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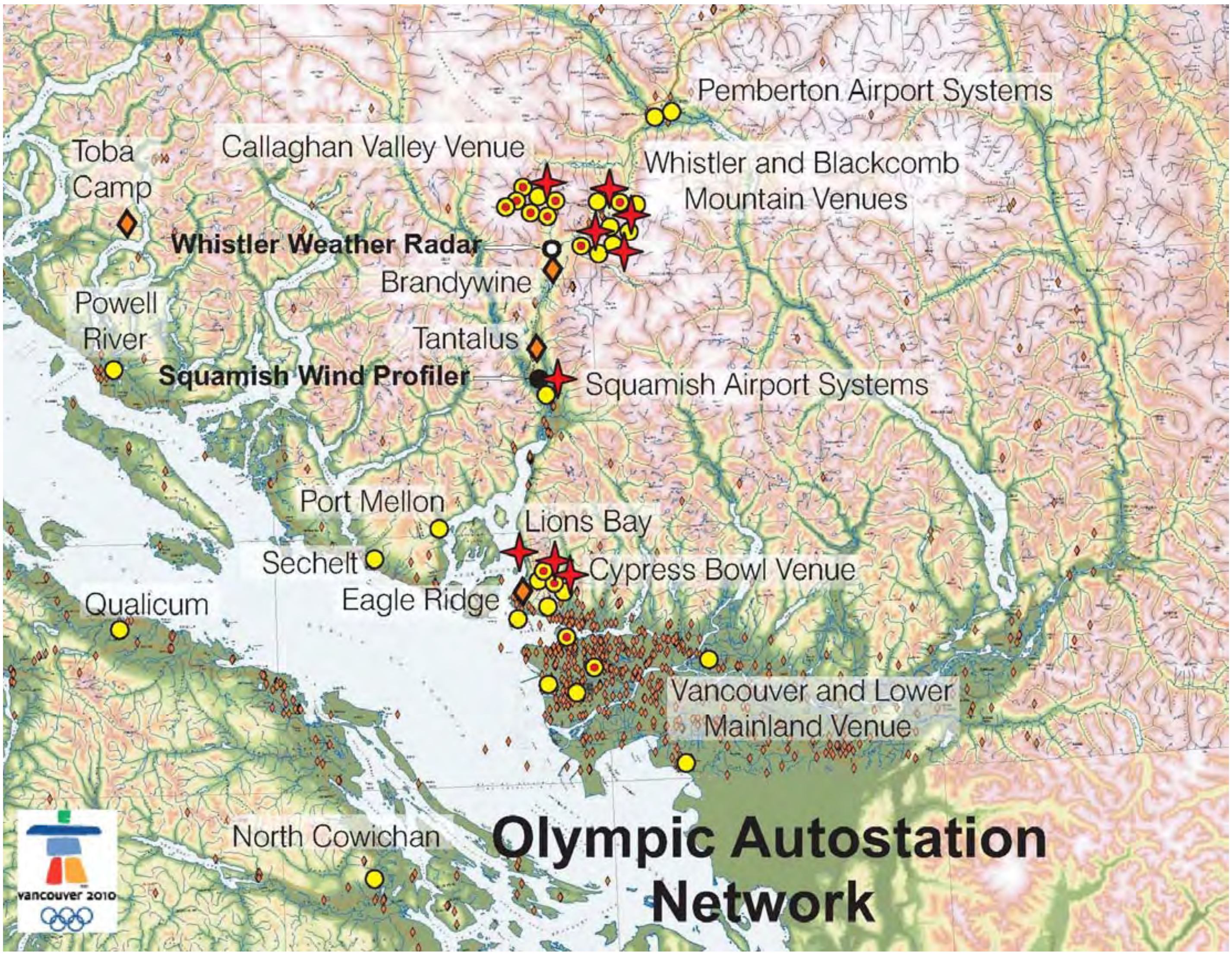
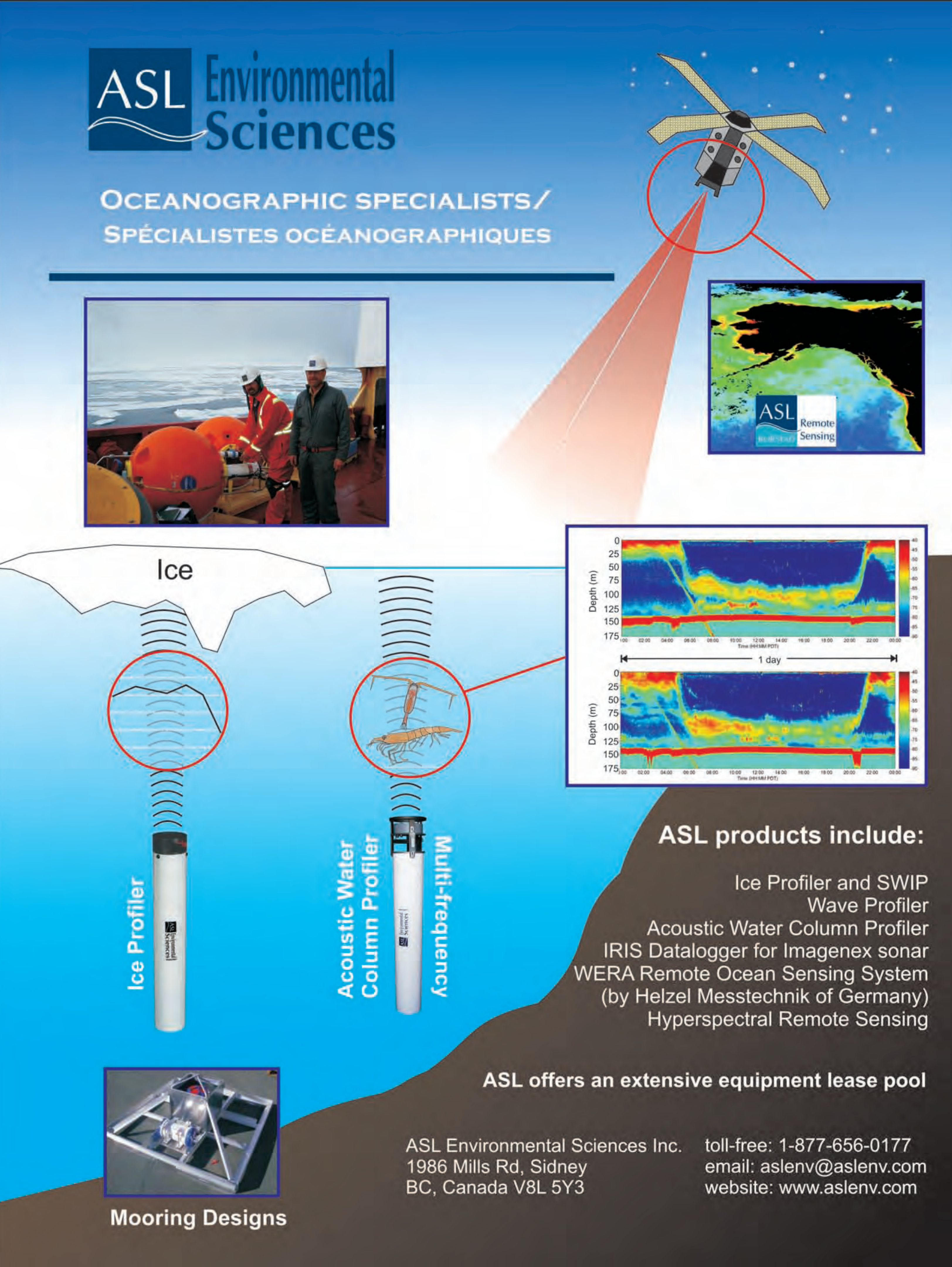


Le réseau des stations automatiques pour les Olympiques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....from the President's Desk

Friends and colleagues:

Bill Crawford
CMOS President
Président de la SCMO

In late October I presented the CMOS Brief to the House of Commons Standing Committee on Finance at its public hearing in Winnipeg. (The full text of this brief was published in our October Bulletin). **Ron Stewart** accompanied me in this presentation. He is a past president of CMOS and Head of the Department of Environment and Geography at the University of Manitoba. In the five minutes for our talk we presented three requests for the federal government to consider in its next budget:

1) Introduce measures to rapidly reduce greenhouse gas emissions;
2) Invest funds in the provision of science-based climate information;
3) Renew financial support for research into meteorology, oceanography, climate and ice science, especially in Canada's North, through independent, peer-reviewed projects managed by agencies such as CFCAS and NSERC.

Questions were asked about scientists whose research funding has ended (Answer: moved or looking for work), and can scientists contribute to establishing sovereignty in the Arctic? (Answer: yes). During informal discussion after the panel hearings, Ron Stewart pointed out the two top science stories from the Winnipeg *Free Press* of that day, one quoting Prime Minister Brown of the UK as saying we had only 60 days to save the planet from climate change, and another noting unprecedented warming in the Canadian Arctic. We hope our messages have an impact on the next federal budget.

Only a few days later, CMOS member **John Stone** spoke on climate change to the Standing Senate Committee on Energy, the Environment and Natural Resources. Professor Stone has been a participant in IPCC for many years. His 40-minute talk covered the cause and urgency of climate change. Senators asked questions long after his talk, and were clearly concerned, especially in the impact that climate change deniers have on the public. Thanks to Professor Stone for his lone role in this hearing.

(Continued on page 179 / Suite à la page 179)

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Inside / En Bref

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

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Cover page: The figure indicates the physical location, type and ownership/affiliation of weather sensing equipment installed in support of forecast operations for the 2010 Olympic and Paralympic Winter Games in Vancouver. These include multi element sensing systems, small systems that measure only a few elements for specific sport requirements, road weather installations and web cams. What the illustration does not include is the large number of extra and complex sensor systems at two outdoor venues, Whistler and Vancouver International Airport installed in support of nowcasting and research. To learn more on the Vancouver Olympics, read the articles on **page 192 and 198.**

Page couverture: L'illustration montre la position, le type et l'appartenance ou affiliation de l'équipement de mesure météorologique installé comme support aux opérations de prévision pour les Jeux olympiques et para olympiques de Vancouver en 2010. Ceci inclut des systèmes de senseurs à multi éléments, des petits systèmes qui ne mesurent que certains éléments requis pour des sports particuliers, des installations de météo routière et des caméras web. Ce qui n'est pas montré est la grande quantité de systèmes de senseurs additionnels et complexes à deux sites externes, Whistler et l'aéroport international de Vancouver, pour supporter la prévision en temps réel et la recherche. Lire les articles aux **pages 192 et 198** pour en apprendre plus.

....from the President's Desk (Continued)

I always list the *CMOS Bulletin SCMO* as a great benefit to CMOS membership. In this issue our editor Paul-André Bolduc presents articles across the CMOS fields. One of our biggest roles is weather forecasting. **Claire Martin** describes the future of a TV weather presenter, based on her experience with CBC weather news. She represents the public face of weather forecasts. For a view from behind the scenes you can read the account in last month's Bulletin by **David Sills**, who describes the changing roles of computers and meteorologists in future Canadian weather predictions. **Pierre Dubreuil** gives more insight on the topic in this month's Bulletin. **Madhav Kandekar** offers his insight into monsoon predictions in this month's issue, and for timely news, you can read all about weather predictions for the 2010 Vancouver Olympic and Paralympic Games. Don't miss in the call for entries to the CMOS annual Photo Contest and nominations for CMOS prizes and awards, as well as news of CMOS members and their activities.

I am taking this opportunity to wish everyone a peaceful and safe holiday and all the best for the New Year.

Bill Crawford
President / Président

Highlights of Recent CMOS Executive and Council Meetings

■ The Halifax 2009 CMOS congress expects to show a profit of $64k from the meeting, of which $20k is required to balance CMOS' budget. There will likely be about $44k to split between CMOS and Halifax Centre. The large profit resulted from lower expenses (e.g. NRC paid for most of the plenary speaker travel) and higher revenues than projected.

■ Plans for the 2010 Ottawa congress to be held in conjunction with the Canadian Geophysical Union are well under way, including some creative options for exhibitors. CMOS Council considered asking registrants to make voluntary carbon offset contributions, but the CGU declined, so it will be left up to individual attendees to decide whether or not to purchase offsets.

■ The 2012 congress will be held in Montréal, Québec, in conjunction with the American Meteorological Society.

■ CMOS President Bill Crawford presented CMOS' Brief to the House of Commons Finance Committee in Winnipeg, Manitoba. (See President's report on page 177).

■ Vice-President David Fissel has set a target of a 10% (80-member) increase in CMOS membership this year. Student membership has already increased, due to a reduction in the student membership fee from $40 to $20, which includes a subscription to the electronic versions of ATMOSPHERE-OCEAN and the Bulletin. A video about the benefits of CMOS membership is available for use by members and can be set up to run on a loop before a meeting.

■ ATMOSPHERE-OCEAN is probably going to be published in a different way, beginning in 2010. The Executive Director and Director of Publications have held meetings with several potential publishers who might take over all or some of the publishing duties from CMOS. More details will follow.

■ This year's CMOS tour speaker will be Jim Drummond of Dalhousie University. Tour dates will be announced once they are set.

Sophia Johannessen
Recording Secretary / Secrétaire d'assemblée

Correspondence / Correspondance

From: Geoff Strong
Ardrossan, Alberta

To: All CMOS Members

Subject: **Countering the Skeptics on Global Warming**

The degree of invective directed at climate scientists and the topic of global warming by the climate change '*skeptics*' is quite appalling, especially over the past few months. Our readers should be aware that these skeptics rarely publish in the peer-reviewed scientific literature on climate-related issues, or express their views at valid scientific conferences such as CMOS Congress, despite the fact that they have been invited to do so many times. They do not accept such invitations for the simple fact that they are well aware that most of their arguments cannot stand up to scientific scrutiny. Moreover, these people make disreputable claims that thousands of the world's climate scientists have collectively and systematically exaggerated their results and have lied about global warming simply to keep research funding coming. Such allegations in the public arena are irresponsible, and represent an affront on science and a moral offence against humanity, given current impacts and future impending threats of global warming.

As the Copenhagen talks approach, this organized campaign of misinformation by skeptics has intensified, and most recently includes paid radio advertisements across the country. CMOS members recognize their responsibility as a scientific community and society to report truthful science, but should also counter this stream of misinformation and distortion of climate science. Why? Because these people are deliberately misinforming and confusing the public, and because they know that humans are reluctant to be proactive when in doubt or confused. The skeptics' primary objective appears to be to simply keep uncertainty regarding global warming in the minds of the public.

Some of their favourite claims are:

1) *that there is huge debate in the scientific community concerning the link between greenhouse gas (GHG) emissions through burning fossil fuels and global warming.* In fact, there is no such debate among scientists. Evidence for this was summarized in an invited essay in the 03 Dec. 2004 issue of Science Magazine (www.sciencemag.org), titled "*The Scientific Consensus on Climate Change*", by Naomi Oreskes of the Dept. of History and Science Studies, Univ. of California. Oreskes analyzed 928 abstracts published in refereed journals between 1993 and 2003 containing the words "climate change". Of all these abstracts, not one single paper disagreed with the consensus view. In fact, 75% explicitly or implicitly accepted the consensus view that "*GHGs are directly responsible for most present global warming*", and the other 25% dealt with analysis methods or paleoclimate and took no position whatsoever. That hardly reflects great scientific debate on the GHG-warming link, and the evident solidarity among climate scientists is still very strong, even though different studies may differ somewhat on the degree of warming, timing, or the big uncertainty of how future GHG emissions will evolve.

2) *that the main cause of climate change is changes in radiation from the sun*. Although true over many millennia, this is simply not true for the present rapid warming of our climate over just a few decades. In fact, incoming solar radiation (insolation) has actually decreased slightly over the past 50 years, the period during which we have experienced rapid warming.

3) *that climate scientists are unwilling to debate the science of human-induced global warming*. This statement does not even deserve a response, because skeptics rarely attend our conferences or publish in journals, but they delight in having debate in the relative safety of radio talk shows, usually where the talk show host is known to have strong leanings towards their views, or is not familiar enough to question their claims.

4) *that there has not been any warming for the past ten years, and that it has actually been cooling*. This statement is false. Nine of the ten warmest years in the instrumented records (now including 2009) have all occurred in this 21st century, the 10th year being 1998. The long-term global temperature trend is positive, while the warmest year on record (globally) was 2005 (NASA's GISS dataset).

5) *that climate scientists attribute every anomalous event to global warming*. This is also false, although that assumption is often made by the media, lobby groups, and hollywood and lay people, but *not* by climate scientists. Yet, the skeptics never fail to mention short-lived regional cooling events as proof of their global cooling claims.

6) *that water vapour is the most important GHG*. Here they fail to add the important fact that while this is true for maintaining the long-term natural global temperature balance (without it, Earth would theoretically be some 30°C cooler and might still be a mostly lifeless world), it is *not true* for present global warming, for the simple fact that there is a natural cap on atmospheric vapour determined by saturation vapour pressure, beyond which precipitation takes care of any sudden imbalance.

7) *that model predictions about global warming have been wrong*. This is a totally unsubstantiated and incorrect statement. For example, the past ten 10-year average temperature anomalies have all been between +0.17 and +0.34 °C per decade, very consistent with model predictions reported by IPCC.

Readers with any doubts on these challenges should visit the NASA, NOAA or British Met Office web sites to see how these and other myths disseminated by the skeptics are easily discounted. Misleading claims by these skeptics should be counteracted by initiating a program of public education, led by climate scientists through a central lead organization such as CMOS. Such a program might include regular climate research updates in the Bulletin, an inventory of available climate speakers across the country, and providing informed responses to misleading articles and letters on climate change in newspapers and other public media. One reason that skeptics are successful in misinforming the public is because of our failure to provide updated climate research results to the public in language that they can understand, a task that unfortunately most scientists do not do well. Can we afford to wait any longer to start?

Next Issue *CMOS Bulletin SCMO*

Next issue of the *CMOS Bulletin SCMO* will be published in **February 2010.** Please send your articles, notes, workshop reports or news items before **January 8, 2010** to the address given on page 178. We have an URGENT need for your written contributions.

Prochain numéro du *CMOS Bulletin SCMO*

Le prochain numéro du *CMOS Bulletin SCMO* paraîtra en **février 2010.** Prière de nous faire parvenir avant le **8 janvier 2010** vos articles, notes, rapports d'atelier ou nouvelles à l'adresse indiquée à la page 178. Nous avons un besoin URGENT de vos contributions écrites.

The Notoriously Unpredictable Monsoon[1]

by Madhav Khandekar[2]

The Indian Monsoon and by extension the Asian Monsoon which impact about 4 billion people (70% of world's humanity) today is perhaps the most complex feature of the earth's climate system. Climate models have achieved only a limited success so far in simulating many features of this complex system.

Normally the Indian monsoon arrives at the southern tip of Indian Peninsula (about 8^{o}N) by May 25 and by June 7/8, the Monsoon begins over Mumbai (largest Indian city, pop: ~20 million) and progresses further into central India. By about June 25 to June 30 the Monsoon generally spreads over most of India. Despite year-to-year variations in these dates, the onset dates over a 150-yr database (one of the best datasets) shows Monsoon arrival dates to be remarkably robust. Delay in Monsoon arrival is often associated with anxiety about water shortage, impact on agriculture and of course an increased hype about "*global warming, climate change and possible adverse impact*". A careful examination of past data, however, shows such *"fears"* about adverse global warming impact are without any merit.

Despite significant advances in Monsoon meteorology, predicting onset and overall intensity and distribution of Monsoon rainfall during the four summer months (June-September) is still a daunting task and considerable research efforts are needed at present to improve predictability of Indian/Asian Monsoon. Since the Indian/Asian Monsoon system transfers sufficient energy across the entire climate system, any future projection of earth's climate must include an improved modelling of the Monsoon system than what is available at present.

This year's (2009) Monsoon was predicted to be about normal (96% of normal) by the India Meteorological Department (IMD) as early as 18 April 2009. The first burst of Monsoon rains during the second week of May at the southern tip of India suggested an early (but possibly normal overall) Monsoon season. However, further progress of Monsoon was stalled for reasons that meteorologists do not fully understand and this stalling and later creating acute shortage of water in Mumbai and New Delhi (India's capital city with a pop, ~14 M) evoked comments like "*Monsoon gamble, looming spectre of a drought etc*" from many, including a scientist working with *Greenpeace* in India.

It must be remembered that such delays in Monsoon arrival have occurred in the past and have affected India's agricultural output, but such delays and irregular Monsoon progression are all part of natural variability, quite possibly linked to large-scale atmospheric circulation systems like the ENSO (El Niño-Southern Oscillation) phase in equatorial Pacific, Eurasian and Himalayan winter snow cover, QBO (Quasi-Biennial equatorial stratospheric wind Oscillation) phase and perhaps a host of other regional features (see Khandekar 1996). This is what makes the Indian/Asian Monsoon so very complex and a challenging scientific problem.

In 1972 the Indian Monsoon was delayed, especially in Peninsular India, by almost six weeks and that year proved to be one of severest drought years for the Monsoon (most certainly the delay and the overall 'drought Monsoon' was attributed to the 1972 strong El Niño) which resulted in sharply reduced rice yield that year. Earlier, in 1961, Monsoon rains were heaviest during the four months with extensive flooding over many parts of India. Such floods and droughts have occurred irregularly and are still not fully understood. The worst ever drought was in 1877 which sparked a paper by Henry Blanford (1884) who was the British Meteorological Reporter for the Government of India then. In his paper, Blanford hypothesized a linkage between extensive snow cover over the Himalayas during the preceding winter and a weak subsequent Monsoon.

Climate modelers almost 100 years later were able to simulate this inverse relationship (Barnett et al 1989). However much remains to be understood about how winter Eurasian snow cover impacts Monsoon circulation a few months down the road and how the tropical easterly jet (TEJ) stream that emanates from east of Bangkok to Saudi Arabia at about 12 km level over Peninsular India (~12N) during the summer Monsoon months, evolves and influences Monsoon rains.

[1] A shorter version of this commentary first appeared in the Benny Peiser internet news letter CCNet 103/2009 July 2nd 2009.

