding Member Dick Morgan Turns 100

David Nowell, Elizabeth Marshall and Veronica Leonard

A member of CMOS and its predecessor, the Canadian Branch of the Royal Meteorological Society, for over 50 years, CDR/Dr Maurice Richard (Dick) Morgan recently celebrated his 100th birthday. A party to honour the occasion was held the following day at the home of his eldest daughter Liz Marshall in Belleville, Ontario.

Dick Morgan was born on 14 July 1917 at Saltash, Cornwall in the United Kingdom. Following university graduation he was commissioned in the Royal Navy as an Instructor Lieutenant shortly before the start of World War II. At the time of the attack on Pearl Harbour, he was serving in the cruiser HMS Diomede which was then assigned to the West Indies Squadron and operating in the eastern Pacific.

After the war, he qualified as a Royal Navy meteorologist. Subsequent appointments included a 1946-49 posting to the Naval Weather Service Centre in Simonstown, South Africa where he helped organize the whaling fleet in taking weather observations when operating in data sparse areas of the Antarctic. On his return to the UK, he worked for three years on the staff of the Naval Weather Service in London. This was followed by a three year posting as Assistant Director of Meteorology in the newly established NATO SACLANT Headquarters in Norfolk, Virginia with the rank of Commander. He returned to the UK in 1956 and was posted as Officer-in-Charge of the Weather Office at the Abbotsinch Naval Air Station in Scotland.

Dick took early retirement from the Royal Navy and immigrated to Canada on 1 July 1958 to take up an appointment as meteorologist with the Meteorological Branch of the Department of Transport. Following a brief period of indoctrination at the then Central Analysis Office in Dorval, he was posted to the Main Meteorological Office in Gander, Nfld. A year later he was seconded to the Royal Canadian Navy for a 5-year Short Service Commission (SSA). After a short appointment as Weather Officer in the aircraft carrier HMCS Bonaventure, he was appointed as Command Weather Officer to the Flag Officer Atlantic Coast in Halifax. In this position he made a major contribution in the rapidly developing field of military oceanography. This resulted in an extension of his SSA and a 4-year posting, again in the rank of Commander, to the newly established position of Assistant Director of Oceanography at SACLANT Headquarters in Norfolk, Virginia.

He returned to Canada in May 1969 and, following his release from the RCN, was appointed Officer-in-Charge of the Maritime Forces Weather Centre in Halifax. There he very ably directed the Centre as it took on additional oceanographic responsibilities and became known as the METOC Centre. In the summer of 1974, he was posted to National Defence Headquarters in Ottawa on the staff of the Director of Meteorology and Oceanography as Superintendent of Meteorological and Oceanographic Plans, Requirements and Training. During this posting, he was the Canadian Member of both the NATO Military Committee Meteorological Group and the NATO Group on Military Oceanography.

Dick retired from the Atmospheric Environment Service of Environment Canada in late 1977. He then accepted employment under contract with the UNDP to work with the ASEAN Planning Group in Kuala Lumpur, Malaysia as an advisor in marine meteorology to South East Asian nations, helping to set up a ring of meteorological stations around the South China Sea, including Thailand, the Philippines and Indonesia.

At the age of 80, he enrolled in a PhD program at the University of Exeter, his Alma Mater. His thesis on “Climate Change in the North Atlantic Relative to the Global Warming Hypothesis” was accepted in 2003 making him the oldest doctoral graduate at the university, a fitting climax to a long, exciting and quite remarkable career. Following the award of his PhD he continued his research work until the early 90s and presented several research papers at CMOS congresses.

During the course of his career Dick was the recipient of several awards including the Royal Navy’s Boyle-Somerville Prize in Meteorology and the CMOS Prize in Applied Oceanography in 1983.

Pictured here with former CMOS President, Neil Campbell, at the CMOS Annual Congress in Halifax in 2009.

Dick receiving his PhD from the University of Exeter.

Dick with long time friend, colleague and CMOS member, David Nowell and his wife Ann, in July 2017.

In Memoriam: Herbert Bertholt Kruger

Herbert Bertholt Kruger (1930-2017)

Herb Kruger was destined to become a meteorologist when as a young boy he rejected the myth that lightning and thunder were caused by God. He resolved to find out the real answer some day (Kruger: How I became a meteorologist Bulletin Vol. 44, No. 5). It was this inquiring mind that drove him throughout his 33-year career. After graduating in 1952 from the U. of Sask., he joined the Meteorological Service of Canada.