[2] Madhav Khandekar is a former Research Scientist from Environment Canada and was an Expert Reviewer for the IPCC (Intergovernmental Panel on Climate Change) 2007 Climate Change Documents. Khandekar continues his research interest on the Indian/Asian Monsoon and linkages to large-scale atmosphere-ocean circulations.

Per an IMD communication (issued on June 25 2009), Monsoon rains were eventually spreading over most of India and this season's rains were projected to be only about 93% of normal. The month of July is the most critical month with regular rains (~ 1cm/day under) over most of eastern & western Gangetic Plains (with a total population of over 250 M) during normal Monsoon. The ENSO phase was about normal during this year's Monsoon, so no adverse impact from equatorial Pacific was expected. Winter Eurasian snow cover during the 2008/09 winter was heavier than normal; however, the continued westerly phase of the QBO would help make up the Monsoon rains over the remainder of the season. As the season was drawing to a close, there were heavy rains leading to some flooding in the southern Peninsular region during the second and third week of September. The end-of-season summary issued by the IMD in mid-October estimated the season's rains over the country as a whole to be only 77% of normal, thus making summer 2009 as one of the major drought years in the Indian Monsoon. Only in the Peninsular region, the summer Monsoon was close to normal, as predicted early in the season.

Accurate simulation and prediction of Monsoon rains with a lead time of few weeks to few months still remains an intractable problem in climate science.

References;

Barnett T P et al 1989: The effect of Eurasian snow cover on regional and global climate variation. *J of Atmospheric Sciences 46 661-685.*

Blanford H F 1884: On the connection of Himalayan snowfall and seasons of droughts in India. *Proc Royal Society London 37 3-22.*

Khandekar M L 1996: El Nino-Southern Oscillation, Indian Monsoon and world grain yields-a synthesis: Land-based and marine Hazards M I El-Sabh et al (eds) Kluwer, Netherlands p. 79-95.

The Future Role of the TV Weather Presenter

by Claire Martin[3]

It was a dark and stormy night - August 25, 1873. Residents of the rugged island of Cape Breton secured their doors and shutters against the rising wind. Few people that night expected anything more than a late-summer gale. But as the night wore on it became obvious that this was no usual storm. After gathering strength for a week in the mid-Atlantic, a hurricane had formed and was tearing up the coast of the United States. Overnight it smashed headlong into Cape Breton's eastern shore.


Claire Martin

By mid-afternoon the next day, the "Great Nova Scotian Cyclone" had laid waste to a large swath of Cape Breton. Newspapers were filled with accounts of death and destruction. The storm's final toll: almost 1,000 people dead, some 1,200 ships sunk or smashed, hundreds of homes destroyed.

Tragically, meteorologists in Toronto, Ontario knew a day in advance that the hurricane could make landfall close to Cape Breton, but no alarm was ever raised because telegraph lines to the closest major city of Halifax, Nova Scotia were down.

It would take many more disasters such as this, before weather services around the world realized the value and importance of mass dissemination of timely and accurate weather forecasts.

Eventually the world of TV weather reporting was born.

Chalkboards, blackboards, white boards, magnetic boards and green screens.

The average TV weather report has evolved to use some of the most hi-tech graphics seen on the small screen. But despite all the advances, the one part of the report that has remained the same is the role of the TV weather presenter. Whether covered in chalk dust as in the early days, or standing in front of a SGI graphic in a 3D chroma-key studio, the role of the weather presenter was to deliver scientific, sometimes convoluted information, sometimes even life saving information, to the masses in a way that was trusted and easily digestible.

As time wore on, more and more meteorologists found themselves removed from the forecast bench and dropped in front of the camera. But the end result was still the same - dependable, likeable, knowledgeable and informative people disseminating information that the general public could trust.

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[3] Senior Meteorologist, CBC News: Weather Centre, Vancouver, BC, Canada

Now fast forward to modern day. The role of the TV weather presenter or broadcast meteorologist has grown to include delivering one of the most disturbing messages of our time. That we must start to care for and clean up our planet, or we will continue to see changing weather patterns that may threaten our very existence.

Delivering the "climate change and variability" message is fraught with difficulty. The politics alone at times seem insurmountable. But there is the odd ray of hope on the horizon – the overall consensus of the general public in the last decade has become one of slow and begrudging understanding, and organizations such as the WMO are now starting to use the vast communication framework created by these adept TV weather communicators to help deliver the message.

In August 2009, for the first time, TV weather presenters, broadcast meteorologists and environmental journalists from around the world were invited to fully take part in a massive climate conference: WCC-3. At this conference it was recognized that indeed TV weather presenters were essentially part of a global framework of expert providers of the climate variability message, and that strengthening WMO's ties with this group of providers would ensure that the very best scientific and climate information was disseminated.

The conference statement from the summary of the expert segment has been published on line (http://www.wmo.int/wcc3/page_en.php) and there are some very important notes that reflect on the future work of TV weather presenters:

".. *that the most urgent need is for much closer partnerships between providers and users of climate services",* that *"Climate services information systems take advantage of enhanced existing national and international climate service arrangements in the delivery of products and information,"*

and that "..(*we) focus on building linkages and integrating information, at all levels, between the providers and users of climate services."*

Let's all hope your local TV weather presenter can rise to the occasion.

Ocean acidification

by James Christian[4]

The oceans have absorbed approximately half of anthropogenic CO_2 emissions to date. "Ocean acidification" is a term for the changes in ocean chemistry that arise principally from dissolution of fossil fuel CO_2. CO_2 combines with water to form carbonic acid, H_2CO_3, which then dissociates to form bicarbonate (HCO_3^-) and carbonate (CO_3^{2-}) ions. Approximately 90% of the total CO_2 (TCO_2 = CO_2+HCO_3^-+CO_3^{2-}) in seawater is present as bicarbonate, 10% as carbonate and 1% as CO_2 gas. Dissociation of carbonic acid releases free protons and lowers the pH of seawater, hence the term "ocean acidification". But the real impact arises mostly from the change in the equilibrium between HCO_3^- and CO_3^{2-}. Seemingly paradoxically, adding more CO_2 to the ocean *reduces* the concentration of CO_3^{2-}. Many marine organisms have shells or skeletons of $CACO_3$, so when the CO_3^{2-} concentration goes down (Ca is one of the major ions in sea salt so its concentration doesn't change much), it takes more energy to build these hard parts, or if the concentration goes low enough they will start to dissolve. If fossil fuel CO_2 emissions continue at current rates, at least some marine organisms will likely disappear from regions where they are now common by the end of this century.

The concentration of CO_3^{2-} is often expressed as the saturation state with respect to common carbonate minerals such as calcite and aragonite, known as Ω. If Ω<1, the water is undersaturated with respect to the solid mineral phase and the mineral will dissolve. (Note: It was a Canadian, Alfonso Mucci, who made the first reliable measurements of the temperature and salinity dependence of the solubility of these minerals, and defined mathematical expressions that are almost universally used by marine chemists today). Deep water is naturally undersaturated, in part because of the pressure-dependence of solubility, and in part because of accumulation of TCO_2 from remineralization of organic matter. The boundary between the supersaturated upper ocean (Ω>1) and the undersaturated deep ocean (Ω<1) is known as the *saturation horizon*. Older waters are more undersaturated because of cumulative remineralization, so the saturation horizon is naturally shallower in the Pacific than the Atlantic.

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[4] Fisheries and Oceans Canada and Canadian Centre for Climate Modelling and Analysis, Victoria, BC, Canada

Aragonite is far more soluble than calcite, so the aragonite saturation horizon (ASH) is much shallower than the calcite saturation horizon (CSH). Many marine organisms, such as reef-building corals and the pelagic snails known as Pteropods, have evolved to produce aragonite shells and so are especially vulnerable to ocean acidification. In parts of the North Pacific the ASH naturally occurs at depths as shallow as 100 m, so it takes very little additional acidification to make the entire water column undersaturated and therefore uninhabitable by aragonitic organisms.

The ocean carbon cycle is controlled by production of particulate matter by plankton in the surface layer and its remineralization and dissolution in the intermediate and deep ocean. Sinking particulate matter includes both organic and inorganic (calcium carbonate) carbon, and the ratio of the two (the "rain ratio") has far-reaching effects on ocean chemistry. Globally, this ratio is estimated at ~0.06 on average, i.e., there are about 6 moles of particulate inorganic carbon (PIC) for each 100 moles of particulate organic carbon (POC) in the flux out of the euphotic zone. Inorganic carbon sinks to a slightly greater depth, on average, than organic carbon, and a small fraction of each is buried in the sediments. While the total particulate flux (POC+PIC) determines the distribution of TCO_2, the rain ratio profoundly affects the speciation. Removal of PIC from the surface layer causes a reduction of CO_3^{2-} and decreases state (Ω) (it also increases $[CO_2]$, exactly the opposite of what happens when an equivalent amount of POC sinks out). Dissolution of PIC in the subsurface has the opposite effect: a relative increase of CO_3^{2-} and Ω. Dissolution of carbonate minerals buried in the sediments will eventually reverse the acidification induced by anthropogenic CO_2, but the time scale for this to occur is very long (tens to hundreds of thousands of years).

Almost all marine organisms will be affected in some way by ocean acidification. The variety of invertebrates that have carbonaceous skeletons is great. Coral reefs are the poster-children, but high-latitude organisms are probably more vulnerable because the saturation horizon is naturally shallow. Molluscs (clams, mussels, oysters, scallops, snails) are among the most familiar species that have carbonate shells, but crustaceans (crabs, shrimp, copepods, euphausiids) and echinoderms (starfish, sea urchins, sea cucumbers) also have carbonate minerals bound into organic matrices in their exoskeletons. Deep-sea corals are present in deep waters at all latitudes including Canadian waters and are particularly vulnerable; very little is known about their biology or present distribution so detecting impacts will be difficult. Acidification also affects noncalcifying organisms in a variety of ways. Some highly active pelagic squids, for example, already live near their limit of tolerance for excess tissue CO_2 due to their high metabolic rates.

There are numerous research topics related to ocean acidification where the present state of knowledge is woefully inadequate. We actually know very little about which organisms are primarily responsible for the carbonate component of the biological pump, where and how vertical transport of carbonates to the deep ocean occurs, or how and how fast dissolution occurs. We know that carbonate minerals contain magnesium as well as calcium, that the Mg/Ca ratio is highly variable, and that solubility depends strongly on this ratio, but we know very little about what regulates this ratio in the ocean or how its variability affects sedimentation of pelagic carbonates. We do not know how vulnerable different classes of organisms are to physiological stresses associated with reduced saturation states above the nominal saturation threshold, how quickly populations can evolve mechanisms to minimize these stresses, or what the ecological repercussions of such adaptation are.

A particular concern for Canadians is the Arctic Ocean, which has a unique configuration of vulnerabilities. Receding sea ice and expanding open water will present Arctic pelagic ecosystems with unprecedented environmental states just as acidification impacts mount. Moreover, the Arctic Ocean has very large freshwater inputs relative to its volume, and fresh water has very little buffering capacity compared to seawater (buffering capacity is a measure of how much the pH of a solution will change for a given input of acid). Much of this fresh water also has high concentrations of dissolved organic carbon, which will tend to exacerbate acidification and which may increase with climate change. At least some Arctic rivers also have very high alkalinity (which increases buffering capacity), which can help to mitigate acidification. Globally, we still know very little about the vulnerability of near shore waters. Terrestrial sources of alkalinity may help to mitigate acidification in the near shore waters where bivalve aquaculture and recreational and subsistence bivalve fisheries are concentrated, but the effects are likely to be highly variable from location to location, and intertwined with a range of other human impacts.

Further reading:

Royal Society, 2005. *Ocean acidification due to increasing atmospheric carbon dioxide*. Available at http://royalsociety.org/document.asp?id=3249

Ocean Acidification Summary for Policymakers 2009. Available at http://www.oceanacidification.net

Doney, S. C., V. J. Fabry, R. A. Feely, and J. A. Kleypas, 2009. *Ocean acidification: the other CO_2 problem*. Ann. Rev. Mar. Sci. 1: 169-192.

Orr, J. C., and others, 2005. *Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms*. Nature 437: 681-686.

Steinacher, M., F. Joos, T. L. Fröhlicher, G.-K. Plattner, and S. C. Doney, 2009. *Imminent ocean acidification in the Arctic projected with the NCAR global coupled carbon cycle-climate model*. Biogeosciences 6: 515-533.

Zeebe, R. E., J. C. Zachos, K. Caldeira, and T. Tyrrell, 2008. *Carbon emissions and acidification.* Science 321: 51-52.

The Interacting Scales of Ocean Dynamics - a Tribute to Chris Garrett

by Denis Gilbert[1] and Patrick Cummins[2]

[1] Fisheries and Oceans Canada, Maurice-Lamontagne Institute, Mont Joli, Quebec

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This article is the introduction to the most recent special issue of **ATMOSPHERE-OCEAN**, Volume 47, No.4: a Tribute to Chris Garrett. It is reprinted with permission of the authors. The complete text of each of the papers cited can be found on the CMOS web site: www.CMOS.ca, by following the links to **ATMOSPHERE-OCEAN** and other publications. The abstracts are published in this issue of the *CMOS Bulletin SCMO* on pages 211-214.

After obtaining a B.A. in Mathematics at Cambridge University (United Kingdom) in 1965, Chris Garrett completed his Ph. D. in 1968, supervised by Francis Bretherton. His thesis dealt with atmospheric waves from large explosions and the sea waves from the eruption of Krakatoa, and, more importantly, with a new conservative property (wave action) for wave propagation in moving media. These studies set the stage for a continuing focus on small scale processes. After a postdoctoral year at the University of British Columbia with Bob Stewart and a paper explaining Faraday's cross waves, Chris enjoyed a productive two years at the Scripps Institute of Oceanography. He collaborated with Walter Munk on a theory of the "age of the tide", worked on ocean engineering problems involving wave forces on structures and harbour resonances, and assisted Walter in the development of a general spectral model of internal waves in the oceans.

After joining Dalhousie University in 1971, Chris successfully modelled the physics of the tides of the Bay of Fundy as a damped, simple harmonic oscillator, using tidal harmonic constants from the Bay of Fundy and the broader Gulf of Maine to derive the resonant frequency and damping rate. Over the years, he has made numerous contributions to the description and understanding of the fundamental physical processes in the ocean such as those involved in ocean mixing, the dynamics of ocean straits, surface mixed layer dynamics, Langmuir cells, air-sea exchange of heat and momentum, ocean fronts, internal tides, inertial waves, tides and surface waves. In addition to his work on fundamental physical processes, he has also worked on applied problems such as iceberg trajectory prediction (relevant to the oil industry), the disposal of materials such as radioactive wastes in the deep ocean, and the potential and impact of tidal power generation from both tidal elevation and tidal currents.

Les échelles d'interaction de la dynamique océanique – un hommage à Chris Garrett

par Denis Gilbert[1] et Patrick Cummins[2]

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Cet article est l'introduction au numéro le plus récent de **ATMOSPHERE-OCEAN**, Volume 47, No.4: un hommage à Chris Garrett. Il est reproduit avec la permission des auteurs. Le texte intégral des articles cités se trouve sur le site de la SCMO: www.SCMO.ca, en suivant les liens à **ATMOSPHERE-OCEAN** et autres publications. Les résumés sont publiés dans ce numéro du *CMOS Bulletin SCMO* aux pages 211-214.

Dr. Chris Garrett

Après avoir obtenu un baccalauréat en mathématique de l'Université Cambridge (Royaume-Uni) en 1965, Chris Garrett a terminé un doctorat en 1968 sous la supervision de Francis Bretherton. Sa thèse portait sur les ondes atmosphériques causées par de fortes explosions de même que sur les ondes océaniques causées par l'éruption du Krakatoa et, ce qui est plus important, sur une nouvelle propriété conservative (action des vagues) pour la propagation des vagues dans des milieux en mouvement. Ces études l'ont mené à porter une attention constante aux processus de petite échelle. Après une année postdoctorale à l'Université de la Colombie-Britannique avec Bob Stewart et un article expliquant les ondes croisées de Faraday, Chris a passé deux années fructueuses au Scripps Institute of Oceanography. Il a collaboré avec Walter Munk pour élaborer une théorie de l'"âge de la marée", il a travaillé à des problèmes de génie océanologique traitant de la force des vagues sur les structures et de la résonance dans les

But over and above all these accomplishments, during the past 40 years Chris has created a rich web of warm relations with former students, post-docs and collaborators. His sixty-fifth birthday thus served as an excuse for about 50 of his friends to get together at Dunsmuir Lodge in Victoria for two days (29-30 July 2008) of great scientific talks in a fun, relaxed atmosphere. This special issue presents six papers that arose from this symposium.

ports, et il a aidé Walter à élaborer un modèle spectral général des ondes internes dans les océans.

Après s'être joint à l'Université Dalhousie en 1971, Chris a modélisé avec succès la physique des marées dans la baie de Fundy comme un oscillateur harmonique simple, en utilisant les constantes harmoniques des marées de la baie de Fundy et du golfe du Maine pour dériver la fréquence de résonance et le taux d'atténuation. Au fil des années, il a fait de nombreuses contributions à la description et à la compréhension des processus physiques fondamentaux dans l'océan, notamment ceux qui ont un rôle à jouer dans le mélange océanique, la dynamique des détroits océaniques, la dynamique de la couche de surface mélangée, les cellules de Langmuir, l'échange air-mer de chaleur et de quantité de mouvement, les fronts océaniques, les marées internes, les ondes internes, les marées et les ondes de surface. En plus de ses travaux sur les processus physiques fondamentaux, Chris a aussi travaillé à des problèmes appliqués, comme la prévision de la trajectoire des icebergs (d'intérêt pour l'industrie pétrolière) et le stockage de matériaux comme les déchets radioactifs dans l'océan profond, et il s'est intéressé au potentiel et aux répercussions de la production d'énergie marémotrice, tant à partir du niveau d'eau des marées que des courants de marée.

Mais au-delà de tous ces accomplissements, Chris a créé, au cours des 40 dernières années, un riche réseau de relations cordiales avec ses anciens étudiants et stagiaires postdoctoraux ainsi qu'avec ses collaborateurs. Son soixante-cinquième anniversaire a donc servi d'excuse à environ 50 de ses amis pour se réunir pendant deux jours (les 29 et 30 juillet 2008) au Dunsmuir Lodge, à Victoria, et discuter de science dans une atmosphère agréable et détendue. Ce numéro spécial comprend six articles découlant de ce symposium.

ATMOSPHERE-OCEAN 47-4 Paper Order

A tribute to Chris Garrett

On Tidal Resonance in the Global Ocean and the Back-Effect of Coastal Tides upon Open-Ocean Tides
by Brian K. Arbic, Richard H. Karsten and Chris Garrett

Internal Wave Observations in the South China Sea: The Role of Rotation and Non-linearity
by David Farmer, Qiang Li and Jae-Hun Park

The Oceanic Variability Spectrum and Transport Trends
by Carl Wunsch

Estimate of the Steric Contribution to Global Sea Level Rise from a Comparison of the WOCE One-Time Survey with 2006-2008 Argo Observations
by Howard J. Freeland and Denis Gilbert

Chlorophyll Patches Observed during Summer in the Main Stream of the Kuroshio
by H. Yamazaki, I. Iwamatsu, D. Hasegawa and T. Nagai

Gas Ventilation of the Saguenay Fjord by an Energetic Tidal Front
by Burkard Baschek and William J. Jenkins

Membership Renewal

The CMOS membership year runs from January 1 to December. Membership/subscription renewals for 2010 are due by 31 December 2009. You can safely and securely renew online using your Visa, MasterCard or American Express at https://www1.cmos.ca or go to www.cmos.ca and click on the "Member Services" link at the top. You must log in with your User ID and Password. If you have forgotten these there is a link on the log-in page to have them e-mailed to you. While there, please update any of your contact information that needs it. Consider allowing at least your email address to appear in the membership directory.

If you have any questions, please contact the CMOS Office at 613-990-0300 or accounts@cmos.ca.

Ian Rutherford
Executive Director, CMOS

Renouvellement des cotisations

L'année de cotisation de la SCMO s'étend du 1[er] janvier jusqu'au 31 décembre. Les renouvellements pour 2010 devraient être faits avant le 31 décembre 2009. vous pouvez renouveler en ligne en toute sécurité en employant les cartes de crédit Visa, MasterCard ou AMEX à https://www1.cmos.ca, ou allez à www.scmo.ca et cliquez sur "Services aux membres" au haut de la page. Vous devez entrer votre Nom d'utilisateur et Mot de passe. Si vous les avez oubliés, il existe un lien sur la page d'entrée pour les obtenir par courriel. Pendant votre visite au site, s.v.p. corriger, s'il y a lieu, vos paramètres de contact. Considérez aussi de rendre votre adresse courriel disponible dans le répertoire des membres.

Si vous avez des questions, n'hésitez pas à communiquer avec le bureau de la SCMO au 613-990-0300 ou affaires@scmo.ca.

Le Directeur exécutif, SCMO
Ian Rutherford

Interview with Wendy Watson-Wright

Conducted by Gordon McBean

Preamble: The October 2009 issue of the *CMOS Bulletin SCMO* (Vol.37, No.5, page 142) provided a brief two-sentence article, under "Stop the Press", on the appointment of Dr. Wendy Watson-Wright, DFO/ADM/Science to the Intergovernmental Oceanographic Commission (IOC) effective January 2010. CMOS has since conducted a follow-up interview with Wendy, via Prof. Gordon McBean, previous EC/ADM/MSC and previous CMOS President, on her experiences in Canada and expectations with the IOC. The following interview took place on November 3, 2009 in Ottawa.

G: Congratulations on your new appointment as Executive Secretary of the Intergovernmental Oceanographic Commission in Paris. You will also be an Assistant Director General of UNESCO. Can you give us a brief description of your new position? How will this relate to Canadian oceanography and related areas? What are the opportunities and challenges?

W: I should begin by telling you about the role the IOC plays. It promotes international cooperation and coordinates research programmes, services and capacity-building, in order to learn more about the nature and resources of the ocean and coastal areas. A challenge, of course is to apply the knowledge gained to improve the decision-making of its Member States. In my role as Executive Secretary, I will be challenged to ensure that the organization is responsive to Member States, and that it functions well in carrying out its leadership on oceans within the UN and UNESCO community.

Important issues surrounding oceans and their use are gaining attention, both in Canada and worldwide. While the role that oceans play in modulating the planet, climate, and the biosphere is very important, it is not well recognized outside the oceanographic and meteorologic communities.

The challenge for me as Executive Secretary of the IOC is to find an effective means of bringing attention to the oceans and the major challenges the oceans are experiencing today. It is an opportunity to bring the UN community together to address these challenges in a productive way. The RIGHT people must be engaged to bring oceans into the forefront as the truly global resource that they are. Capacity building, of course, is a challenge around the world and Africa is a special priority of UNESCO.

For many years, Canadians have been heavily involved and shown leadership in the IOC. Just to name a few…. Geoff Holland, formerly of DFO, was a recent Chair of IOC while Savi Narayanan, Director General of Ocean Sciences – Canadian Hydrographic Service and Dominion Hydrographer, was one of the two first co-Chairs of the IOC-WMO Joint Technical Commission on Oceanography and Marine Meterology (JCOMM) and is currently Vice-Chair of Finance for IOC.

Canada and Canadians are viewed as leaders. This leadership extends into other international oceanographic programs. Bjorn Sundby is the immediate Past President of the Scientific Committee on Ocean Research of the International Council for Science (ICSU). Mike Sinclair, Regional Director of Science for DFOs Maritimes Region is President of ICES, and the international secretariat for PICES is located at DFOs Institute of Ocean Sciences. The Ocean Biogeographic Information System, which originated in the Census of Marine Life, where another Canadian, Ron D'Or, is the leader, has now moved into IOC.

G: Here is another opportunity for Canadians, working internationally, to make a difference as I am now President of START International, which is a global environmental capacity program for Africa and Asia.

W: I have looked at the most recent START annual report, and am very impressed and encouraged by what that organization is doing. I foresee opportunities for IOC and START to work together effectively in the future.

G: You have had a long successful career in DFO and other departments. Can you describe some of the most satisfying aspects of that career and some of the challenges?

W: The most satisfying part of working in DFO has always been working with great people on incredibly important issues for Canadians and for the planet. Many of the brightest people in the country are in the Public Service of Canada, and it is so stimulating to work with people of such high calibre. I have worked in DFO for 19 of the 21 years I have been in the public service.

As a government manager I have been able to help people with their careers and this has been very important to me. People make the organization; they are critical to the overall success of the organization. I have met staff who were very bright, motivated and hard working, but who needed training or more advanced education in order to progress. It was very satisfying to be able to assist these staff in improving their opportunities, and subsequently see their careers take off.

Communicating the importance of the Oceans has been a challenge. I have made every effort to impress upon people across Canada, including decision makers in Ottawa, the importance of oceans to Canada. Healthy oceans are as important for the people of Alberta as they are for those in British Columbia and Atlantic Canada.

I have to say that at times I have found it very challenging to work with people who seem think their mandate is to impede progress by focussing on rules and processes that in many cases are outdated, rather than to attempt to overcome the hurdles and see how they can be helpful.

G: How can we make oceanographic and related sciences more attractive to the policy-makers, the public and future young scientists?

W: We need to work with communities of interest to make oceans much more relevant to ALL Canadians. They need to understand why the Health of the Oceans should matter to them. The challenge is telling the story in a way that will resonate with the audiences. The importance of the oceans needs to be made more understandable and relevant. For young scientists, we need to grab their attention. One way may be for those of us who have been around for awhile to become proficient in the use of social media and to adapt the messages to them. Within DFO, Barbara Adams has for the past 6-7 years been leading our Strategic Science Outreach group. As Barry McLoughlin, a member of my Science Advisory Council, has said *"DFO science has the best stories never told*". We have been working hard to address that. The DFO Science Stories, the ADM Science Lecture Series and DFO Science active participation in National S&T week are three examples of DFO activities that raise awareness and bring oceanographic sciences to the attention of the public and younger people.

G: These are good activities that could well be copied in other government agencies. Related to the issue of raising the profile, how can CMOS play a bigger role?

W: CMOS, like DFO Science, needs to be more visible. It is largely unknown outside of its membership. Perhaps working with The Weather Network could provide more opportunities to get the message out. We need to all work on this and be supportive of CMOS efforts.

G: What advice would you give to a PhD student in oceanography and/or a beginning science student in a Canadian university on how to make career choices?

W: First of all I would say that anyone who is focussing on oceanography has already made a very good choice, so bravo. Students should go with their interests and part of our role, as we have discussed, is to make oceanography more of a central issue. Within oceanographic studies, or really any graduate studies, it is important to choose a good supervisor for the studies – a supervisor who knows and is respected within their subject area, and perhaps most importantly, cares for the student as a person, not just as a means of achieving their own goals.

G: The climate change issue is foremost in many minds now. What role does IOC play and what different role could it play?

W: As we have discussed, the oceans play a key role in climate variability and change. The IOC is a co-sponsor of the World Climate Research Programme (WCRP) and this co-sponsorship came into place when you were Chair of the Joint Science Committee (JSC) WCRP.

A huge new issue, related to climate change with respect to being caused by increased atmospheric CO_2, is ocean acidification. This is having and will have in the future even more impacts on marine life and fundamentally change the ocean ecosystems. IOC's role and challenge is to ensure optimal coordination of global efforts surrounding ocean science and services, and to make the importance of the oceans more evident to policy makers and the public. This is a global resource, shared by all and its degradation affects all.

G: Thank you Wendy very much both for doing this interview and also for all your contributions to Canadian oceanography and science, as well as CMOS. We look forward to continuing our collaboration in your new position.

On the future of operational forecasting tools

by Pierre Dubreuil[1]

Reply to David M. L. Sills' article titled *On the MSC Forecasters Forums and the Future Role of the Human Forecaster*, published in the *CMOS Bulletin CMOS*, Vol.37, No.5, October 2009, pp147-151.

Résumé: L'auteur présente ses vues personnelles concernant l'évolution souhaitable des outils de prévisions opérationnels. Notant qu'Environnement Canada dispose de beaucoup moins de ressources et de personnel que les services météorologiques d'autres pays développés, trois caractéristiques essentielles du système SCRIBE sont décrites : l'automatisation totale du processus lorsque le prévisionniste accepte les guides numériques, la présentation de guides de la plus haute qualité possible et une interface qui maintient l'automatisation des systèmes de production et dissémination. Ces caractéristiques doivent être conservées dans le système du futur, car

[1] Meteorologist retired from Environment Canada
Former Director General of the Atmospheric Environment Prediction Directorate

elles sont la source de plusieurs efficiences et économies.

La majorité des difficultés notées durant les forums des prévisionnistes sont reliées à deux faiblesses du système actuel. L'utilisation d'une interface par point plutôt qu'une interface graphique, et la difficulté d'identifier les événements à haut impact. Une approche différente est proposée pour l'amélioration du système de prévision : une approche graphique dont les intrants seraient les concepts SCRIBE, ce qui conserverait les meilleurs guides comme point de départ et l'automation totale de la production et de la dissémination, tout en ajoutant une interface graphique plus intuitive pour les prévisionnistes.

Concernant l'identification des événements à haut impact, l'expérience Phoenix amène à proposer que les prévisionnistes concentrent leurs efforts sur l'analyse des observations et le diagnostic de la situation actuelle, afin d'identifier le problème météorologique du jour AVANT de regarder les produits numériques. Ceci permet au prévisionniste d'avoir un regard critique sur les guides numériques. Les outils à développer sont donc reliés à l'analyse et au diagnostic à partir des observations. Ces outils sont très similaires à ceux requis pour les prévisions de temps violent : on pourrait éventuellement intégrer ces outils et l'interface graphique des concepts SCRIBE pour simplifier davantage le travail des prévisionnistes tout en permettant la production d'avertissements graphiques.

It was with great interest that I read this article in the CMOS Bulletin of October 2009. I was the senior manager within MSC responsible for the forecasting system at the time of the Forecasters Forums. Indeed, I initiated and funded these forums, insisting on a broad attendance of operational forecasters.

Now retired for more than three years, I feel authorised to express my personal views on the possible evolution of operational forecasting tools. This document is not endorsed by MSC or EC management: it presents the personal opinions of the author, who has had a passion for operational meteorology for more than 3 decades, and significant time to reflect on this topic.

The results of the Forecasters Forums are faithfully presented by David M. L. Sills. The issues are clear and the forecasters' aspirations and needs are well described. However, I cannot support the recommended path forward for the development of future public and marine forecast tools.

Canada has a very difficult and unique challenge for the provision of meteorological services: the effort required is roughly proportional to the geographical area, while the resources available are roughly proportional to the Gross Domestic Product. For developed countries, population density is the primary factor that determines the relative wealth of a meteorological service. Canada is a sparsely populated very large country.

More specific to the issue of operational forecasting, the reality is that Environment Canada employs of the order of 100 forecasters for public and marine forecasts. To put things in perspective, the corresponding numbers are around 1200 in the USA and 1000 in France. Forecast Centres are located in 7 cities in Canada; while there are about 120 forecast offices in the USA, and more than 50 in France.

In addition, as the vast majority of Canadians live in southern Canada not far from the US border, they expect meteorological services of similar quality and accessibility as those in the northern USA.

This places tremendous pressures on all components of the organisation. The surprising reality is that Environment Canada, through the dedication of all its personnel, has succeeded in delivering remarkable meteorological services to Canadians! There is a price to pay: hard decisions are always required and many of its staff and managers are overworked, including operational forecasters.

In this context of scarcity of resources, SCRIBE has been developed with three essential characteristics:

a) the forecast process becomes totally automated when the forecaster agrees with the NWP and statistical post-processing guidance; this includes automated generation of all products and automated feeds of all dissemination systems;

b) the system presents to the forecaster the best possible guidance of the forecast, in order to maximize the frequency of acceptability to the forecaster of the NWP and statistical post-processing guidance;

c) the system provides an interface for the forecaster to introduce changes to the guidance when required, in a way that maintains the automated generation of all products and automated feeds to all dissemination systems.

These essential characteristics provide major time savings when the forecaster agrees with the guidance, allowing the limited forecaster time to be spent on warnings and on areas-parameters needing improvement. These characteristics also provide major cost savings in the product generation and dissemination systems.

A point forecast approach is the basis of the SCRIBE system for many reasons; in particular, this allows the presentation of all weather elements for a forecast location or region, in a format that includes all components of the forecast, with sufficient time resolution to be able to generate the worded or icon forecast automatically once the weather concepts are approved. This also allows the utilization of UMOS statistics which provide the best local forecast guidance based on all the information contained in the NWP model, statistically linked to local observations to add local effects; as well UMOS filters out model biases and adapts to NWP improvements.

No system is perfect; from my perspective, the SCRIBE system has two predominant drawbacks.

First, the forecaster interface is built on these point forecasts, while the majority of forecasters would prefer an area-based graphical approach as this is much more intuitive to use. This is a minor nuisance when the forecaster needs only to make small local adjustments, but this becomes a major challenge when the forecaster needs to adjust the speed of motion, intensity or pattern of a synoptic system over an extended geographical area: for such cases, an area-based approach appears much more efficient.

Second, the existence of a draft forecast in final form, in an operational context where workload is heavy and time is always very limited, tends to 'promote forecaster acceptance of the guidance' more than the intrinsic quality of the guidance would dictate. Some forecasters feel that the system tends to reduce their ability to properly identify HIW (High Impact Weather) situations, precisely at the time when they are asked to focus their efforts on such situations.

Almost all the difficulties noted by forecasters during the Forecasters Forums can be traced back to these two problems. The evolution of the forecast system tools must thus address these two drawbacks, but at the same time, the three essential characteristics noted above must all be kept. Otherwise, such forecast tools would be rejected as not meeting operational constraints in Canada, even if they have valuable attributes.

There are two major difficulties with any form of graphical interface. First, no matter the interface, it takes time to draw all parameters, for various forecast times. Even if such interface may be more appealing, forecasters will not be able to use it if it requires more time than what is available on a shift. Second, automated word forecast generation becomes very challenging: such a graphical interface depicts 2D synoptic fields; then, local effects must somehow be added. The post-processing to add local effects is based on limited information (2D fields of a few forecast parameters, while the SCRIBE word generator starts with weather concepts that already include all local effects).

The automation of the textual product generation with SCRIBE has proven to be much more difficult than anticipated. It took a few years of hard work to cope with all special weather situations. The automation of text product generation based on 2D fields cannot be expected to produce acceptable text for all situations. Hence, forecasters would need to be involved either in writing the forecast, or reviewing-editing a draft text containing many imperfections. Not only is this time-consuming for the forecaster, but this also implies decoding these worded forecasts to feed the dissemination systems, plus translating them: this adds errors, costs and delays which have now been eliminated with the SCRIBE system.

Based on the above, it appears to me that Dave M. L. Sills' proposal, based on a graphical 2D approach where the forecaster draws maps at various time intervals, is not applicable in Canada as an operational forecasting tool due to the scarcity of resources and staff.

So, how can we address the existing drawbacks? I offer the following suggestions which should be discussed and evaluated by the operational and research forecasting community.

To address the first drawback, i.e. the lack of a graphical interface, I would recommend that experienced public forecasters specify precisely what aspects of the SCRIBE interface, under what weather situations, cause the most problems today. There has been evolution of the guidance since the Forecasters Forums, and other changes may have occurred: there is a need to validate the current issues and specify them as precisely as possible. Then, focussing on the major irritants, a graphical interface could be built starting with the SCRIBE concepts: the weather concepts would be contoured and thus could be processed as 2D objects. These objects could be modified with a graphical interface, and then the point weather concepts would be recalculated from the modified graphics, allowing the automated generation of products.

The above approach has many advantages: it keeps the best forecast guidance as the original input, not losing any quality; it keeps the full automation of the process when the forecaster agrees with the NWP solution; it adds a way of modifying spatially the weather concepts when adjustments are needed; and it maintains full automation of product generation and dissemination feeds.

Such an approach is far from perfect. How does a forecaster move some graphical patterns while not moving the imbedded local topographic effects? Also, this would not ensure consistency between weather elements. The forecaster would thus have to exercise great care in using such an interface. Hence, development of such a system would need to include very experienced operational forecasters at every step. Significant training would be needed when introducing this in operations. It is likely that for some types of required modifications, the current point approach interface would be more effective, but this graphical approach might be effective in dealing with some cases that are difficult to handle with the current SCRIBE interface.

The second drawback is for me the most important issue: identifying and focussing on HIW. Here, the Winnipeg Phoenix experiment provides valuable insight.

In a few words, the Prairie Storm Prediction Centre in Winnipeg ran a remarkable experiment where some forecasters were placed in a simulated office, working with exactly the same information as the official office, and producing exactly the same products with the same deadlines, with one exception: in the simulated office, they had no access to NWP charts, they only saw the observations and the SCRIBE weather concepts. Against expectations, the forecasters in the simulated office consistently produced better forecasts than the official ones. As all forecasters went through this experiment, the forecast skill of both offices is identical.

This is a surprising result: forecasters with less information produced improved forecasts! In addition, forecasters without access to horizontal 2D depictions (the weather maps) produced improved forecasts! The only logical explanation I can see is that the ‘Phoenix forecasters’ spent no time studying models, so they had much more time to analyze observations and diagnose better the current weather situation. Then, they modified the SCRIBE weather concepts where they felt they did not match their diagnosis. They also focussed on the early part of the forecast, as they were looking only at observations. In contrast, the forecasters in the official office likely suffered from information overload and a lack of time to develop their mental picture of the weather situation independently from NWP models.

Even if this may sound counter-intuitive, I would formulate the hypothesis that the best way for forecasters to improve upon the guidance as well as the best way to augment their ability to identify and deal with HIW situations is to initially focus their attention on analysis and diagnosis based solely on observations. The goals would be to assess the underlying dynamic causes of the large-scale and local-scale observed weather patterns, and to identify the specific weather problem of the day and specific area of interest of the day within their large domain of responsibility, prior to looking at any NWP model or guidance.

This is fully consistent with the Phoenix results obtained in Winnipeg, but the extension to all of Canada remains a hypothesis. The first step should be to repeat a Phoenix-like simulated office experiment in other locations, guided by a rigorous scientific evaluation of the results. In particular, it would be important to test this hypothesis on both coasts, where ocean data void areas present a very different forecasting challenge than what Winnipeg forecasters deal with. If the Winnipeg Phoenix results are confirmed, then the focus of the R&D on new forecast tools must concentrate on helping forecasters look at the observations, analyse them and diagnose the current weather situation.

This R&D work is very similar to what is required to improve severe weather forecasting, so synergies and further integration are possible. Especially in winter, the limits between HIW and severe weather become quite fuzzy. The ideal solution would be tools to analyze and diagnose the weather situation, followed by tools to graphically modify the SCRIBE concepts, which would drive the automated generation of both warnings and public forecasts. This would ensure consistency between warnings and forecasts at all times. In summer, the tools to analyze and diagnose the convective weather situation would be followed by tools to graphically depict movement and severity of convective cells, then warnings would be drafted automatically for review by the forecaster; public forecasts would be automatically amended to match the warnings. This would also lead to the possibility of issuing on the WEB and to the media official warnings in graphical depictions. The NINJO platform appears to be very well suited for the development of such an integrated approach.

This proposal is not an easy sell: many forecasters would prefer to spend more time on analyzing and comparing a broader range of NWP models. I have never seen any proof that a Storm Prediction Centre (SPC) forecaster, within operational time constraints, has any consistent ability of selecting the best model for a particular weather situation, between a variety of models not all available at the same time, not using the same observations, and obviously using different assimilation and physical parameterization schemes.

The argument presented by David M. L. Sills that models don’t perform well for HIW is not substantiated by verification: especially for winter storms, NWP systems have improved to the point that boundaries between precipitation types and snow quantities are frequently very precise. The biases and incapacities to treat some phenomena have been significantly reduced, so the majority of the remaining error is random and chaotic in nature: assessing subjectively the quality of the NWP guidance on a particular day has become extremely difficult. With the recent addition of ensemble systems which contain dozens of model runs, even using all available time on shift would not be sufficient for a coarse review.

Comparing many NWP models is very time-consuming and in reality it provides limited real information to an SPC forecaster on how to select which model is the best today. I strongly favour an approach where the forecaster uses all the observations, his understanding and knowledge of meteorology, his pattern recognition skills and his diagnostic skills to develop a clear understanding of the current weather situation and its underlying dynamic causes independently from any NWP output. This increases his ability to detect where the SCRIBE weather concepts need adjustments; at the same time this increases his ability to identify and predict HIW situations.

The above proposals are presented to broaden the discussion on this important topic. I believe that they are consistent with existing facts and results. Canada’s unique challenges have led Environment Canada to introduce a system that quasi-automates forecasts of routine non-HIW situations one decade before any other country. We are now facing issues that other countries will start experiencing over the next decade. We thus have the opportunity to become world leaders in re-engineering the operational activities and in shaping the future of the operational meteorology profession. This is difficult and challenging; it will be extremely rewarding if we succeed.

Weather Services for the 2010 Winter Olympic and Paralympic Games

by Chris Doyle[1], Al Wallace[1], Bill Scott[1], Patricia Wong[1], Paul Joe[2]

Résumé: Pour les Jeux olympiques et paralympiques d'hiver de 2010 à Vancouver, le Service météorologique du Canada, d'Environnement Canada, sera le fournisseur officiel des informations et des prévisions météorologiques. Un vaste réseau de capteurs météorologiques en temps réel en surface et en altitude a été déployé sur le site olympique et est déjà opérationnel. Au mois de janvier 2006, à Whistler, pour préparer les prévisionnistes aux Jeux, on leur a donné un programme de formation en cours d'emploi et il s'est terminé cette année. De plus, un cours en prévision météorologique de montagne a été développé en collaboration avec le groupe COMET («Consortium on Meteorological Education and Training»). Trois cours ont eu lieu à Boulder au Colorado et un cours terminal s'est donné à Whistler au mois d'août 2008. Lors des Jeux, on promet une approche novatrice dans le domaine de la science et de la technologie. Tout en maintenant la production courante de la prévision numérique du temps à haute résolution temporelle et spatiale, la division de Recherche en Prévision Numérique du temps (RPN) d'Environnement Canada et le Centre Météorologique Canadien (CMC) produiront des applications à résolution réduite pour quelques éléments des prévisions numériques à haute résolution, en particulier pour les précipitations et le vent. Des ensembles nouveaux de prévision seront intégrés dans la prévision opérationnelle courante. Dans le plus grand intérêt pour la prévision à court terme et la prévision immédiate «nowcasting», un Programme mondial de recherche sur la prévision du temps a reconnu que le Projet-pilote en marche comprendra des produits de prévisions immédiates opérationnels pour guider les prévisionnistes aux sites olympiques. Le support des services météorologiques pour les Jeux olympiques d'hiver, du 12 au 28 février 2010, et paralympiques, du 12 au 21 mars, comprendra un système complet de prévision météorologique opérationnelle. On y inclut aussi : des prévisions spécialisées aux sites et des produits ciblés sur mesures pour l'utilisateur final ; des prévisions météorologiques en temps réel et des données observées transmises aux systèmes d'information exclusifs de 2010 ; et la fourniture d'information en temps réel et des avis professionnels en météorologie aux partenaires du gouvernement fédéral, au Comité Olympique de VANcouver (COVAN), au Comité International Olympique (CIO), aux responsables des sports et des équipes sur les sites et au Centre principal des opérations des Jeux.

Introduction

On July 2, 2003, the IOC awarded Canada the rights to host the 2010 XXI Olympic and X Paralympic Winter Games in Vancouver & Whistler.