Following his training in Trenton, he was posted to Canadian Forces Base Comox, and later served at several bases in Manitoba. Herb then returned to earn his Masters degree in meteorology at U of T. He served several years at Goose Bay NL which was then a very busy military and civilian base in the pre-jet era. At Goose Bay, in addition to his regular forecasting duties, he produced several monographs useful for forecasting various phenomena for the base.

In the early sixties, he won a position in the Numerical Research Division, a small but very important component of the Central Analysis Office in Montreal. There his focus was on the objective analysis (OA) aspect of the early Canadian NWP models. Ian Rutherford, a subsequent authority in the field, and who continued Herb's work after the latter was promoted, in the early 1970s, to a job in Toronto, wrote: "I think Herb was the first to try OA by using Gandin's approach applied to “trial field residuals” i.e. 12-hr forecast errors. He recognized that this was a better approach than the Cressman method. I got a note (from Gandin) acknowledging the Canadian success with 'Gandin' interpolation of forecast errors. Herb was the pioneer. In my view, Herb's approach was the first real recognition that the problem of initializing forecasts was not a problem of analyzing initial fields but rather a problem of updating a running forecast with new information, i.e. moving from objective analysis to data assimilation. I was always amazed at how difficult it was to get the OA community to recognize this. Herb was ahead of his time."

At AES Downsview headquarters, both as Chief of Observational Systems and later as Chief of Network Standards (above photo), Herb continued his efforts to improve the quality of data, the efficacy of the sparse but expensive data collection network in our vast and relatively unpopulated country. He was a strong advocate of new data gathering systems such as satellites. He was also very much involved with the modernization efforts of the field forecasting system under the leadership of Frank Benum and Paul Johns. He was very active with the World Meteorological Organization (WMO) during this period.

In 1975, the Department of Environment selected him as its candidate to the National Defence College course aimed at developing senior managers. In 1979, Herb was appointed Regional Director AES Atlantic Region based in Halifax. Unfortunately, a misdiagnosed illness curtailed his term. However, after a period of convalescence, he was assigned to the Assistant Deputy Minister's Planning and Policy Directorate in Ottawa and subsequently was appointed Director of Planning for the Director General of Weather Services. In both assignments, Herb's fertile mind continued to generate forward looking ideas. As with many from Saskatchewan of his era, Herb was strongly imbued with the principles of social justice, human rights and civic responsibility.

After hearing of Herb's passing, Ken Henley, a retired military radar technician and instructor who had been a meteorological observer at Comox, wrote: "My favourite memory of Herb was at Comox when his name was not on the voter's list, and he was very determined to have his vote. So we drove off the base to a polling booth a few miles down the road and Herb got to vote. After I retired from the Air Force and was working as a technical writer at Downsview, I was happy to make his acquaintance again. A really nice man"

Herb was an early supporter of quiet revolution in Quebec and an active supporter of bilingualism as witnessed by his enthusiastic participation in the AES HQ French club. In retirement, Herb continued his quest for new knowledge as an active participant in seniors' groups at universities both in Regina and Kitchener. He was a founding member of CMOS and his interest in meteorological and environmental issues continued until his last illness.

Gordon M. Shimizu

CMOS Strategic Plan

CMOS' Strategic Plan (2018-2020) is now available for comment on the CMOS website.

Books in search of a Reviewer*:

(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

(2017-4) *Minding the Weather: How Expert Forecasters Think*, 2017. By Robert R. Hoffman, Daphne S. LaDue, H. Michael Mogil, Paul J. Roebber, and Gregory Trafton, The MIT Press, ISBN 978-0-262-03606-1, Hardcover, 469 pages, $66.69

(2017-5) *Risk Modelling for Hazards and Disasters*, 2017. By Gero Michel, Elsevier, ISBN 9780128040713, paperback, 338 pages, US$100.00

(2017-6) *Introduction to Satellite Remote Sensing; Atmosphere, Ocean and Land Applications*, 2017. By William Emery and Adriano Camps, Elsevier, ISBN 9780128092545, 860 pages, US$130.00

(2017-7) *Remote Sensing of Aerosols, Clouds and Precipitation*, 2017. By Tanvir Islam, Yongxiang Hu, Alexander Kokhanovsky and Jun Wang, Elsevier, ISBN 9780128104378, 364 pages, US$120.00