The Olympic Games will be held February 12 to 28, 2010. In the 17 days of Olympic events, 7 Winter Sports and 15 Sport Disciplines will be held at 15 venues. More than 80 countries will participate, bringing 5,500 athletes and officials to the Olympic area. The Paralympic Games, to be conducted March 12 to 21, 2010, include 5 Winter Sports at 5 venues. More than 40 countries will send participants totalling approximately 1,350 athletes and officials. During the Games more than 17,000 media representatives will operate in the area on-site, and Olympic Broadcasting Services Vancouver (OBSV), the International Olympic Committee Host broadcaster, will provide televised feeds to 3 billion international television viewers. This is the first winter games to be held, in part, at or near sea level. The period of the Games is near the very end of our climatological winter. From all perspectives, it is an ambitious undertaking.

In the Olympic area, including the Cities of Vancouver, Richmond and the Resort Municipality of Whistler, an estimated 250,000 visitors will come to view Olympic events and participate in related activities.

Venues.

Outdoor venues are located in the alpine areas of south-western BC, and indoor venues are located in Vancouver and Richmond. Outdoor venues include:

- Whistler Creekside: Completely within the Resort of Whistler-Blackcomb, this venue has hosted World Cup downhill events several times in the past, mainly prior to 1995. Events: Alpine Skiing, Alpine Skiing (Paralympic).
- Whistler Olympic Park: This new facility includes a two kilometre square core featuring approximately 14 kilometres of cross country and biathlon competition trails, 8 kilometres of training trails, a temporary 10-metre biathlon range, two ski jumps and three 10,000-seat temporary stadiums. All Paralympic cross country skiing and biathlon events will start and finish at the Olympic cross-country stadium and will use parts of the Olympic cross-country competition trails. Several kilometres of training and recreational trails will be available near the competition courses. Events: Cross Country Skiing; Ski Jumping; Biathlon; Nordic Combined; Cross Country Skiing (Paralympic); Biathlon (Paralympic).

- Whistler Sliding Centre: The new Whistler Sliding Centre features 1,700m of bobsleigh, luge and skeleton sliding track. Events: Bobsleigh; Luge; Skeleton.

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● Cypress Mountain: Cypress Mountain, in Cypress Provincial Park, features spectacular views of Vancouver. The freestyle skiing and snowboard competition sites will include a new in-ground halfpipe, a new freestyle site for aerials and moguls, a re-graded parallel giant slalom course and two 12,000-seat temporary stadiums. Events: Freestyle Skiing; Snowboard.

Indoor venues include:

● Hillcrest/Nat Baily Stadium Park: This is a new facility that will feature the largest-ever Olympic Games spectator capacity for curling. Events: Curling; Wheelchair Curling.

● Pacific Coliseum: This facility is home to the annual Pacific National Exhibition (PNE), which attracts 60,000 people a day each summer. Events: Figure Skating; Short Track; Speed Skating.

● University of British Columbia (UBC) Winter Sports Centre: UBC is an expansive university campus on Vancouver's west side, well-served by public transportation. A new arena will be located on the site of the existing Thunderbird Winter Sport Complex. Events: Ice Hockey; Ice Sledge Hockey.

● General Motors Place: This facility will be one of the two venues for Men's and Women's Ice Hockey, along with the UBC Winter Sports Centre. This world-class facility, home to the National Hockey League Vancouver Canucks, will feature round robin and medal round games. Events: Ice Hockey.

● BC Place Stadium: This stadium in downtown Vancouver will be the site of the Opening and Closing Ceremonies for the Vancouver 2010 Olympic Winter Games and the Opening Ceremonies for the Vancouver 2010 Paralympic Winter Games. It marks the first time ever that opening and closing ceremonies will be held indoors. BC Place Stadium will also be one of two nightly Victory Ceremonies presentation sites along with an 8,000-person temporary venue in Whistler. BC Place Stadium is a four-hectare multi-use facility with the largest air-supported stadium roof in North America.

● Richmond Oval: The new 31-hectare Richmond Oval site will feature a 33,000-square metre multi-purpose facility with a 400-metre track. Events: Speed Skating.

Weather Services

The Government of Canada signed a Multi Party Agreement in 2002. The scope extends across the mandates and areas of jurisdiction of many federal departments and agencies and includes providing the full delivery of essential services under federal purview, generally at no cost to Vancouver Organizing Committee (VANOC). A "whole-of-government approach" is being used to ensure the 2010 Winter Games leave sustainable athletic, social, cultural and economic opportunities and legacies for all Canadians. The Government of Canada's total investment in the 2010 Winter Games is approximately $700 million (including $127.6 million for federal essential services, of which 9 million dollars has been allocated to weather services, to be expended over a six-year period of development and operations). This investment in weather services was predicated on the fact that weather can have a very serious impact on Games operations and the safety of participants and spectators. Specifically for sport-specific weather services, EC is recovering costs from the Organizing Committee.

EC has been working on preparations since 2003; in one role to serve the public good through the provision of general weather and weather warning services in the Olympic area and to support essential Federal Services like the RCMP and Department of National Defence. Its second role is to serve the needs of Sport and the Organizing Committee. To develop a comprehensive weather services for the Olympics required considerable research and planning. In this we were aided by weather managers and planners who worked for prior Olympic Organizing Committees, especially 2006 in Torino, 2002 in Salt Lake and the 1988 Calgary Games.

EC is the official provider of weather services to the Vancouver 2010 Olympic and Paralympic Winter Games. We were asked by the organizers early in 2004 to provide a "turn key" weather service for Sports and related Olympic operations and to meet VANOC's requirements for venue-specific weather information, including data, forecasts and warnings.

To help meet the mandate we have established partnerships with the province of British Columbia concerning the sharing of weather monitoring instrumentation and data, and to contribute to the provision of data that aids in the preparation of avalanche forecasts, snow clearing forecasts and flood forecasts — areas of provincial jurisdiction.

Observing Systems

Prior to the completion of the Olympic weather observing system, the mountainous corridor between Vancouver and Whistler was rather data-sparse. In fact, the pre-Olympic network comprised a few stations around Vancouver, an automatic weather station (autostation) at Squamish (about midway between Vancouver and Whistler) and a daytime-only observing station at Whistler.

Given the combination of mountains and ocean, there are vast differences in the climate of the area. In the month of February alone, precipitation ranges from less than 130 mm of water-equivalent in the rainshadow of Vancouver Island encroaching the City of Vancouver to more than 400 mm on the North shore Mountains, just a few kilometres north of the City. Olympic venues range in elevation from a few metres above sea level to approximately 1700 m (the start of the Men's downhill course in Whistler). The main transportation corridor between Vancouver and Whistler, the Sea-to-Sky, extends for about 120 km, ranging irregularly from near sea level to about 660 m.

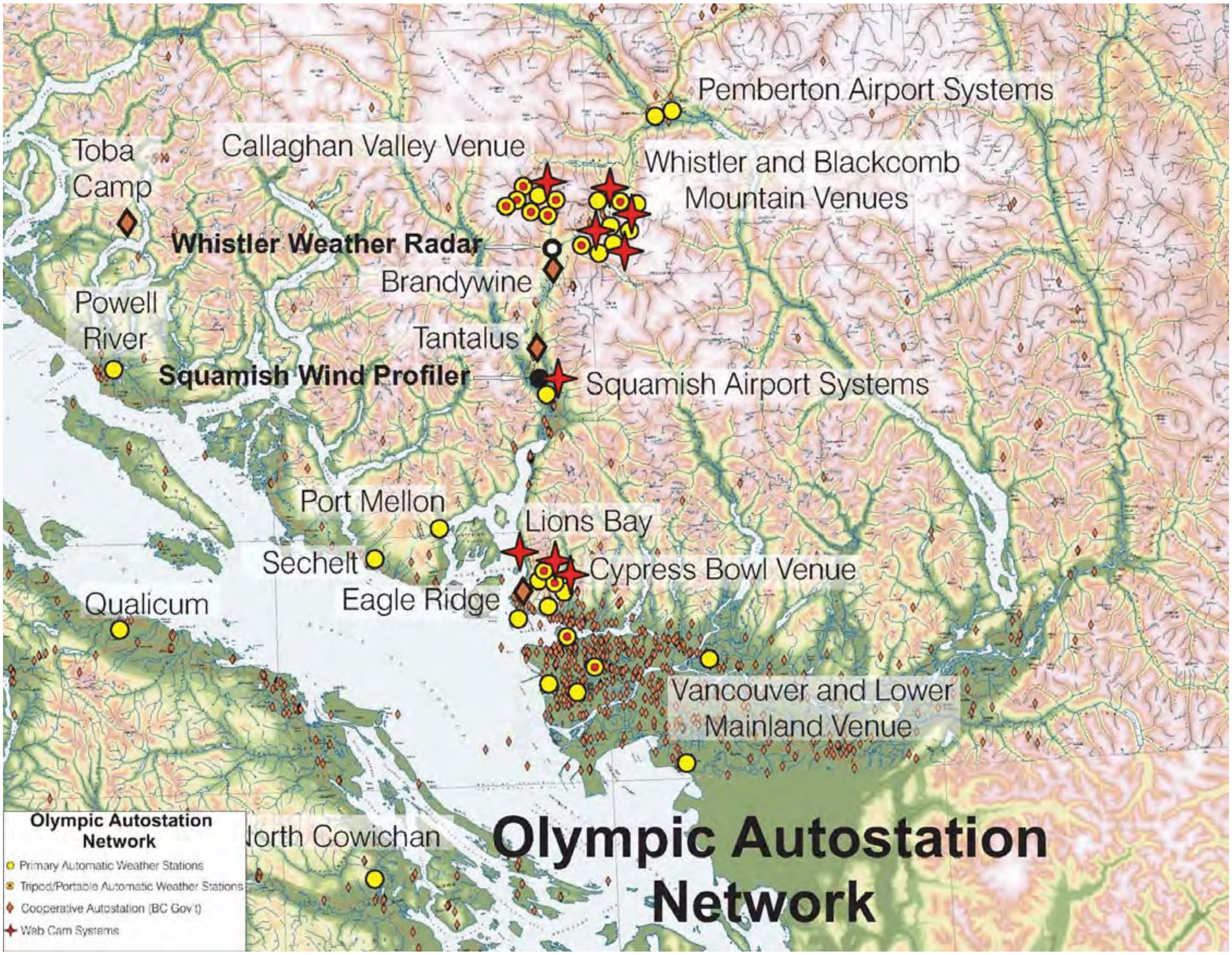

Figure 1: Olympic observing systems map

It was clearly evident that the priority was to expand the monitoring system well in advance of the games to develop the necessary understanding of the weather in this complex regime. Not only was it important to capture a more detailed climatology of the Olympic area, but it was realized that the vertical dimension of weather was poorly understood. Hence, a new Doppler weather radar system was planned for the Whistler area to complement coverage provided by 2 pre-existing weather radars in the Vancouver area, and a wind-profiler and radio-acoustic sounding system (RASS) was procured and located at the Squamish airport in the Sea-to-Sky corridor about half-way between Vancouver and Whistler. A microwave profiling radiometer was obtained and installed in the Alpine skiing venue to obtain continuous profiles of temperature and humidity from the surface to the tropopause.

With a few exceptions, Figure 1 indicates the complete observing system for the Games. It was critical that the installation of the entire surface network was completed in the fall of 2007. This provided data for two complete winters before the 2010 Winter Games.

Installation of the autostation network has improved the understanding of monitoring in complex terrain and much has been learned about installation and maintenance. Measuring precipitation is a particular challenge as the mountains around Vancouver receive significant amounts of both snow and rain during the winter.

Other instrumentation

There is a short but significant history of World Weather Research Program (WWRP), an initiative of the World Meteorological Organization (WMO), participation in weather services for prior Olympics. WWRP Research and

Forecast demonstration projects were conducted at the Sydney Summer Olympics (2000), and Beijing (2008). There is a WWRP-sponsored now-casting Research Demonstration Project (SNOW V10) planned and underway for the 2010 Games; the first for a Winter Olympics. Led by the Meteorological Research Branch of EC's Science and Technology Division, SNOW V10 and its 11 local and international participant agencies have brought many new observing systems and innovative forecasting technology to the Games area. Venue forecasters will be provided with now-casting outputs and data to further refine their predictions at Games time.

Data sources for 2010

2010 Weather Services (MSC) installations

• Approximately 35 new or upgraded surface observing systems, including special surface sensors for Sport (snow temperature).
• Access to more than 30 webcams.
• Wind Profilers/RASS – installed at Squamish Airport.
• Doppler radar –installed near the entrance to Whistler.
• Olympic Park about 11 km from the Town of Whistler.
• Profiling Microwave Radiometer (Whistler Alpine venue).

Upper Air (Radiosonde) program

• Operational for test events 2009 and 2010 Games with 4 launches per day during the Games.
• Two locations: Whistler and Canadian Forces Base Comox.

Upgrades and partner sites

• 24/7 Manned observations at Whistler, Pemberton and Squamish provided by NAV Canada.
• Precipitation gauges collocated at BC Ministry of Environment monitoring stations at 4 locations, plus access to data from 4 road weather systems along the Sea-to-Sky.

Snow V10 installations

• Visibility/ceilometers at 3 locations.
• Microwave distrometers at 5 locations.
• Present weather sensors at 4 locations.
• 2 Microwave rain radars (vertically pointing).
• Mobile dual polarization NO-XERES (courtesy of NOAA's National Severe Storms Laboratory).

Scientific research and development for 2010

Numerical Weather Prediction

The operational weather forecasting model for EC is the GEM (Global Multiscale Model). A global variant and analysis is used operationally for longer term (3-7 day) forecasting and provides an analysis and boundary conditions for a 15 km resolution regional model used for days 1 and 2. EC's RPN (Research en Prévison Numérique / Numerical Weather Prediction Research division), together with Canadian Meteorological Centre (CMC) scientists and developers have prepared a suite of Numerical Weather prediction (NWP) guidance for the benefit of forecasters at the Games. A regional high resolution model was developed in the pre-games period to produce 2.5 km resolution model output. To meet the requirements for high precision forecasting, a 1.0 km resolution model with its domain centered over the Olympic area is now producing 18 hour forecasts for venue locations. These models utilise appropriate and innovative model physics to better replicate features of clouds and energy transfers at these scales. Some of the 1.0 km model outputs are being downscaled to a 100 metre resolution for improved predictions of temperature and snow at venues.

Since much of the art and science of NWP deals with forecast uncertainty, a final innovation is the deployment for Games time of a regional ensemble prediction system, based on 20 members of the 33 km GEM. Forecasts are provided twice daily.

The NWP advances made on behalf of the Olympics by RPN and CMC have contributed, and will continue to contribute to significantly accelerated innovation and improvements within the national prediction program.

Nowcasting Research Demonstration Project (Snow V10)

Snow V10 has goals well beyond bringing a suite of esoteric weather observing instrumentation to the Olympic area. There are well known problems concerning the forecasting of weather in complex and rugged terrain, and most of these problems can affect venue operations. Poor visibility, intense precipitation, strong winds, precipitation phase changes with elevation, local flows, diabatic forcing, and other localized phenomena can drastically affect the outcome of any particular event. Besides offering prototype nowcast and short range forecasting products for the benefit of forecasters during the Games, Snow V10 will seek to evaluate the utility and value of the products generated, and the efficacy of the systems used to produce guidance. Ultimately, knowledge gained during Snow V10 will be passed on both in Canada and to other WMO member states that face similar forecasting problems.

T-PARC Winter Phase (Jan-March 2009)

T-PARC (the THORPEX Pacific Asian Regional Campaign), was a two-phase multi-national field experiment. Its summer phase was primarily concerned with tropical-extratropical interactions. The winter phase, conducted January through March of 2009, was mainly about data assimilation and predictability issues. Operations involved a large number of extra radiosonde ascents, launched from central and eastern Russia, and targeted dropsondes from two aircraft, over the western and central Pacific. Forecasters from EC's Pacific Storm Prediction Centre (PSPC) aided in the targeting of observations using European Centre for

Medium Range Forecasting (ECMWF) NWP targeting guidance products.

Besides exposure to interesting ECMWF products and experience in the targeting phase, PSPC forecasters, including many Olympic forecasters, learned more about areas of initial condition sensitivity and the effects of extra observations. Although no field experiment is planned for this Olympic year, the US National Centers for Environmental Prediction (NCEP) Winter Storms Pacific reconnaissance project will be targeting areas of initial condition sensitivity with extra dropsondes through the Olympic period.

Although many national weather centres assimilated T-PARC data during the experimental period, we have collaborated with NCEP to produce a set of US Global Forecast Model (GFS) results both with and without the T-PARC data set included in the assimilation cycle. These time-synchronous results will be used *post-facto* to create two sets of forecasts for the Games period. From those forecasts will be derived a simulated evaluation of operational decisions made on the basis of those forecasts, and their many consequences. This will enable an evaluation of additional observations from T-PARC Winter phase and, in turn, a calculation of potential costs and benefits to the Games, were the period of study to be the actual V2010 interval.

Finally, a considerable number of case studies have been developed on high-impact weather events in the Olympic area. These have been and will be used for Olympic forecaster training. They have been developed over several years, and use the most advanced and complete data sets that were available at the time of the event.

2010 Forecaster Selection and Training

Expressions of interest were solicited in 2005 from meteorologists working for Environment Canada and several other organizations regarding participating in the 2010 weather forecasting project. Over 100 applications were received, from which 35 forecasters were recruited. One hopeful application was received from a Director-General in EC but it was regretfully rejected on the basis of a lack of recent experience. Although the majority of team meteorologists work for Environment Canada (from every operational centre and CMC), forecasters also come from EC's Aviation and Defence Services, the Canadian Weather Network, and the US National Weather Service (NWS) – Juneau and Seattle offices.

Although we believed we had picked the "cream of the crop", when it came to talented meteorologists, it was apparent that Olympic (not athletic but pertaining to the venues and region) training was necessary. This was split into three phases:

- Classroom;
- Practicum (venue forecasting experience);
- Workshops.

Classroom training involved setting up a week-long residency course in cooperation with and at the Boulder Colorado facilities of COMET, the Cooperative Program for Meteorological Education and Training; a training partnership of the University Consortium for Atmospheric Research, the NWS and the MSC. Based on the notion that the depth of knowledge of theoretical concepts has impact on forecaster performance and that training in fundamental and current meteorological concepts promotes a more complete understanding of weather phenomena, subject matter experts from Universities and a variety of meteorological agencies were invited to prepare and deliver lectures and case studies on topics of relevance to alpine and complex terrain meteorology. This course, the MSC/COMET Mountain Weather Course, was held three times between 2006 and 2008, and every Olympic forecaster attended.

The Practicum phase began under somewhat austere conditions in the winter of 2005-06 and has continued every winter to the present time. Initially no venue except Cypress Mountain had facilities available to accommodate forecasters and their technology, so forecasters for the Whistler area worked from hotels and in the venue locations with laptops and, where available, wireless connectivity. Conditions improved quickly and a full practicum effort was held for the winters of 2006-07 through 2008-09. For approximately three weeks each winter, team forecasters have each produced venue-specific forecasts. In addition, they were tasked with forecast verification, and to become familiar with the weather and climate of the local area, through observations and journal-keeping for weather events. As venues became complete enough to hold sporting events, forecasters have had the opportunity to provide real time weather support to event organizers during the last two years, including nine World-Cup events in 2008-09. This provided them the essential opportunity to interact with the client in an Olympic fashion, by providing briefings to team captains and coaches, interacting with Judge and Jury members, Sporting Federation officials and others who will be on the scene at Games time, and most importantly, to witness first hand how sporting events were affected by weather conditions.

A number of workshops have been held in support of 2010 team training. The first immediately followed the 13th AMS Conference on Mountain Meteorology and 17th Conference on Applied Climatology held at Whistler in August 2008. This period was chosen as both a number of prospective trainers and a large number of team members were on hand for the prior conference. It focussed on case studies and role playing, where a number of team members took on the role of intense and skeptical sport judges during a simulated briefing. Venue forecasters will need to be able to cope with a number of simultaneous pressures, especially when weather conditions turn adverse. Subsequent workshops were held in Montréal and Vancouver in the fall of 2009. These workshops were held to introduce new forecast production technology and to study cases of synoptic and local situations that proved to be difficult to predict.

Other 2010 team forecasters, although not destined to work at outdoor venues, have received essentially identical training. These meteorologists will be providing support to venue forecasters out of offices located at the EC PSPC in downtown Vancouver. This unit will also provide support to essential Federal Services Agencies; for example, through the provision of real time weather conditions and short term outlooks for environmental and perhaps civil emergencies. In cases where dispersion modeling may be necessary, it will be provided in real time from CMC's Environmental Emergency Response Division in Dorval, Québec.

Related and supporting activities

In addition to providing detailed forecasts for Sport, emergency services to essential Federal Service agencies, and routine forecast and warnings for the public in the Olympic area, the Olympic project encompasses a number of related initiatives. These are principally related to the dissemination of weather data at Games time to the public and to communication with media. EC's national website, **www.weatheroffice.ec.gc.ca** hosts a special Olympic weather page where warnings, forecasts, observations, Whistler radar and satellite imagery can be obtained. A web-based pilot project featuring user selected street-level forecasts for the Vancouver area is being prototyped. Weatheradio service has been implemented in Whistler. Also linked to the weather office Olympic page is Drive BC where local motorists can obtain road condition reports, route forecasts and web cam imagery along major roadways.

For the media, EC has a special internet service called mediaweb. Mediaweb will feature Games time daily streaming video briefings of regional weather with special streaming feeds for forecast high impact weather situations. It will also feature weather vignettes for viewing or download that can be used to provide background or content for local weather stories. EC warning preparedness meteorologists will be available for media briefings in person for extended hours at Games' time. All web and briefing services will be available in both official languages.

The official Games Broadcast service, OBSV, will receive three channels of weather information from EC during the games for the use of host or country broadcasters. Two will carry observation data and satellite imagery. The third is dedicated to radar images, with loops varying between the EC Aldergrove weather radar located near Abbotsford, BC, and the Whistler radar. Radar and Satellite feeds will be in high definition (HD).

Special services for VANOC

Other than Games time venue weather forecasts, a number of meteorological products, services and supports were developed to assist VANOC in its planning and delivery phase. In 2005 a website was developed for the benefit of the Olympic Family (Organizing committee, Sport Federations, IOC, Essential Federal Services (EFS) agencies). It was built to host real time and archive Olympic observing network observational data and web cam imagery, as well as annual climatological studies and weather assessments prepared for VANOC, local weather and climate studies and venue forecast verification reports. A forecast template has been developed for VANOC Medical Services to enable them to anticipate workload, likely casualty types and the difficulty of medical evacuations based on forecast weather conditions. Beginning during the last week of October 2009, a daily forecast briefing is being provided for the operators of the Olympic Torch Relay. Finally, as was provided during the winter of 2008-09 and for the months immediately preceding the Games, forecasts for snowmaking potential will be produced for venues.

Concept of operations

Forecast production for the games will begin January 2nd 2010 from a special Olympic weather support desk, the POD (PSPC Olympic Desk), collocated with EC's Pacific Storm Prediction Centre in downtown Vancouver POD forecasters (or "PODcasters") will prepare regular public forecasts for the Olympic areas and venues, and specially formatted forecasts for INFO 2010, the IOC's Games-time public information Olympic results website. On February 5th, venue forecasters will arrive at the venues and begin preparing highly detailed sports specific forecasts plus the special format forecasts for INFO 2010. PODcasters will maintain their production of regular public forecasts, help coordinate the work of the venue teams, and increase their readiness to support EFS requirements. Detailed venue forecasts will cease on the evening of February 28th and resume for the Alpine and Whistler Olympic Park venues on March 5th for the Paralympics. All Olympic forecast operations will cease on March 24th, 2 days after the end of the Paralympics.

From January 12th until March 24th, two meteorologists will remain on staff at the VANOC main operations centre's (VMOC) Sport Communications Centre (SCC), located at VANOC headquarters in east Vancouver. The role of the VMOC and SCC is Olympics command, communications and control. Weather, in the SCC part of the VMOC, will maintain situational awareness and will bring the weather perspective to executive meetings (that will include Sport Federation heads, IOC officials and Broadcast heads) regarding Games activities at, or potentially at, the mercy of weather. Decisions about postponements or cancellations take place at the VMOC.

To maintain weather observing and telecommunications/laptop and computer workstation services, three of EC's Pacific and Yukon Region Surface weather instrument technical staff will take up residence in Whistler during the Games, as will one computer specialist.

Final Preparations

Besides the final workshops mentioned earlier, several other activities required completion. The first was EC's participation in the third Games-area-wide security exercise, Exercise Gold, held in November, 2009. It is the final and biggest of Vancouver 2010's pre-Games security rehearsals. EC role mainly involves support to environmental emergency response and assisting VANOC in weather contingency planning. Other than that, maintaining telecommunications and finalizing contingency plans for data outages and H1N1 outbreaks will take the program up to Games' time.

Legacy

What we hope to leave behind are the following:

1. Improved predictive capability through science and technology;

 • Improved understanding of Alpine weather, local high impact scenarios, and the use and interpretation of high and very high resolution models, nowcasting techniques and data management.

 • A deeper understanding of physical processes particularly related to precipitation and wind; to improve dispersion modelling.

2. Transfer Games-related forecast innovations to advance the national prediction program.

 • A cadre of highly skilled forecasters from across EC and other agencies will bring their knowledge and experience back to their home offices and enrich the capacity of the national prediction system.

3. Infrastructure upgrades.

 • We will endeavour to maintain some of the higher density observing network and other sensors in partnership with other agencies.

4. To give every participant a "gold medal" experience.

Over one hundred individuals; too many to mention, from EC and many other organizations have contributed to the development of the Olympic Weather Service program. The Olympics does seem to bring out the best in people. Their efforts have been tireless and are matched only by the efforts made by the many talented people of the Vancouver Organizing Committee for the 2010 XXI Olympic and X Paralympic Winter Games.

High Resolution Near Surface and Land Surface Assimilation and Forecast System for the Vancouver 2010 Winter Olympic and Paralympic Games

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Résumé: Un système de modélisation à haute résolution (100-m) a été dévelopé pour produire des prévisions des conditions de neige (ex: température, épaisseur, densité, albédo) et de température au niveau abri pour les Jeux Olympiques et Paralympiques d'hiver de 2010 à Vancouver. Les prévisions horaires de 96h sont pilotées par les prévisions des modèles opérationnels, corrigées pour les différences d'élévations entre les modèles opérationnels et le système à haute résolution (qui assure une meilleure définition de l'orographie complexe de la région en particulier dans la partie alpine). Le système a été validé en utilisant les températures et épaisseurs de neige observées. La prévision de température au niveau abri est améliorée. Le nouveau système reproduit aussi mieux la présence intermittente du couvert de neige aux stations côtières. En région alpine (à plus de 500-m d'altitude), les prévisions de l'épaisseur de neige sont généralement améliorées avec une diminution d'erreurs qui excède 3-m à certaines stations.

The Vancouver 2010 Winter Olympic and Paralympic Games (hereafter VO2010) will be held 12 to 28 February 2010 and 12 to 21 March 2010, respectively. In support of these upcoming Games, Environment Canada has been tasked with providing timely and accurate forecasts over the Games Venue Region (Figure 1). In order to fulfill these requirements, Environment Canada will make use of existing operational and experimental forecast products (Mailhot et al. [2010]). In this article, we describe two high resolution near surface and land surface systems specially developed and implemented for VO2010. The first system is a 100-m grid size model that covers the Olympics region (Figure 1, and Bernier et al. [2010a]). The second is a novel imbedded point system, collocated with the Olympics Venue sites (Figure 1, dots) that allows for observation driven assimilation runs and data assimilation at each grid point during the spin-up process (Bernier et al. [2010b]).

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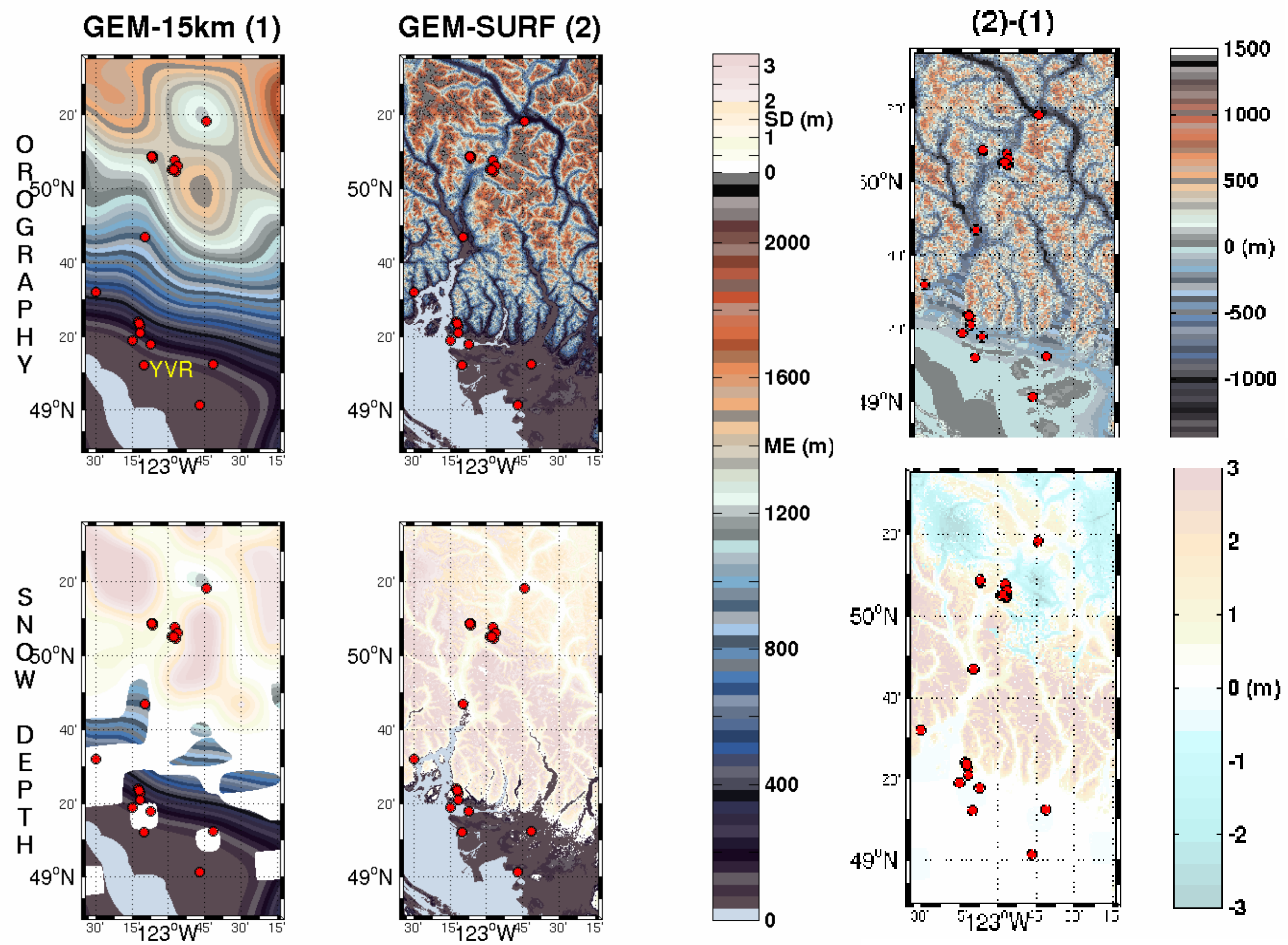


Figure 1: Domain and orography of the Olympics Region along with snow depth forecasts valid 12 February, 2009. The red dots mark observation stations and grid point location of the imbedded point system. YVR indicates the location of Vancouver International Airport. The top left and middle panels show the orography (in m) of GEM-15km and GEM-SURF models respectively. The top right panel is the orography difference GEM-SURF minus GEM-15km. The bottom row is snow depth (in m) or orography for areas not covered with snow. The bottom left panel shows the GEM-15km forecast, the bottom right panel shows the GEM-SURF forecast. The bottom right panel is the forecast snow depth difference (GEM-SURF minus GEM-15km).

The near surface is the level at which athletes and public alike experience weather. Numerous villages, scenic drives, and sporting and vacation resorts are spread over a wide range of altitudes that can also have different types of vegetation, soil textures, etc. The lack of resolution (over regions of rapidly changing terrain) in large scale forecast models such as Environment Canada's regional 15 km (GEM-15km) and global 33 km (GEM-33km) forecast models (Mailhot et al. [2006] and Bélair et al. [2009]) can lead to systematic surface temperature and snow depth forecast errors (several degrees and metres, respectively). Any improvement of forecasts at the level experienced by the public is of high value both in case of commodities as simple as deciding what to wear or whether to go out or not and to safety (in the event of extremely cold or warm temperatures, or in the correct forecast of a large snow accumulation as opposed to a freezing rain or rain event and vice versa). The goal of this work was thus to develop and implement in time for VO2010 a robust yet computationally inexpensive system to improve on current operational near surface and land surface forecast capabilities, in particular to improve on snow condition forecasts for competitions, in the complex alpine region of the 2010 Winter Olympic Games.

GEM-SURF, the VO2010 version of the near surface and land surface model, is based on the Interaction between the Surface, Biosphere and Atmosphere (ISBA) scheme (Noilhan and Planton [1989], Douville et al. [1995], Bélair et al. [2003a], and Bélair et al. [2003b]). The model has two set-ups: i) a 100-m grid spacing over the VO2010 Region and ii) an unevenly distributed grid with points collocated with VO2010 Competition or Supporting Venue sites at which observations are available. In both settings, GEM-SURF is forced with hourly operational forecasts (i.e., GEM-15km or GEM-33km) of precipitation rate, incident radiation, downscaled surface pressure, and downscaled low level (~40 m) temperature, wind, and downscaled humidity (Figure 2). Other fields such as soil moisture and soil temperature are prescribed by the regional operational model (i.e., GEM-15km) at the first time step of the season (on 1 September). Thereafter, GEM-SURF fields are internally evolved through the Fall and Winter seasons. The model is integrated daily to produce 96-hour (4-day) forecasts of near surface and surface fields such as screen level air temperature and snow conditions (depth, temperature, albedo, density). The gridded (regional) version uses the 24th hour forecast of the previous day as initial condition for the current day forecasts. In the point system version, the assimilation runs over the previous 24 hours are performed prior to launching the current day forecasts. When and where available the assimilation runs are driven with observations (e.g., screen level air temperature). Variables not observed or unavailable are replaced with GEM-15km output. In addition, snow data assimilation is allowed for stations with snow depth observations (see Bernier et al. [2010b] for details).

Some fields (namely pressure, humidity, temperature and the precipitation phase which is adjusted according to temperature) used to drive GEM-SURF are a priori downscaled to correct the orography differences that result from the difference in resolution between the two models. In the alpine region, these orographic differences can exceed 1 km (Figure 1, top row). The downscaling applied to GEM-15km and GEM-33km outputs is simple. The method takes into account variations of temperature with elevation ($6K\ km^{-1}$, based on observations within the region) and allows for the adjustment of temperatures and of variables that are sensitive to this variation (e.g., precipitation phase). Variables sensitive to elevation variations are also corrected (e.g., pressure).

Overall, the downscaling process reduces the mean temperature bias by $0.7^{o}C$ and $1.1^{o}C$ for GEM-15km and GEM-33km forecast respectively. In the alpine region (i.e., for stations located above 500 m), the gain is roughly $0.5^{o}C$ for both models whereas the low lying areas have gains of roughly $1.5^{o}C$ and $2.2^{o}C$ respectively. The spatial variability (not shown) of the correction highlights the importance of the downscaling process along the region's most rapidly changing orography where peaks and valleys are close enough that the low resolution model cannot follow the rapid changes without some form of smoothing. The pressure error statistics are also greatly improved by the downscaling process. The post-downscaling pressure biases are still below 2 hPa after 96 hours (compared to roughly 50 hPa before downscaling is applied) thereby effectively validating the orography of the high resolution model.

Snow depth forecasts are indirectly improved by the downscaling method discussed above. The effect of changes in the phase of precipitation on the snow albedo and the snow density fields are not accounted for during the downscaling process. Local variations in temperatures associated with variation of vegetation or soil texture (for example) are also not considered yet. GEM-SURF, the high resolution near surface and land surface forecast model, is used to carry out all further refinement.

In general, GEM-SURF reproduce well screen level temperatures. A degradation of GEM-SURF forecasts is apparent between days 2 and 3. It is primarily due to the change in the forecast model used to drive the near surface and land surface model when the regional forecasts are replaced by the global forecasts (see Figure 2). GEM-15km and GEM-33km sometimes exhibit temperature minima several degrees below the observed values. We note that since these models provide the forcing fields for GEM-SURF, the problem still remains in the surface forecasts.

The improved skill of GEM-SURF is demonstrated in Figure 3 for the forecast period 1 January to 31 December 2008. Here, the forecast error (i.e., observed minus forecast temperature) for each of the 26 stations for each forecast hour was calculated. Thus, for each station, we have 26 values per forecast hour. The lines plotted in Figure 3 show the median of the mean (top) and standard deviation (bottom) of the hourly forecast errors. Following these lines from hour to hour reveals a generally increasing error with lead time and a diurnal cycle in forecast error with errors (within a given day) being largest at the time of temperature minima occurrences. In general, Figure 3 shows that both the bias and standard deviation of the error are improved in the new high-resolution system.

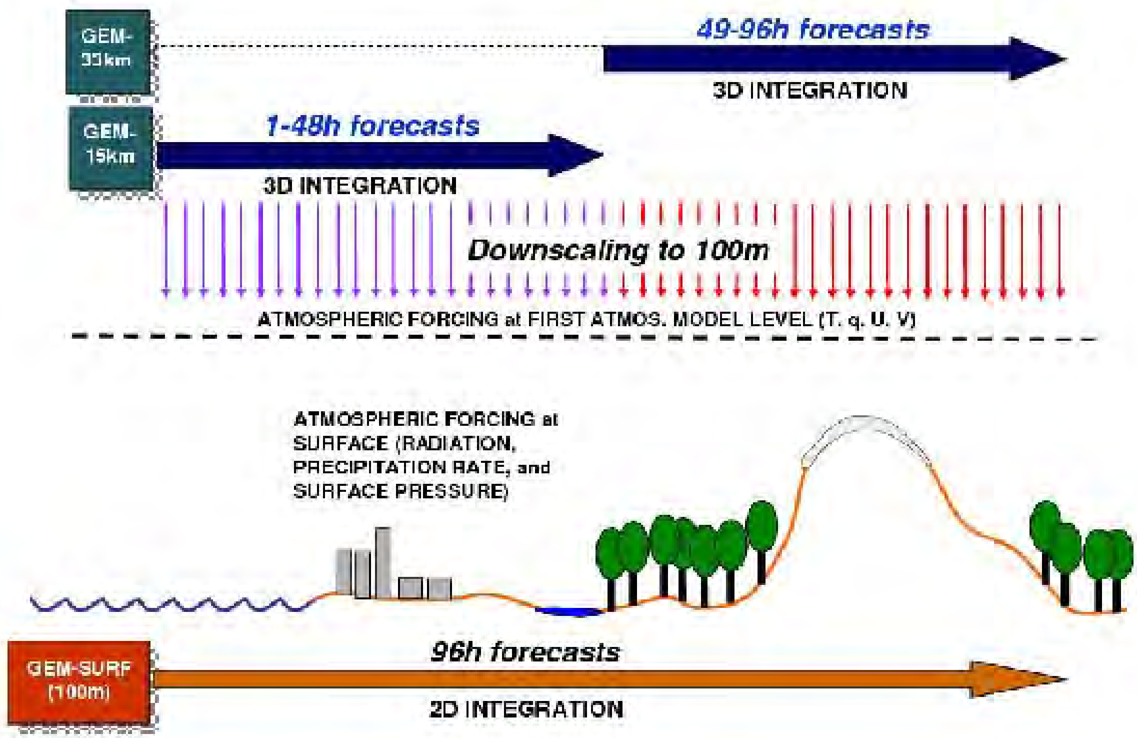


Figure 2: Schematics of the Vancouver Olympics high resolution forecast system. GEM-SURF, the near surface and land surface model is driven by hourly downscaled forecast fields issued by the Meteorological Service of Canada Operational forecast models. The first 48 hours of forcing are obtained by downscaling GEM-15km forecasts, hours 49 to 96 are driven using downscaled GEM-33km forecasts. Forcing fields are temperature (T), humidity (q), and winds (U,V) at the atmospheric model's first level (~40 m above the surface) as well as surface pressure, radiation and rate of precipitation.

GEM-SURF snow forecasts were found to greatly improve on current operational systems for both low lying and alpine stations. At low lying stations, it is the intermittency of the presence of a snow cover that is better captured by GEM-SURF. There, the refinement of the surface leads to more realistic periods of accumulation and melt. The gain in forecast skill is also evident within the alpine region where snow depth errors are systematically reduced. At some alpine stations, the peak seasonal snow depth error reduction exceeded 3 m for the 2 Winter seasons run thus far (Bernier et al. [2010a,b]). Snow depth forecasts and forecast differences between the GEM-SURF and GEM-15km are illustrated for 12 February, 2009 in Figure 1 (bottom row). Note the smooth snow cover produced by GEM-15km (bottom left panel) compared to that of GEM-SURF (bottom middle panel) where valleys and low lying lands are clearly discernible from mountain tops. Note also the differences in snow depths (and thus volume of water stored on land) in the bottom right panel. The differences in the snow fields also lead to differences in the snow densities and the snow albedo (snow albedo is temperature, density, and age dependent (e.g., Mölders et al. [2008]). Once two-way coupled modelling is allowed, the effects of these surface changes (e.g., albedo and thus radiation, temperatures and all other related terms) will be communicated back to the operational 3D forecast model (e.g., GEM-15km). It is hoped that improvement to numerical weather predictions will follow from the high resolution near surface modeling efforts discussed here.

The system presented in this article now runs in real-time with daily updates. Production of daily 96 h forecasts resumed 1 November 2009 and is set to continue until 31 March 2010. Figure 4 is a selection of plots generated from GEM-SURF forecasts that are automatically generated and made available to the Olympics forecast team in time for their morning briefing.