(2017-8) *Mixed-Phase Clouds: Observations and Modeling*, 2017. By Constantin Andronache, Elsevier, ISBN 9780128105498, 300 pages, US$89.95

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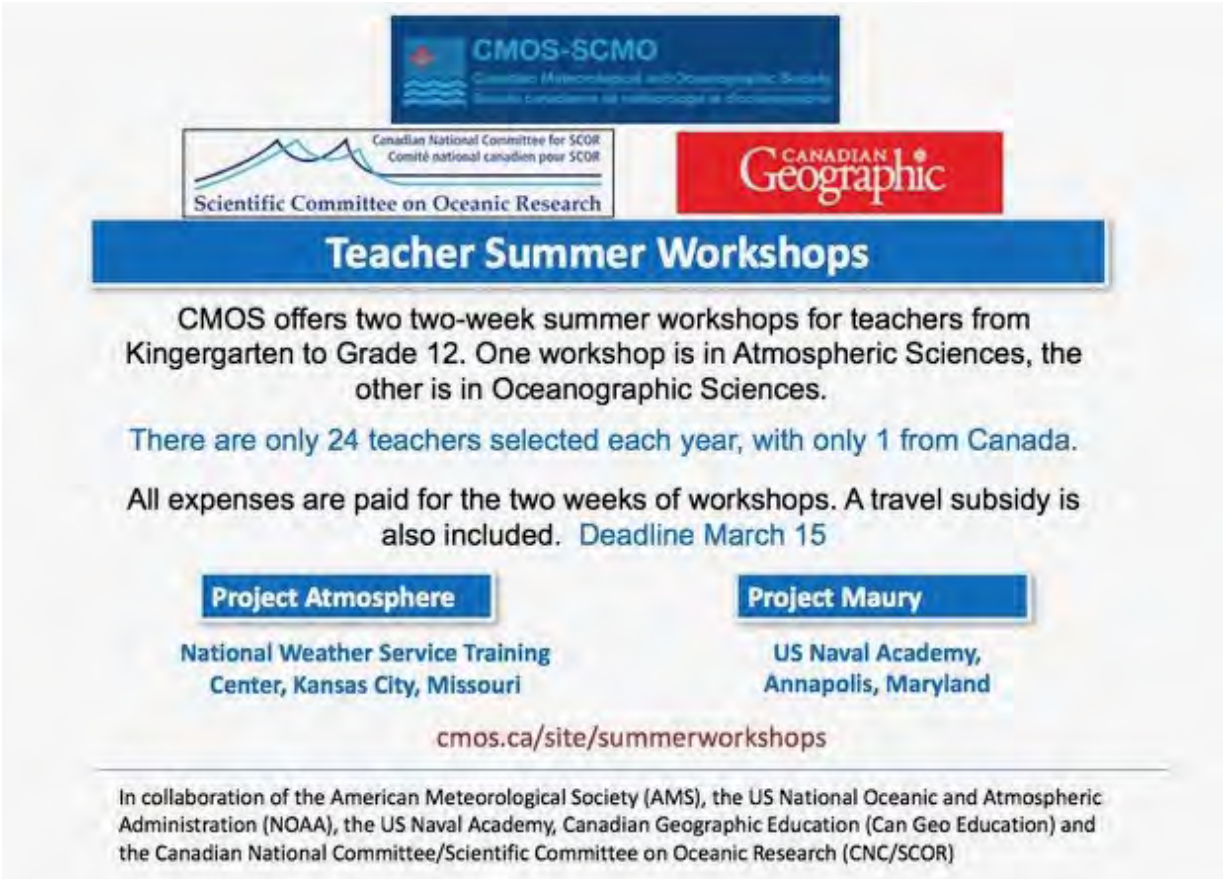

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The CMOS Bulletin has moved on-line to http://bulletin.cmos.ca. Please continue to send articles, notes, workshop reports and news items to bulletin@cmos.ca. We will be accepting, reviewing, and publishing content on an on-going basis.