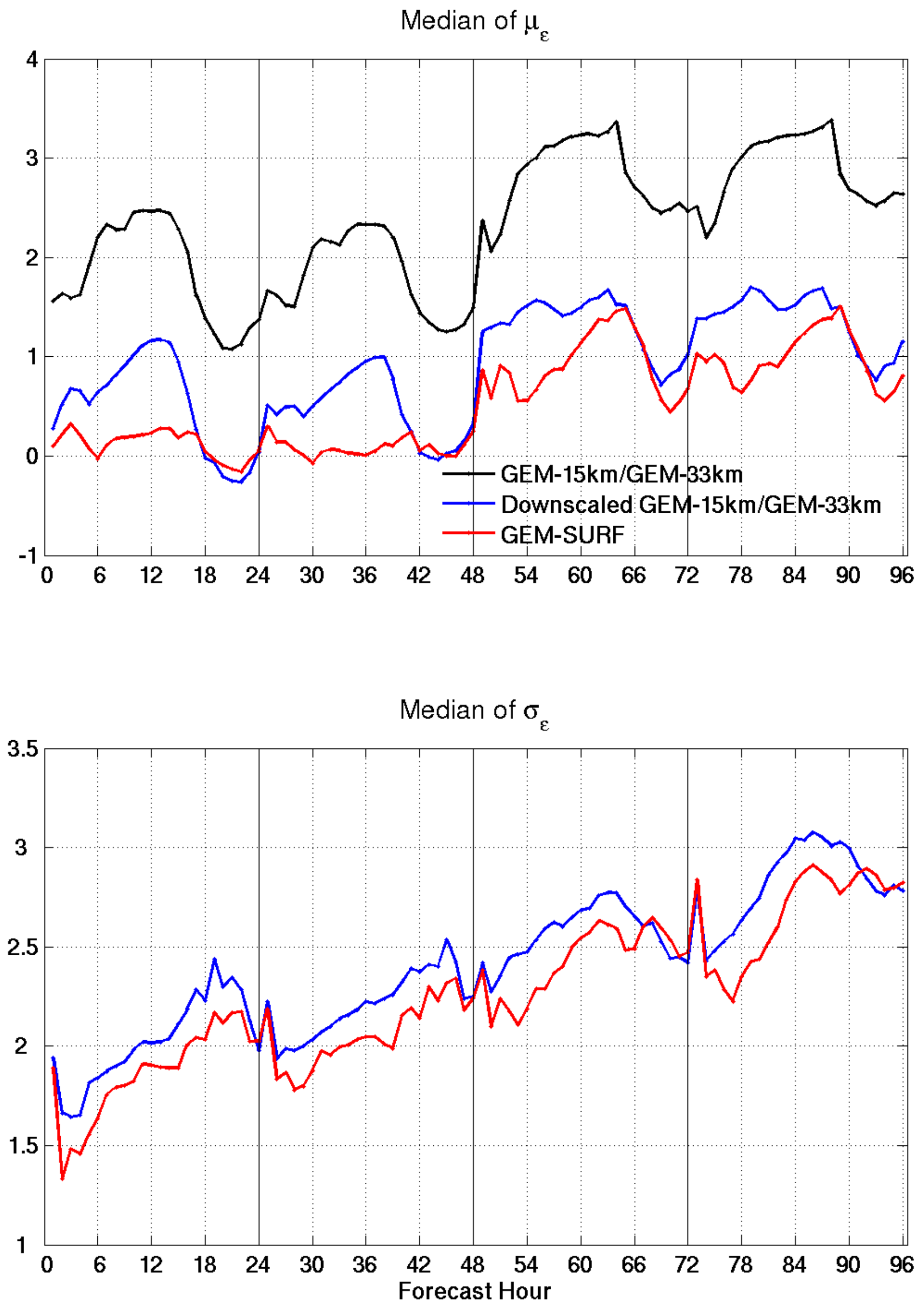


Figure 3: Median of the bias and standard deviation of the screen level temperature forecast error (Observations – Forecast) for each forecast hour. The top panel is the median of the bias in K. The black line is GEM-15km and GEM-33km median forecast bias. The blue line is the same but for the downscaled (i.e. corrected for elevation) GEM-15km and GEM-33km output. The red line is GEM-SURF. The bottom panel is the standard deviation of the hourly forecast error in K.

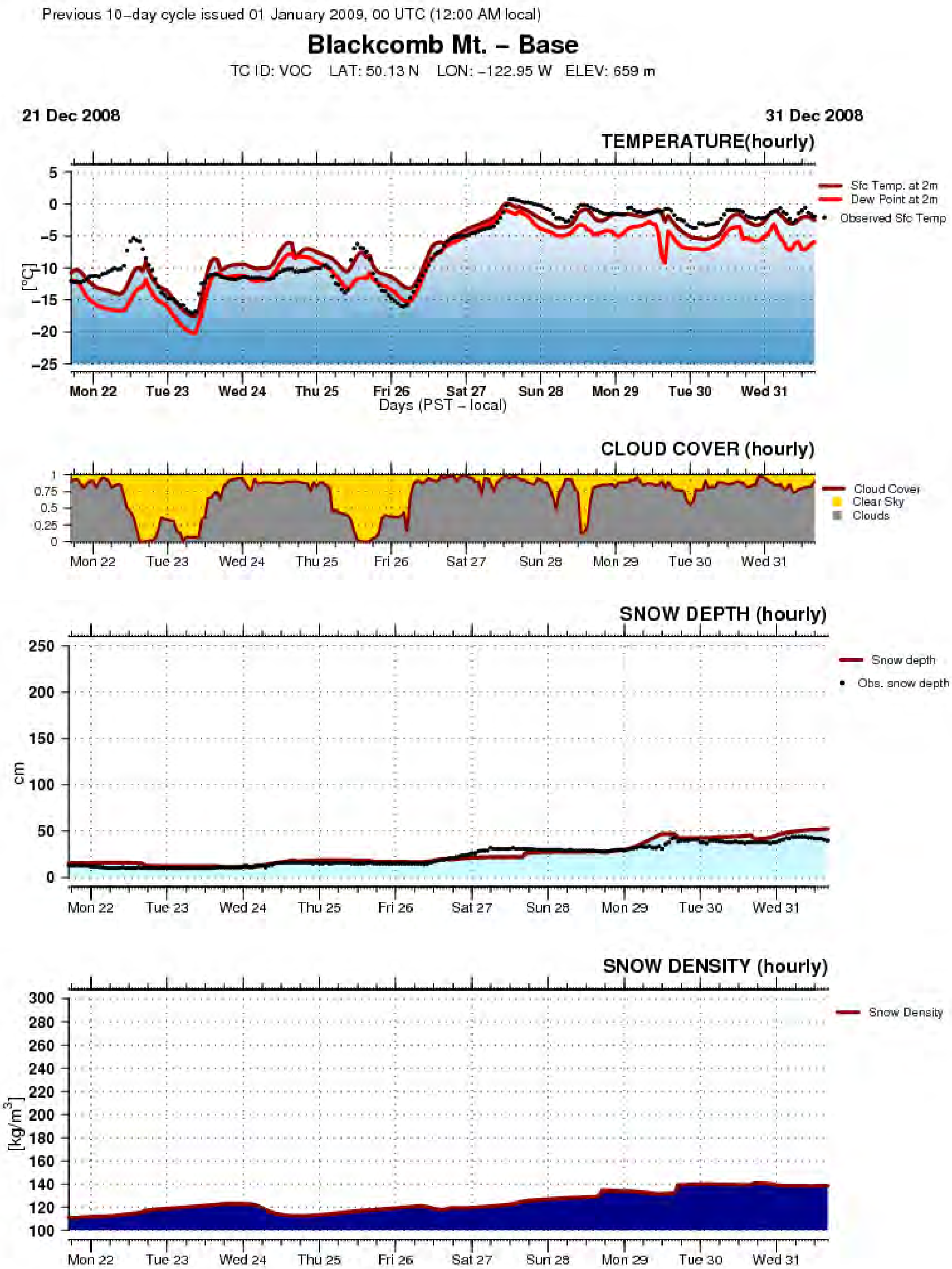


Figure 4 : Meteorograms produced from GEM-SURF (first, third, and fourth panels) and GEM-15 (second panel) outputs for Blackcomb Base (VOC) 1 January, 2009. The top panel is observed (black dots) and forecast temperature (dark red line) and forecast dew point (light red line) in °C. The second panel is cloud cover fraction. The third panel is observed (black dots) and forecast (red line) snow depths in cm. The bottom panel is forecast snow density in kgm-3.

In addition to the Olympics region, other Canadian regions are also the site of complex local settings (e.g., the Appalachians and cities). The near surface and land surface forecast system (GEM-SURF) was therefore developed with a future panCanadian expansion in mind. The Olympics settings are thus a testbed for the panCanadian operational GEM-SURF to follow. Expansion plans include a Canada-wide coverage at 1-km grid spacing. Future development plans also include two-way coupling between GEM-SURF and GEM-15km. In addition to the gridded system, a number of locations of interest (e.g., airports) could be grouped together or per region. There, rapid and frequent updates could be made available when needed using a set-up similar to that of the imbedded point system developed for VO2010 (see Bernier et al. [2010b] for details).

REFERENCES:

Bélair S., L.P. Crevier, J. Mailhot, B. Bilodeau, and Y. Delage. 2003a: *Operational implementation of the ISBA land surface scheme in the Canadian regional weather forecast model. Part I: Warm season results.* J. Hydrometeor., 4, 352-370.

Bélair S., R. Brown, J. Mailhot, B. Bilodeau, and L.P. Crevier. 2003b: *Operational implementation of the ISBA land surface scheme in the Canadian regional weather forecast model. Part II: Cold season results.* J. Hydrometeor., 4, 371-386.

Bélair S., M. Roch, A.M. Leduc, P.A. Vaillancourt, S. Laroche, and J. Mailhot. 2009. *Medium-Range Quantitative Precipitation Forecasts from Canada's New 33-km Deterministic Global Operational System.* Weather and Forecasting, 24(3), 690-708.

Bernier N.B., S. Bélair, B. Bilodeau, and L. Tong. 2010a. *Near Surface and Land Surface Forecasts for the Vancouver Olympic and Paralympic Games Part I: High Resolution (100 m) Regional Forecast System.* J. Hydrometeor. (submitted).

Bernier N.B., S. Bélair, B. Bilodeau, and L. Tong 2010b. *Near Surface and Land Surface Forecasts for the Vancouver Olympic and Paralympic Games Part II: Localized Assimilation and Forecast System.* J. Hydrometeor. (submitted).

Douville H., J.-F. Royer, and J.-F. Mahfouf. 1995. *A new snow parameterization for the Meteo-France climate model. Part 1: validation in stand-alone experiments.* Clima. Dynam. 12, 21-35.

Mailhot J., S. Bélair, L. Lefaivre, B. Bilodeau, M. Desgagné, C. Girard, A. Glazer, A.-M. Leduc, A. Méthot, A. Patoine, A. Plante, A. Rahill, T. Robinson, D. Talbot and A. Tremblay and P. Vaillancourt and A. Zadra and A. Qaddouri. 2006. *The 15-km version of the Canadian regional forecast system.* Atmos-Ocean, 44(2), 133-149.

Mailhot J., S. Bélair, M. Charron, C. Doyle, P. Joe, M. Abrahamowicz, N.B. Bernier, B. Denis, A. Erfani, R. Frenette, A. Giguère, G.A. Isaac, N. McLennan, R. McTaggart-Cowan, J. Milbrandt, and L. Tong. 2010. *Environment Canada's Experimental Numerical Weather Prediction Systems for the Vancouver 2010 Winter Olympic and Paralympic Games.* Bull. Amer. Meteor. Soc. (submitted).

Mölders N., H. Luijting, and K. Sassen. 2008. *Use of atmospheric radiation measurement program data from Barrow, Alaska, for evaluation and development of snow-albedo parameterizations.* Meteor. Atmos. Phys., 99 (3-4), 1999-219.

Noilhan J. and S. Planton. 1989. *A simple parameterization of land surface processes for meteorological models.* Mon. Wea. Rev., 117, 536-549.

Hudson 70 Expedition 40th Anniversary

CCGS Hudson

On November 19, 1969, the Hudson 70 Expedition left Halifax for a 107,416-kilometre voyage that combined scientific discovery with adventure on the high seas. It was a journey of a lifetime that has never been repeated — a 330-day circumnavigation of North and South America, beginning and ending in Halifax. A series of international scientists, totalling more than 120, boarded the Canadian Survey Ship Hudson (now the Canadian Coast Guard Ship Hudson) during various legs of the voyage. They conducted an array of experiments in chemistry, biology, geology and physics that have helped us better understand the ocean and the challenges it now faces. In November, the Bedford Institute of Oceanography honoured the scientific team and crew in a ceremony that marked the 40th anniversary of the expedition. The Hudson was a state-of-the-art research vessel seeking out a new frontier. The group had the backing of the Canadian government, commitment from a crew and scientists who loved the ocean and had new equipment and new ideas. The Hudson 70 Expedition has been seen to many at the time as the greatest single effort that Canada had ever made in oceanography. [Based on articles published in the Nova Scotian Chronicle Herald, November 15, 2009, written by Harry Bruce and November 18, 2009, written by Patricia Brooks Arenburg]. A 5:49-minute video of the expedition is available on You Tube at:
http://www.youtube.com/watch?v=npWZ5DrQY-c

Announcement and Call for Papers

CMOS/CGU Joint Congress

The joint CMOS/CGU Congress will be held on May 31 to June 4, 2010 in Ottawa, Ontario at the Crowne Plaza. This will be the 44th Annual Congress of the Canadian Meteorological and Oceanographic Society (CMOS) and the 36th Annual Scientific Meeting of the Canadian Geophysical Union (CGU). This will be the third occasion for a joint Congress between the two societies. The Congress theme for this year will be *"Our Earth, Our Air, Our Water: Our Future*". See

http://cmos.ca/congress2010/indexe.html

The Congress will feature :

● Plenary presentations by leading researchers;

● Science sessions that highlight top Canadian and international research contributions spanning the meteorological, oceanographic, geophysical, climatic and hydrologic sciences, as well as the policy implications of research in these fields;

● An evening lecture of general-interest, open to the public;

● A banquet, a hosted lunch, awards of CMOS and CGU prizes, and the Annual General Meetings of both societies.

Please submit abstracts electronically to the link found on the Congress website

http://cmos.ca/congress2010/abstractse.html)

after January 7, 2010 and before the deadline of February 17, 2010. You will be asked to submit your abstract to one of several planned sessions that are listed on the website and to specify your preference for either an oral or a poster presentation. An abstract fee of $50 will be charged at the time of submission. Your abstract will be evaluated by the Scientific Program Committee and you will be notified of acceptance by **2 March 2010**. Details for your oral or poster presentation will be provided by **17 March 2010**.

CMOS and CGU student members are welcomed and encouraged to apply for a Student Travel Bursary when submitting an abstract; the application form may be found at

http://cmos.ca/congress2010/studentse.html

The deadline for submission is **February 26, 2010**.

If you are an exhibitor, an educator, a member of the media, or anyone else with an interest in the meeting, please visit the Congress website

http://www.cmos.ca/congress2010

and contact the Chair of the Local Arrangements Committee for further information.

• *Dick Stoddart* (dick.stoddart@sympatico.ca)
• *Rod Blais* (blais@ucalgary.ca)

Co-Chairs of the Scientific Program Committee for the Ottawa 2010 Congress.

Annonce et appel à des soumissions de résumés

Congrès conjoint SCMO/UGC

Le Congrès conjoint SCMO/UGC aura lieu du 31mai au 4 juin 2010 à Ottawa, en Ontario, au Crowne Plaza. Il s'agira du 44e Congrès annuel de la Société canadienne de météorologie et d'océanographie (SCMO) et de la 36e Rencontre scientifique annuelle de l'Union géophysique canadienne (UGC). Il s'agira de la troisième participation de ces deux sociétés à un congrès conjoint. Cette année, le thème du congrès sera : *"La Terre, l'air et l'eau : Notre avenir*". Visitez

http://cmos.ca/Congress2010/indexf.html

Le congrès comprendra :

● Des conférences plénières réalisées par des scientifiques à la fine pointe de la recherche;

● Des sessions scientifiques accentuant les contributions ultimes de la recherche canadienne et internationale dans les domaines du climat, de la météorologie, de l'océanographie, de la géophysique et de l'hydrologie, ainsi que les implications politiques de la recherche avancée dans ces domaines.;

● Une présentation d'intérêt général dans la soirée ouverte au public;

● Un banquet, un déjeuner inclus, la remise des prix de la SCMO et de la UGC, et l'assemblée générale annuelle des deux sociétés.

Veuillez soumettre vos résumés électroniquement en utilisant le lien sur le site du congrès http://www.cmos.ca/Congress2010

entre le **7 janvier et le 17 février 2010**. Vous devrez soumettre votre résumé sous une des nombreuses sessions affichées sur le site et spécifier votre préférence quant à une présentation orale ou une présentation affichée. Un frais de $50 sera retenu au moment de la soumission. Votre soumission sera évaluée par le comité du programme scientifique du congrès qui vous avisera de son acceptation le **2 mars 2010**. Les détails pour votre présentation orale ou affichée vous seront communiqués le **17 mars 2010**.

Les membres étudiants de la SCMO sont les bienvenus et ils sont encouragés à soumettre une demande de bourse étudiante d'aide au voyage lors de la soumission de leur résumé; le formulaire d'application se trouve à :

http://cmos.ca/congress2010/studentsf.html

La date butoir pour les soumissions est le **26 février 2010.**

Si vous êtes un exposant, un éducateur, un membre des médias, ou quelqu'un avec un intérêt particulier pour le congrès, veuillez visiter le site Web du congrès

http://cmos.ca/Congress2010/indexf.html

ou contactez le président du Comité des arrangements locaux pour obtenir plus d'information.

- *Dick Stoddart* (dick.stoddart@sympatico.ca)
- *Rod Blais* (blais@ucalgary.ca)

Coprésidents du Comité du programme scientifique pour le Congrès de 2010 à Ottawa.

Congress 2010 Update

Ottawa May 31 – June 4

Our Earth, Our Air, Our Water: Our Future

Planning for the 2010 Joint CMOS-CGU Congress is in full swing. The Congress website is up and running with new information being posted regularly – you can reach it from the CMOS website at http://cmos.ca. You should note that the Congress begins on Monday evening with the icebreaker. Science sessions run from Tuesday through Friday.

The Local Arrangements Committee has been meeting monthly to deal with the myriad issues, big and small, involved in organizing such a large conference. This is the third joint conference with the Canadian Geophysical Union (the last was in 2007 in St. John`s) and we are anticipating about a thousand attendees. We have reserved every meeting space possible in the Crowne Plaza and have even taken inspiration from the Kelowna Congress to arrange a tent on an outdoor terrace for the poster sessions.

The Scientific Program Committee under Dick Stoddart's leadership, along with CGU Co-Chair Rod Blais, has completed its preliminary work for the Congress. Eight high-profile plenary speakers have been confirmed and are guaranteed to start each day on an inspiring note. The Call for Session Proposals resulted in some 65 sessions being proposed on a broad range of meteorological, oceanographic and geophysical topics. The Call for Abstracts is now out and appears elsewhere in this issue of the Bulletin. We expect to be able to accommodate about 700 oral presentations in 8-10 parallel sessions and another 150 posters in two dedicated sessions.

Registration will open in January via the website. Sign up early and get your hotel reservations!

John Falkingham
Local Arrangements Committee Chair

Mise à jour sur le congrès 2010

Ottawa, du 31 mai au 4 juin

La terre, l'air, l'eau: Notre avenir

La planification pour le Congrès conjoint SCMO/UGC de 2010 bat son plein. De façon régulière, le site Web du Congrès affiche des informations nouvelles. On peut le visiter à partir du site Web de la SCMO : http://scmo.ca. Il est à noter que le Congrès débute le lundi soir par un cocktail de bienvenue. Les sessions scientifiques auront lieu du mardi au vendredi inclusivement.

Le Comité local d'organisation se rencontre mensuellement afin de régler une quantité innombrable de dossiers, plus ou moins importants, qui sont soulevés pour une organisation de cette ampleur. C'est la troisième conférence conjointe avec l'Union géophysique canadienne (la dernière a eu lieu à St-Jean, Terre-Neuve, en 2007) et on prévoit recevoir environ mille participants. On a réservé toutes les salles disponibles à l'hôtel Crowne Plaza et on s'est inspiré du Congrès de Kelowna pour tenir les sessions d'affichage sur une terrasse extérieure sous abri.

Les co-présidents du Comité du programme scientifique, Dick Stoddart de la SCMO et Rod Blais de l'UGC, ont complété le travail préliminaire pour le Congrès. Huit conférenciers prestigieux pour les sessions plénières ont été confirmés et ont accepté de choisir, à chaque jour, un thème de nature à soulever l'enthousiasme. La demande de propositions de sessions va nécessiter quelques 65 sessions sur des sujets d'envergure en météorologie, en océanographie et en géophysique. La demande des communications a déjà été publiée dans le Bulletin. On pense accommoder environ 700 présentations orales au rythme de 8 à 10 sessions en parallèle et 150 présentations d'affichage sur deux sessions.

L'inscription débutera en janvier à partir du site Web. Inscrivez-vous tôt et obtenez votre réservation d'hôtel.

John Falkingham
Président du Comité local d'organisation

Call for Nominations for CMOS Prizes and Awards

Background:

The Prizes and Awards Committee is anxious to receive nominations for CMOS awards and offers the following background information for potential nominators. The Committee is made up of meteorological and oceanographic researchers and managers from academia, government and non-government agencies.

1) The Committee requires a nominating letter that should include an up-to-date CV and a summary of the candidate's work that is to be considered for an award. Note that the President's Prize and the Roger Daley Postdoctoral Publication Award pertain to a specified scientific paper, book or other major publication.

2) Letters of support are essential and should indicate the extent of influence of the candidate's work.

3) The Committee prefers that nominations and supporting documentation be submitted in electronic format; however, hard-copy material will be accepted if electronic material is not available.

All Society members are encouraged to consider nominating individuals of the meteorological or oceanographic community who have made significant contributions to their fields. The award categories are:

• The President's Prize
• The J.P. Tully Medal in Oceanography
• The Dr. Andrew Thomson Prize in Applied Meteorology
• The François J. Saucier Prize in Applied Oceanography
• Rube Hornstein Medal in Operational Meteorology
• The Tertia MC Hughes Memorial Graduate Student Prize
• Roger Daley Postdoctoral Publication Award
• The Neil J. Campbell Medal for Exceptional Volunteer Service
• Citations

CMOS 2010 Photo Contest

All members with a photographic bent are invited to participate in the 2010 Photo Contest. Please submit your own original image files, either in colour or black and white, from scans or digital capture of a meteorological or oceanographic subject, event, or phenomenon. Details on the photo contest can be found on the CMOS Web Page at http://www.cmos.ca/photocontest.html. The deadline for submissions is **May 15, 2010.** If you have any questions please contact Bob Jones at webmaster@cmos.ca.

Concours photographique 2010 de la SCMO

Tous les membres qui ont une passion pour la photographie sont invités à participer au concours de photographie 2010 de la SCMO. Prière de soumettre vos photos numériques originales, soit en couleur, soit en noir et blanc, à partir de copie papier ou de fichier numérique portant sur des sujets ou phénomènes météorologiques ou océanographiques. Les détails du concours se trouvent sur le site web de la SCMO à http://www.scmo.ca/photocontest.html. La date butoir pour les soumissions est le **15 mai 2010.** Pour toutes questions, prière de contacter Bob Jones à webmaistre@scmo.ca.

Report on AGU Forum

by Ian Rutherford[1]

The American Geophysical Union (AGU) is the largest society for the geophysical sciences in the world. Although based in the USA it has over 50,000 members across the globe, including more Canadian members (over 2000) than CMOS and CGU combined! It covers earth, ocean atmosphere, space and planetary sciences through eleven broad subject area sections and eight somewhat more specialised Focus Groups. It has been very successful in growing its membership and the influence and popularity of its publications and meetings. Both are major sources of revenue, allowing membership fees to be kept at only $20. In 2008 the organisation embarked on a serious strategic planning process. A small strategic planning group laid out a sequence of events and mechanisms that would be needed, starting with "THE NEW AGU: A Forum on the Future AGU", that was held at AGU headquarters in Washington DC on 1-3 October 2009. More than sixty stakeholders were invited to participate. CMOS received an

[1] CMOS Executive Director

invitation as an "external partner" and it fell to me to represent us. The goals of the forum were to:

■ Create a shared understanding across multiple stakeholder groups of the environment in which AGU will be operating;

■ Focus AGU's energy towards those opportunities that will deliver the greatest value to members and the the science in the future;

■ Create a strategic framework for practical action over the next 5-10 years to achieve AGU's vision for the future; and

■ Establish a planning culture that is both transparent and inclusive.

AGU Forum 1-3 October 2009, Washington, D.C.
Photo credit: AGU website

The process of the meeting was that of a "Future Search Conference", a well-known form of large-group consultation. It was smoothly facilitated by two excellent consultants and a visual facilitator who captured the essence of the discussion in "cartoon" format. The participants were divided into about eight "stakeholder" groups representing AGU executives, AGU section heads, AGU focus group heads, AGU staff, academics, students and early career scientists, domestic partners, external partners. Most, but not all, of the participants were AGU members. The meeting started with and often returned to a full round table plenary session, but most of the work was carried out by the small cross-representative groups, each with one representative from each stakeholder group. These mixed groups met separately and then reported back to the plenary where an attempt was made to come up with a consensus view. Occasionally, however, feedback was sought from the stakeholder groups who would meet as such and try to come up with a consensus stakeholder view of certain questions. The broad subjects that were explored proceeded from "Reviewing the Past" to "Focusing on the Present" to "Focusing on the Future" and ending with "Confirming Common Ground" and "Actions needed to achieve the agreed future". Each stage was accomplished by alternating between small group discussions and presentations followed by plenary consideration. One of the small group reports was done in the form of skit or a work of art or a song, which really engaged the participants and produced some remarkable results!

The products of the Forum will be consensus statements of what the Forum considered to be the most important influences on the future of the science and the Union, a vision of the future AGU and a list of actions needed to achieve it. These suggestions and recommendations do not constitute by themselves a strategic plan, but instead will be fed into a further process, starting with the strategic planning committee, to create the plan and have it ratified by the AGU Council sometime next spring. The Forum agreed on a number of broad actions, including the following, paraphrased by this author and probably incomplete, that the AGU should:

■ improve its communications, both internally with its members and externally with the public;
■ be more active in putting forward scientific positions to the public and to governments;

■ be more transparent regarding how it functions;

■ update its business model to take account of developments in the "open access to publications" movement;

■ be more open to and encouraging of inter-disciplinary science;

■ do all of these things while maintaining the excellence of its scientific publications and meetings;

■ be less competitive with sister societies both in the USA and abroad and instead seek partnerships to advance common goals.

Parallel to this strategic planning exercise, the AGU has decided to change its governance structure by setting up a new Board of Directors to look after business matters, leaving the Council free to concentrate on science matters. This change was the subject of a membership vote for which the deadline was 15 October and the result unknown when this was written.

So what might all of this mean for CMOS? Well, first of all CMOS's Strategic Plan was last drawn up and approved by the CMOS Council in 2004. Now, five years later, might be a good time to re-visit it. The process employed by AGU is sophisticated and expensive, but some lessons might be drawn from it, in particular the consultation of stakeholder groups outside the Society itself. Secondly, given the will on the part of AGU to be more cooperative with sister societies, CMOS might consider how it might become a better partner, rather than a competitor with AGU. AGU has a huge oceanographic section with a very successful and equally huge annual scientific meeting. AGU has a rapidly growing Biogeophysics section. Should CMOS resolve its long-standing debate about expanding beyond physical oceanography into biological oceanography? And what about CMOS and CGU that together cover most of the subject areas that AGU does. Should we be thinking about going beyond the loose association that we now have through the CSGS? What about the CMOS business model that features much higher membership fees and non-profit publications? Readers of the CMOS Bulletin SCMO are encouraged to comment on these and other questions through letters to the editor or through discussions at CMOS meetings.

The CMOS Archives

by Emily Bourque

The national CMOS archives in Ottawa received a much-needed cleaning this year. While the archives had once been in good shape, the integrity of the archives had eroded due to time, relocations and a flood. Occupying eleven metres of space, the archives consisted of unconsolidated documents, videocassettes, photographs and floppy disks spread out over four filing cabinets, fifteen boxes and thrirty binders. This collection of items was in need of reorganization.

With the help of Kyle Hipwell (a Carleton University student), the archives were culled, classified and re-filed. By the end of the project in October, the archives were reduced to approximately five metres of total shelf space, and fit into two filing cabinets. Most of the disposed items were unnecessary copies (one original document had nine copies of itself in the archives); original documents were rarely disposed of.

Many documents of interest and importance to CMOS came to light, including the origins of many centres, committees, awards and prizes. Items of special historical significance, such as the split from the Royal Meteorological Society, were consolidated in new, easy-to-use files.

Thanks must be extended to Uri Schwarz and Morley Thomas, who created the current CMOS file system and maintained the CMOS archives, respectively. Without the decades of work of these two gentlemen, the archives would likely not exist at all. If any CMOS members have documents or items that may be of interest to the CMOS archives (including CMOS publications), please contact the CMOS National Office in Ottawa.

Appel de mises en candidature pour les Prix et Honneurs de la SCMO

Préambule:

Le Comité des prix et honneurs de la SCMO attend avec impatience les mises en candidature pour les prix de la SCMO et désire donner l'information pertinente suivante aux personnes faisant des nominations. Le Comité est constitué de chercheurs et gestionnaires en météorologie et océanographie du monde universitaire, du gouvernement et des agences non-gouvernementales.

1) Le Comité demande une lettre de nomination dans laquelle on devrait trouver un curriculum vitae mis-à-jour et un sommaire du travail du candidat qui devrait être considéré pour l'attribution d'un prix. Prière de prendre note que le Prix du Président et le Prix de publication postdoctoral Roger Daley s'adressent spécifiquement à une communication scientifique, un livre ou une publication d'importance.

2) Des lettres supportant la candidature sont essentielles et devraient indiquer l'étendue de l'influence du travail du candidat.

3) Le Comité préfère recevoir les nominations et les documents les supportant sous forme électronique; par contre, des copies papier seront acceptées en l'absence de document électronique.

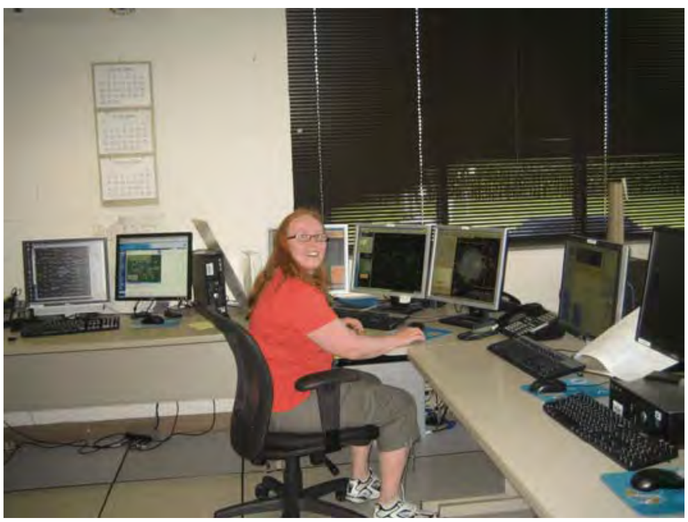
Tous les membres de la société sont encouragés à présenter des nominations de personnes considérées comme ayant contribué de façon significative dans leur sphère d'activités tant en océanographie qu'en météorologie. Les catégories de prix sont:

- Prix du président
- Médaille de J.P. Tully en océanographie
- Prix du Dr. Andrew Thomson en météorologie appliquée
- Le prix François J. Saucier en océanographie appliquée
- Médaille de Rube Hornstein en météorologie opérationnelle
- Les prix commémoratifs Tertia M.C. Hughes
- Le prix Roger Daley pour une publication postdoctorale
- La médaille Neil J. Campbell pour service bénévole exceptionnel
- Citations

Project Atmosphere 2009

reported by Aliisa Sarte[2]

In July 2009 I attended *Project Atmosphere – Weather Workshop for Teachers*, a program in Kansas City, Missouri, run by the American Meteorological Society, and co-sponsored by NOAA and the National Science Foundation. I spent two weeks with sixteen American teachers, at the National Weather Service's (NWS) training centre, attending workshops and listening to speakers. We covered various atmospheric science topics including El Niño, hurricanes, tornadoes, weather systems, and climate, as well as forecasting with satellites, radar and weather maps. Each day included a weather briefing, guest lectures and activities for teachers and students. Every day, I learned something new; the opportunity to listen to and ask questions of scientists and experts was wonderful. We heard from Dr. Louis W. Uccellini (Director of the NWS's National Centers for Environmental Prediction), Dr. Jack Hayes (Director of NWS), Dr. Joe Schaefer (Director of the NOAA Storm Prediction Center), Eric Blake (Hurricane Specialist from the National Hurricane Center) and many others.



Project Atmosphere 2009 participant Aliisa Sarte sitting at the Advanced Weather Interactive Processing System (AWIPS) display; photo taken at the Topeka, Kansas National Weather Service (NWS) office.

One of the highlights of our time was a field trip to the NWS office in Topeka, Kansas where we met meteorologists and heard about their education, training and job responsibilities; we also watched a balloon launch. Not only was this interesting and educational for me, but it also gave me knowledge to share with my students concerning atmosphere-related careers and opportunities. As a high school science teacher in British Columbia (at Port Moody Secondary School), I can teach my students about the atmosphere in both Science 10 (a required course for all students) and Earth Science 11 (an elective course) and it is important that I can talk to them about their options for their futures.

Apart from learning about atmospheric sciences, I also met and talked with my American counterparts. It is always interesting to hear about different education systems and to make comparisons. Our science curriculum is drastically different from that of most of the States, as British Columbia students take general science courses until grade 11 (each year has some biology, chemistry, earth and space sciences and physics) whereas in the US each grade covers a different topic (for example, biology in grade 8, Earth Science in grade 9). I also realized how much more atmospheric science I get to teach compared to many teachers in the US. Now I'm wondering about the rest of Canada; as Canadian curricula are provincial, I don't know a lot about what goes on in other provinces. We talked about curriculum, assessment, responsibilities and overall school systems and I think we all learned a lot from each other. Aside from education, I went to a Kansas City Royals baseball game, wandered around much of downtown Kansas City, ate wonderful and saucy barbeque, took a long drive through parts of Missouri and Kansas, and made friends with a wonderful group of teachers.

Thank you for sponsoring me as the Canadian participant in this year's Project Atmosphere Workshop. I am looking forward to sharing my knowledge with my peers and my students this year and throughout my career.

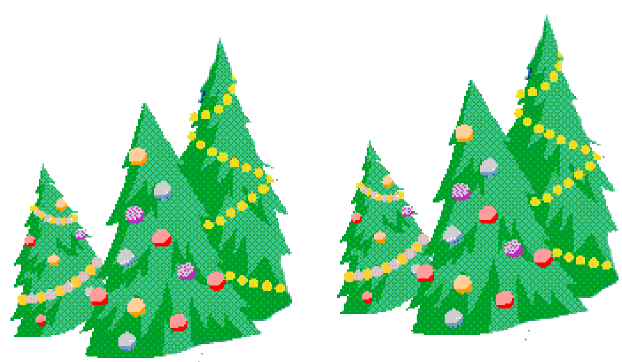
[2] Aliisa Sarte is a teacher at Port Moody Secondary School in BC.

Best Wishes for the New Year

The *CMOS Bulletin SCMO* Editorial Board wishes everyone a happy season holiday and all the best for the New Year!

Meilleurs souhaits pour le nouvel an

L'équipe éditoriale du *CMOS Bulletin SCMO* souhaite à tous de joyeuses vacances pour la saison des fêtes et bonne et heureuse année!



A-O Abstracts Preview

Avant Première des résumés de A-O

The following abstracts will soon be published in your next (47-4) ATMOSPHERE-OCEAN publication

Les résumés qui suivent paraîtront sous peu dans votre prochaine revue (47-4) ATMOSPHERE-OCEAN

A tribute to Chris Garrett

un hommage à Chris Garrett

On Tidal Resonance in the Global Ocean and the Back-Effect of Coastal Tides upon Open-Ocean Tides

by Brian K. Arbic, Richard H. Karsten and Chris Garrett

Abstract

The resonance of semi-diurnal tidal elevations is investigated with a forward numerical forced-damped global tide model and an analytical model of forced-damped tides in a deep ocean basin coupled to a shelf. The analytical model contains the classical half-wavelength and quarter-wavelength resonances in the deep ocean and shelf, respectively, as well as a forcing-scale dependence which depends on the ratio of the phase speed of open-ocean gravity waves to that of the astronomical forcing. In the analytical model, when the deep ocean and shelf resonate separately at the same frequency, the resonance in the coupled system shifts to frequencies slightly higher and lower than the original frequency, such that a double bump is seen in plots of elevation amplitude versus frequency. The addition of a shelf to a resonant open-ocean tends to reduce open-ocean tides, especially when the shelf is also near resonance. The magnitude of this ‘back-effect’ is controlled by shelf friction. A weakly damped resonant shelf has a larger back-effect on the open-ocean tide than does a strongly damped shelf. Numerical simulations largely bear out the analytical model predictions, at least qualitatively. Idealized simulations show that continents enhance tides by enabling the half-wavelength resonance. Simulations with realistic geometry and topography but varying longitudinal structure in the astronomical forcing display an influence of the forcing scale on tidal amplitudes somewhat similar to that seen in the analytical model. A frequency sweep in the semi-diurnal band in experiments with realistic geometry and topography reveals weakly resonant peaks in the amplitudes of several shelf regions and in the globally averaged open-ocean amplitudes. Finally, the back-effect of the shelf upon the open ocean is seen in simulations in which locations of resonant coastal tides are blocked out and open-ocean tidal elevations are significantly altered (increased, generally) as a result.

Résumé

Nous étudions la résonance des élévations des marées semi-diurnes à l’aide d’un modèle numérique direct des marées mondiales forcées-amorties et d’un modèle analytique de marées forcées-amorties dans un bassin océanique profond couplé à une plate-forme continentale. Le modèle analytique contient les résonances classiques de demi-longueur d’onde et de quart de longueur d’onde dans l’océan profond et sur la plate-forme continentale, respectivement, de même qu’une dépendance de l’échelle de forçage liée au rapport entre la vitesse de phase des ondes de gravité en haute mer et le forçage astronomique. Dans le modèle analytique, quand l’océan profond et la plate-forme résonnent séparément à la même fréquence, la résonance dans le système couplé se déplace vers des fréquences légèrement plus élevée et plus basse que la fréquence originale, de sorte qu’on observe une double bosse dans les tracés de l’amplitude de l’élévation en fonction de la fréquence. L’addition d’une plate-forme à une haute mer résonnante a tendance à réduire les marées en haute mer, en particulier quand la plate-forme aussi est proche de la résonance. L’ampleur de ce «rétro-effet» dépend du frottement contre la plate-forme. Une plate-forme résonnante avec faible friction produit un rétro-effet plus fort sur la marée en haute mer qu’une résonance de plate-forme avec forte friction. Les simulations numériques confirment dans une large mesure les prévisions du modèle analytique, du moins qualitativement. Des simulations idéalisées montrent que les continents accentuent les marées en permettant la résonance de demi-longueur d’onde. Des simulations avec une géométrie et une topographie réalistes mais avec une structure longitudinale variable dans le forçage astronomique montrent une influence de l’échelle du forçage sur l’amplitude des marées à peu près comparable à celle que l’on voit dans le modèle analytique. Un balayage de fréquence dans la bande semi-diurne dans les expériences avec une géométrie et une topographie réalistes révèle des pics faiblement résonnants dans les amplitudes de plusieurs régions de la plate-forme et dans la moyenne d’ensemble des amplitudes en haute mer. Finalement, le rétro-effet de la plate-forme sur la haute mer se voit dans les simulations dans lesquelles les endroits où se produisent les marées côtières résonnantes sont bloqués, ce qui a pour résultat de modifier (en général, d’augmenter) de façon importante l’élévation des marées en

haute mer.

Internal Wave Observations in the South China Sea: The Role of Rotation and Non-linearity

by DAVID FARMER, QIANG LI and JAE-HUN PARK

Abstract
Observations of internal waves travelling across the deep basin of the South China Sea provide an opportunity for exploring the effects of rotation and non-linearity on their evolution. Time series measurements using inverted echo-sounders at three locations illustrate the progressive steepening of the internal tide generated in Luzon Strait and the subsequent development of short non-linear internal wave trains. Potential mechanisms for internal tide generation are discussed in terms of tidal beam interaction with near-surface stratification and mode 1 response to flow over a ridge. For transformation of an internal tide under the influence of non-linearity and rotation, we apply Boyd's (2005) criterion for wave stability in a rotating flow to separate waves dominated by non-linearity, which can be expected to steepen and break, from waves that are inhibited from breaking due to rotational dispersion of energy into internal inertial gravity waves. Wave breaking in this context refers to the point at which the wave becomes steep enough for non-hydrostatic effects to come into play, with the subsequent generation of a short period non-linear internal wave train. For a monotonic M_2 internal tide generated over the eastern ridge, breaking is predicted close to the location at which remotely sensed images first indicate the presence of short non-linear internal waves; steepening of a K_1 internal tide, on the other hand, is predicted to be dispersed before steepening by rotational effects. Time series observations acquired just west of the eastern ridge provide initial conditions for applying the stability criterion to mixed internal tides over a spring-neap cycle and for comparison with time series measurements at two additional sites further west. When the stability criterion is applied to wave slopes, initial conditions predicted to be unstable generally result in the formation of high frequency non-linear internal wave trains. In the case of initial conditions for which rapid steepening is not predicted we see evidence of the interaction between rotation and non-linearity, specifically the formation of 'corner waves' with the characteristic parabolic shapes first predicted by Ostrovsky (1978).

Résumé
L'observation des ondes internes parcourant le bassin profond de la mer de Chine méridionale fournit une possibilité d'étudier les effets de la rotation et de la non-linéarité sur leur évolution. Des séries chronologiques de mesures faites à l'aide d'échosondeurs inversés à trois endroits montrent l'accentuation progressive de la marée interne générée dans le détroit de Luzon et la formation subséquente de courts trains d'ondes internes non linéaires Nous discutons des mécanismes possibles de génération de marée interne en fonction de l'interaction du faisceau de marée avec la stratification superficielle et la réponse du premier mode à l'écoulement au-dessus d'une crête. Pour la transformation d'une marée interne sous l'effet de la non-linéarité et de la rotation, nous appliquons le critère de Boyd (2005) sur la stabilité des vagues dans un écoulement rotatif pour séparer les vagues dominées par la non-linéarité, qui devraient éventuellement devenir plus abruptes et déferler, des vagues qui sont empêchées de déferler à cause de la dispersion rotationnelle de l'énergie en vagues de gravité inertielle internes. Le déferlement dans ce contexte désigne le point auquel la vague devient suffisamment abrupte pour que des effets non hydrostatiques entrent en jeu et entraînent la génération subséquente d'un train d'ondes internes non linéaire de courte période. Pour une marée interne M_2 monotone générée au-dessus de la crête est, le déferlement est prévu près de l'endroit où des images de télédétection indiquent initialement la présence de courtes vagues internes non linéaires; il est prévu, d'autre part, que l'accentuation d'une marée interne K_1 se dispersera avant l'accentuation par les effets rotationnels. Des séries chronologiques d'observations acquises juste à l'ouest de la crête est fournissent les conditions initiales pour l'application du critère de stabilité à des marées internes mixtes sur un cycle vive-eau/morte-eau et pour la comparaison avec des séries chronologiques de mesures faites à deux autres endroits plus à l'ouest. Quand le critère de stabilité est appliqué aux pentes des vagues, les conditions initiales qui ont été prévues instables aboutissent généralement à la formation de trains d'ondes internes non linéaires de fréquence élevée. Dans le cas de conditions initiales pour lesquelles on ne prévoit pas d'accentuation rapide de la pente, on voit des signes de l'interaction entre la rotation et la non-linéarité, plus précisément la formation d'«ondes en coin» avec les formes paraboliques caractéristiques initialement prédites par Ostrovsky (1978).

The Oceanic Variability Spectrum and Transport Trends

by CARL WUNSCH

Abstract
Oceanic meridional transports evaluated over the width of the Pacific Ocean from altimetric observations become incoherent surprisingly rapidly with meridional separation. Even with 15 years of data, surface slopes show no significant coherence beyond 5° of latitude separation at any frequency. An analysis of the frequency/zonal-wavenumber spectral density shows a broad continuum of motions at all time and space scales, with significant excess energy along a 'non-dispersive' line extending from the barotropic to the first baroclinic mode Rossby waves. It is speculated that much of that excess energy lies with coupled barotropic and first mode Rossby waves. The

statistical significance of apparent oceanic transport trends depends upon the existence of a reliable frequency/wavenumber spectrum and for which only a few observational elements currently exist.

Résumé
Les transports océaniques méridiens évalués sur la largeur de l'océan Pacifique à partir d'observations altimétriques deviennent incohérents de façon étonnamment rapide avec la séparation méridienne. Même avec 15 ans de données, les pentes de la surface n'affichent pas de cohérence significative au-delà de 5° de séparation latitudinale, quelle que soit la fréquence considérée. Une analyse de la densité spectrale de fréquence/de nombre d'ondes zonal montre un assez large continuum des mouvements à toutes les échelles temporelles et spatiales, avec une quantité appréciable d'énergie en excès le long d'une ligne «non dispersive» s'étendant du mode barotrope jusqu'au premier mode barocline des ondes de Rossby. Nous posons l'hypothèse qu'une grande partie de cet excédent d'énergie se trouve dans les ondes de Rossby barotrope et du premier mode couplées. La signification statistique des tendances apparentes du transport océanique dépend de l'existence d'un spectre de fréquence/de nombre d'ondes fiable et pour lequel seuls quelques éléments d'observation existent actuellement.