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

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

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

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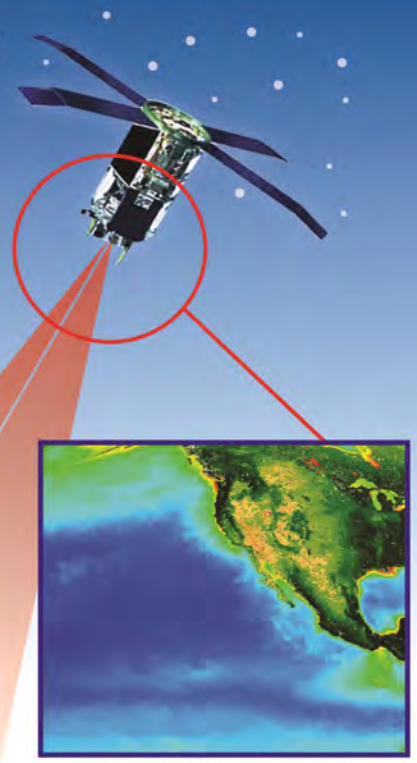
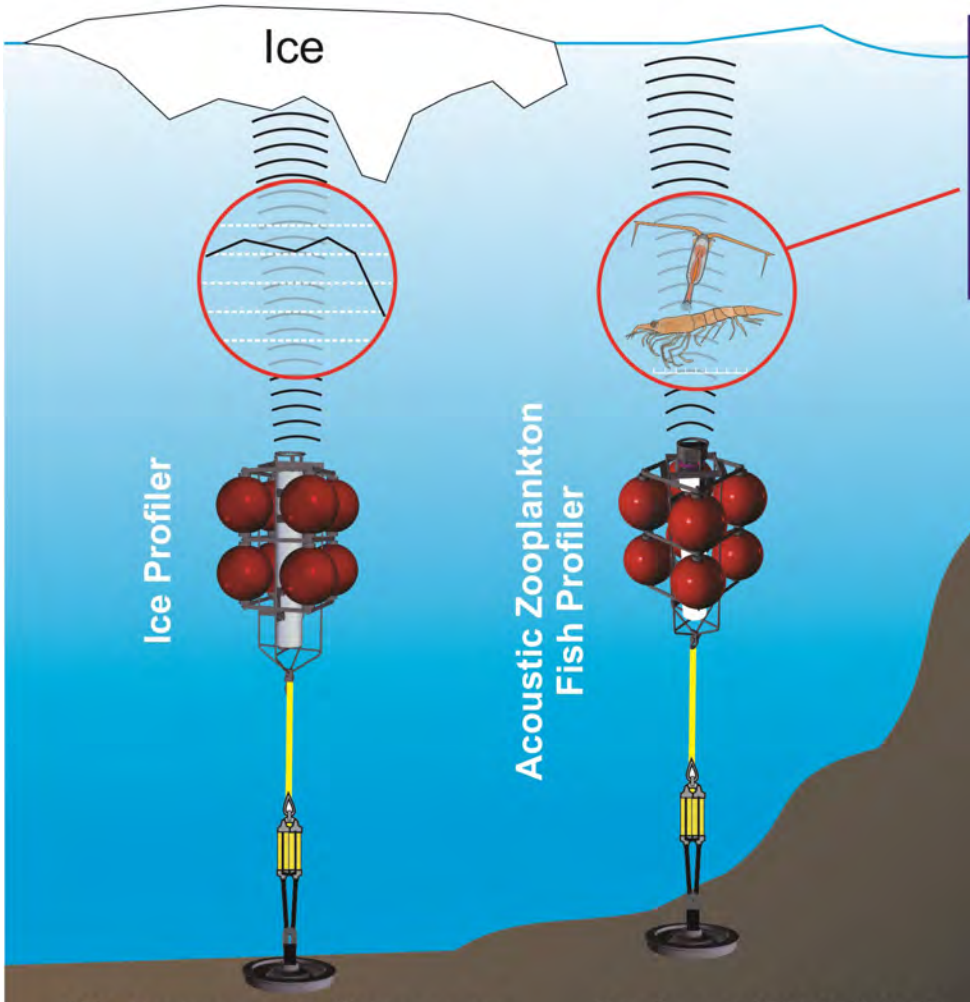
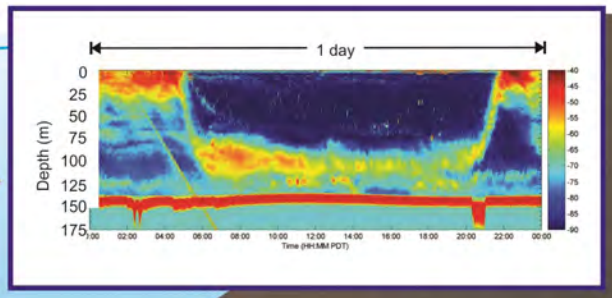


Ocean colours are chlorophyll concentrations and land colours are NDVI





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