Estimate of the Steric Contribution to Global Sea Level Rise from a Comparison of the WOCE One-Time Survey with 2006-2008 Argo Observations

by Howard J. Freeland and Denis Gilbert

Abstract
It is well known from observations by altimetric satellites (predominantly TOPEX/Poseidon and Jason-1) that global sea level is rising. What is less well known is exactly how the observed sea level rise is partitioned between a steric contribution (sea level rising because of changes in ambient temperature and salinity) and a contribution arising from the addition of new water mass to the oceans. Strictly speaking, such a separation is not possible because of the non-linearity in the equation of state for sea water, but in practice the non-linearities are sufficiently small to allow this separation as a very good first approximation.

A careful comparison of the World Ocean Circulation Experiment (WOCE) one-time survey with recent observations by the Argo array indicate a steric component to sea level rise of 2.2 mm y^{-1} between the early 1990s and 2006 to 2008. This is a significantly larger rise rate than previously estimated and, along with recent estimates of melt rate from ice sheets, is in much closer agreement with the total rise rate as reported by altimetric satellites, 3.2 ± 0.4 mm y^{-1}, over this period.

Résumé
Les satellites altimétriques (en particulier le TOPEX/Poseidon et le Jason-1) montrent sans équivoque que le niveau des mers du globe s'élève. Il est plus difficile, toutefois, de savoir dans quelle mesure cette hausse est attribuable à un effet stérique (élévation du niveau de la mer résultant de changements dans la température et la salinité ambiantes) et dans quelle mesure elle est attribuable à l'addition d'une nouvelle masse d'eau aux océans. À proprement parler, il n'est pas possible de faire une telle distinction à cause de la non-linéarité dans l'équation d'état de l'eau de mer, mais sur le plan pratique, les non-linéarités sont suffisamment petites pour que cette distinction constitue une très bonne première approximation.

Une comparaison minutieuse du relevé à occupation simple de l'Expérience sur la circulation océanique mondiale (ECOM) avec des observations récentes du réseau Argo indique une composante stérique d'élévation du niveau de la mer de 2,2 mm a^{-1} entre le début des années 1990 et 2006 à 2008. C'est là un taux d'élévation nettement plus important que ce qui avait été estimé auparavant et, compte tenu des estimations récentes du taux de fonte des glaciers continentaux, il s'accorde beaucoup mieux avec le taux d'élévation total observé par les satellites altimétriques, qui est de 3,2 ± 0,4 mm a^{-1} au cours de cette période.

Chlorophyll Patches Observed during Summer in the Main Stream of the Kuroshio

by H. Yamazaki, I. Iwamatsu, D. Hasegawa and T. Nagai

Abstract
Two transects through the Oyashio-Kuroshio frontal region were made off the coast of Japan using a towed CTD-fluorometer (Aquashuttle). These show numerous patches of elevated chlorophyll concentration adjacent to the Kuroshio front. In particular, a few patches are found in the main stream of the Kuroshio. Using the temperature and salinity (TS) properties of the identified patches, the origin of the patches is inferred. It is confirmed that the patches appearing in the Kuroshio are not from the adjacent coastal waters. Their TS properties are similar to those in the upstream portion of the Kuroshio. These facts suggest that the elevated levels of chlorophyll in the patches arise because of mixing that occurs while the Kuroshio passes over the Izu Ridge. The patches found in the main stream of the Kuroshio are transported to the Kuroshio extension, which is the nursery ground for many pelagic larval fish. These patches, if they appear during the spawning season, may provide food for these larval fish. Thus mixing due to bottom topography and islands of the Izu Ridge may play an important role for the survival of larval fish downstream, in the region of the Kuroshio extension.

Résumé
Deux transects à travers la région frontale d'Oyashio-Kuroshio ont été tracés au large de la côte japonaise à l'aide d'un CTP-fluorimètre (Aquashuttle) remorqué. Ils montrent de nombreux bancs aux concentrations élevées de chlorophylle adjacents au front du Kuroshio. En particulier, quelques bancs ont été trouvés dans le courant principal du Kuroshio. En se servant des propriétés de température et de salinité (TS) des bancs identifiés, on déduit l'origine des bancs. Il est confirmé que les bancs apparaissant dans le Kuroshio ne proviennent pas des eaux côtières adjacentes. Leurs propriétés de TS sont semblables à celles que l'on observe dans la partie amont du Kuroshio. Ces faits suggèrent que le niveau élevé de chlorophylle dans le banc est attribuable au mélange qui se produit au moment où le Kuroshio passe au-dessus de la crête d'Izu. Les bancs trouvés dans le courant principal du Kuroshio sont transportés dans l'extension du Kuroshio, qui est l'aire d'alevinage de plusieurs larves de poissons pélagiques. Si ces bancs apparaissent durant la période du frai, ils peuvent fournir de la nourriture à ces larves de poissons. Donc, le mélange causé par la topographie du fond marin et par les îles de la crête d'Izu peut jouer un rôle important pour la survie des larves de poissons en aval, dans la région de l'extension du Kuroshio.

Gas Ventilation of the Saguenay Fjord by an Energetic Tidal Front

by Burkard Baschek and William J. Jenkins

Abstract
Dissolved noble gas samples were taken during a pilot study in the Saguenay Fjord, Quebec, Canada, in order to determine the contribution of different air-sea gas exchange mechanisms in an estuary and to assess the contribution of tidal fronts to the aeration of subsurface waters. The noble gases He, Ne, Ar, Kr, and Xe span a large range of molecular diffusivities and solubilities and hence constitute a useful probe of various gas exchange and bubble injection processes. Samples were taken at flood tide upstream and downstream of an energetic tidal front that is generated by a hydraulically controlled flow over a shallow sill at the entrance to the Fjord. The results are interpreted with the help of hydrographic measurements of density and currents along cross-sill transects describing the physical forcing at the sill. High gas saturations downstream of the sill indicate the aeration of water within the frontal region. An inverse model is used to compare the contribution of bubble injection in the front to diffusion across the air-sea interface. The large ratio of completely 'trapped' bubbles to diffusion suggests that bubbles injected by waves breaking in the front contribute significantly to air-sea gas exchange with 76% for He, 79% for Ne, 56% for Ar, 47% for Kr, and 35% for Xe.

Water samples were analyzed for helium isotopes and tritium in order to explore the possibility of constraining ventilation time scales. The relationship between tritium and salinity revealed two end-member waters: a freshwater component from the Saguenay River of 23.6 ± 0.5 TU, likely a residual of bomb-produced tritium, and a seawater end-member of approximately 1.5 TU originating in the subpolar Atlantic. An unexpected contribution of radiogenic ^4He was detected in the deep waters of the St. Lawrence Estuary, likely a consequence of outgassing from old uranium and thorium rich granitic terrain.

Résumé
Des échantillons de gaz rares dissouts ont été prélevés au cours d'une étude pilote dans le fjord du Saguenay, au Québec (Canada), dans le but de déterminer la contribution de différents mécanismes d'échange de gaz air-mer dans un estuaire et pour évaluer la contribution des fronts de marée à l'aération des eaux de subsurface. Les gaz rares He, Ne, Ar, Kr et Xe affichent un large intervalle de diffusivité et de solubilité moléculaires et constituent donc une sonde utile pour divers processus d'échange de gaz et d'injection de bulles. Les échantillons ont été pris à la marée montante en amont et en aval d'un front de marée énergétique produit par un débit hydrauliquement régulé au-dessus d'un seuil de faible profondeur à l'entrée du Fjord. Les résultats sont interprétés à l'aide de mesures hydrographiques de densité et de courants le long de transects en travers du seuil décrivant le forçage physique au seuil. Des saturations élevées de gaz en aval du seuil indiquent l'aération de l'eau à l'intérieur de la région frontale. Nous utilisons un modèle inverse pour comparer la contribution de l'injection de bulles dans le front à la diffusion à travers l'interface air-mer. Le fort rapport des bulles complètement «piégées» à la diffusion suggère que les bulles injectées par les vagues qui déferlent dans le front contribuent grandement aux échanges de gaz air-mer, avec 76 % pour He, 79 % pour Ne, 56 % pour Ar, 47 % pour Kr et 35 % pour Xe.

Les échantillons d'eau ont été analysés pour y déceler des isotopes d'hélium et du tritium afin d'explorer la possibilité de contraindre les échelles de temps de ventilation. La relation entre le tritium et la salinité a révélé l'existence de 2 «pôles» d'eau : une composante d'eau douce du Saguenay de 23,6 ± 0,5 u.t., probablement un résidu de tritium produit par explosions nucléaires, et une composante d'eau de mer d'environ 1,5 u.t. provenant de l'Atlantique subpolaire. Une contribution inattendue de ^4He radiogénique a été détectée dans les eaux profondes de l'estuaire du Saint-Laurent, probablement une conséquence du dégazage du vieux terrain granitique riche en uranium et en thorium.

John Maybank

1930-2009

It is with sadness that we report the death of Dr. John Maybank, a *Fellow*, *life member*, former *President* (1980-81), and one of the original founding members of the Canadian Meteorological Society (before it became CMOS), who passed away suddenly at his home in Brockville, Ontario on October 28th.

He is remembered by many members for his vociferous support of the ideals of the Society, and as one who was a stickler on the finer points of the constitution and by-laws, not too surprisingly since he helped write the original ones.

Contributions to the Society

John was a long-term member of the forerunner of CMOS, the Canadian Branch of the Royal Meteorological Society (RMS), and was a member of its Executive as the minutes of the first meeting of the Meteorology Subcommittee (held at the Université de Montréal on 06 June 1961) show. John was still a member of that subcommittee at its 8th meeting in Ottawa on 29 October 1964, when consideration was first given "*to form its own society*". This eventually came to a vote by all members of the Canadian Branch of the RMS, and the minutes of the 12th meeting of the Meteorology Subcommittee (27 October 1966), for which John Maybank was now Secretary, indicated that the Canadian Meteorological Society would come into being on 01 January 1967, with funds from the RMS being transferred at that time. An interesting sidenote is that the CMOS Science Committee (carried forward from the former Meteorology Subcommittee of the RMS) actually existed prior to the Society itself, and formed the nucleus of CMOS. At that same 12th meeting, John moved that the Subcommittee ask the (future) CMS executive to study the potential for a Canadian journal in meteorology. This ultimately resulted in *Atmosphere*, the official journal of CMS, and now known as ATMOSPHERE-OCEAN of course. The 13th meeting (23 February 1967) confirmed the formation of CMS, with initial membership of 300. Interestingly, the minutes note that 250 of these were from the Meteorological Branch (now the Meteorological Service of Canada).

John demonstrated great foresight for the broader science perspectives. For example, during the early-1970s, he recognized the need for a second society to cover all of the geophysical sciences in Canada, and thus helped found the Canadian Geophysical Union (CGU). Later, even prior to the incorporation of *oceanography* into the Society in 1980, he made a number of attempts to have Canadian hydrologists included in a special way within the Society, resulting in a compromise *hydrometeorology* special interest group (SIG). Thus, John also helped organize a Canadian hydrologists' research group, although they eventually made their primary home in CGU-Hydrology. Even later during the 1990s, John made a part-tongue-in-cheek, part-serious suggestion at an AGM that the society be renamed the *Canadian Hydrology Atmosphere and Oceanography Society*, and coined the fitting acronym CHAOS to replace CMOS. It was only in 2007 that CMOS and CGU finally formed a collaborative committee called the Canadian Societies for Geophysical Societies (CSGS), and now hold joint congresses every 2 to 3 years, the latest of which will occur in Ottawa in 2010. He had foreseen the benefits of such collaborative work between meteorologists, hydrologists, and oceanographers much earlier in the 1970s.


Dr. John Maybank

John volunteered his talents and service to CMS/CMOS in many capacities apart from his terms as *Vice-President* and *President*. He was also instrumental in the initiation of the *CMOS Accredited Consultant* program in 1986, and later became one of the five initial recipients of that status. He was book review editor for the *CMOS Bulletin SCMO* for several years during the 1990s. He was a regular attendee at most annual Congresses well past retirement, and was well-known for his many fruitful discussions and debates at AGMs, Council meetings, etc. One moment he would call members to task about a by-law, then perfectly relax everyone with a funny story or joke the next, reassuring everyone that no ill intent was ever intended. He brought a liveliness and fun to CMOS meetings.

Contributions to Science and Education

John commenced his career as a scientific officer for the DND at the Suffield Experimental Station in Alberta in 1954-56. He took hiatus to complete his Ph.D. in 1959 under the famous cloud physicist B.J. Mason, at the prestigious University of London, his thesis title being "*Mechanisms of Ice Crystal Production in the Atmosphere*". He was awarded the Diploma of the Imperial College (DIC) in meteorology at this time, and was co-author with Mason on three journal articles (1958-60). He returned to his Suffield position in 1959, then joined the Saskatchewan Research Council (SRC) in 1961 where he carried out research on aerosols, specifically work on the formation, downwind movement, and evaporation of small droplets in the atmosphere. During 1970-71, John took a 12-month leave of absence from SRC to work with the World Meteorological Organization at the Caribbean Meteorological Institute in Barbados, helping to upgrade meteorological services in the region. Later studies at SRC

included the development of agriculturally-oriented weather forecasts during the crop season, and what became his primary area of expertise, agricultural spray-drift of pesticide vapour and droplets, conducted jointly with the Agriculture Canada research station in Regina. During the 1980s, John also carried out early work on the potential impacts of climate change on prairie agriculture. On global warming, he once quoted directly from his favorite cartoon character, *Pogo*, that "*we has found the enemy, and he is us*".
John wrote approximately 100 papers in areas of cloud physics, ice nucleation, weather modification, agriculture, pesticide spray drift, grain dust, air pollution, and hydroclimatology, including about 40 refereed journal and conference articles. Throughout his career, he passed along his experience and expertise through teaching courses and supervising many M.Sc. and Ph.D. students at the University of Saskatchewan. In addition, he served as a lecturer and special consultant to the Australian Weed Science Societies during August to October, 1981.

John also held various administrative positions during his career, including the Director of Environment Division at SRC, 1983-88. In late-1988, he was asked by the Grant Devine government in Saskatchewan to review a proposal to conduct cloud seeding for rainfall increase during drought periods. This came on the heels of the very severe 1988 drought in Saskatchewan when there were no clouds of seeding potential throughout July. John understood that the government anticipated a 'positive review' of the proposal, which his conscience would simply not allow. Shortly thereafter, John Maybank retired from SRC in early-1989, gaining new respect from those who were aware of the real reasons. He was subsequently contracted as a senior advisor by Environment Canada to review their operational climate services.

Some of us had the added benefit of being a personal friend to John, and knew him as a most friendly, gregarious, and fun-loving individual. His family in particular also knew him as a very loving individual.

All of us, colleagues, friends, and family shall miss you John, and offer a verse from Alfred Lord Tennyson's poem of 1849, *In Memoriam*, on the death of his dearest friend.

I hold it true, whate'er befall;
I feel it when I sorrow most;
'Tis better to have loved and lost
Than never to have loved at all.

Rest in peace, John.

Cedric Robert Mann

1926 - 2009

Ced Mann passed away after a brief illness on October 15, 2009. Cedric was born in Auckland, New Zealand on February 14, 1926. He earned his BSc. and MSc. degrees from the University of Auckland, New Zealand before emigrating to Canada in 1949.

After earning his Ph. D. in Physics at the University of British Columbia, Cedric went on to work with the Defence Research Board of Canada, doing research on acoustic problems related to submarine detection. At DRB he designed and constructed a scientific barge moored in Bedford Basin to serve as a test platform for ocean instrumentation. The barge remains on station to this day, still serving scientists from both Defence Research and Bedford Institute of Oceanography and raising the curiosity of Halifax commuters along the Bedford Highway.

In the early 1960s Cedric moved to the newly formed Bedford Institute of Oceanography. A quick course at the Institute of Oceanography at UBC retrained this ocean acoustician to a physical oceanographer. Scientific visits to Woods Hole and participation in ICES and IOC committees allowed Ced to develop an appropriate strategy for the new Canadian thrust into the circulation of the northern North Atlantic. His work on the circulation east of the Grand Banks of Newfoundland lead to the naming of the Mann Eddy, a quasi-stationary eddy in the Newfoundland Basin. In addition to his own research, he was responsible for the recruitment and mentoring of the first generation of oceanographers at BIO. For a number of years, he also lectured as a visiting professor at Dalhousie University in Nova Scotia.

He was probably best known for his organization and leadership of the Hudson 70 expedition; the first and only circumnavigation of the Americas by a research ship. In 1972, Cedric was granted an honorary Ph.D. in Engineering from the Nova Scotia Technical College for his leadership in the Hudson 70 expedition. After many years serving as its director of physical and chemical oceanography, he was appointed Director General of the Bedford Institute in 1978.

In 1979, Cedric and his wife Frances moved to the west coast, where he became Director General of the Institute of Ocean Sciences at Pat Bay in Victoria, a position he held until his retirement in 1986. When Cedric came to IOS, he had decided that he would no longer conduct personal research and instead concentrated on the development of what was still a rather young laboratory. He was responsible for the construction of a new major research vessel, the John P. Tully, made critical hirings to expand the arctic group and initiated a new research program in the Beaufort Sea, known as NOGAP.

After his retirement he said that when he moved on he didn't believe in looking back: this was as appropriate to his move from BIO as it was to his retirement. Cedric spent much of his leisure time in Sidney, B.C. playing golf, growing roses, reading mystery novels, swimming and participating in lawn bowling at the Sidney Lawn Bowling Club with friends. Cedric was honoured to receive the J. P Tully Medal awarded by the Canadian Meteorological and Oceanographic Society in 1994. Cedric will be greatly missed by his family and friends.

McGill

JOB - JOB - JOB - JOB

Tenure-Track Faculty Position in Physical Oceanography

The Department of Atmospheric and Oceanic Sciences at McGill University is seeking outstanding applicants for a tenure-track Assistant Professor position to strengthen its component in physical oceanography. The successful applicant will be expected to develop an active research program, supervise graduate students, and teach a variety of undergraduate and graduate courses.

The preferred areas of research are fairly broad, but should include a strong modelling or field component addressing one or more of a range of topics. These include, but are not limited to, large-scale ocean circulation, the ocean mesoscale, marginal seas or ocean-climate interaction.

The Department of Atmospheric and Oceanic Sciences has strong ties with Mathematics and Statistics, Chemistry, the McGill School of the Environment, CLUMEQ (a Quebec consortium for high performance computing), GEC3 (Global Environmental and Climate Change Centre), as well as with chemical oceanographers in the Earth and Planetary Sciences Department.

A Ph. D. in physical oceanography, or a closely-related field is required.

McGill University is an English-speaking university located in Montréal, one of North America’s most cosmopolitan cities. For more information about McGill University and the Department of Atmospheric and Oceanic Sciences, please see http://www.mcgill.ca/meteo

Qualified candidates are invited to submit an application, including a curriculum vitae, a research proposal, and a teaching statement to: Dr. John R. Gyakum, Chair, Department of Atmospheric and Oceanic Sciences, McGill University, 805 Sherbrooke Street West, Montreal, QC H3A 2K6, Canada (Telephone: 514-398-3760; fax: 514-398-6115), or by e-mail with pdf format application to: ocean@meteo.mcgill.ca.

Candidates should also provide three names, with contact information of referees, with their application. After preliminary screening, the search committee will request reference letters from the list of names that candidates have provided.

The preferred starting date for this position is September 1, 2010.

Review of the applications will begin on January 15, 2010, and continue until the position is filled.

McGill University is committed to equity in employment and diversity. It welcomes applications from indigenous peoples, visible minorities, ethnic minorities, persons with disabilities, women, persons of minority sexual orientations and gender identities and others who may contribute to further diversification. All qualified applicants are encouraged to apply; however, in accordance with Canadian immigration requirements, priority will be given to Canadian citizens and permanent residents of Canada.

International Conference

50 Years of Education and Awareness Raising for Shaping the Future of the Oceans and Coasts

The Russian State Hydrometeorological University in St.Petersburg has offered holding an International Conference under the title "***50 years of Education and Awareness raising for shaping the Future of the Oceans and Coasts***" on 27-30, April, 2010 in St.Petersburg. The offer was endorsed by the 41st session of the IOC Executive Council in 2008 and is included in the list of commemorative events at the 25th session of the Assembly of the UNESCO in 2009.

Objectives of the Conference

Overarching objective of the Conference will be to establish a platform for the exchange of views on sustainable education and training methods in marine related areas in order to ensure that the gains made in capacity development in the last 50 years are not lost.

The Conference will help to develop ways for meeting new challenges and increasing effectiveness of the results. The Conference will identify new policies in education and training which are needed to target the development goals facing the humankind such as shortage of fresh water and food, unemployment and poverty, and will identify ways for strengthening the capacity of educational institutions to lead programmes focussed on ocean's protection and research and on sustainable development issues.

Finally, the Conference will stimulate and examine practical opportunities for cooperation based on common competencies and interests, make recommendations for putting into practices the ideas formulated by the participants and propose methods and ways of implementation based on the last 50 years of experience and with a clear vision of the future.

Questions to be Answered

- What is the education and training in marine science about?
- Who are those to be educated and trained and for what?
- What is the role of relevant international organizations in promoting and strengthening the education and training policy?
- Can the use of modern technological achievements in the areas of communication and information exchange help in solving all problems of capacity development?
- What should be done for receiving support from the governments and administration at different levels to foster the development of education and awareness-raising in the area of marine science?
- How much funding is needed to support education and training programmes?
- What are the obstacles to progress in the field of education and training in marine science?

More Information

For more information on this international conference, please contact Dr.Vitaly Sychev, IOC-UNESCO/RSHU Chairholder at ioc50@rshu.ru or the IOC Secretariat in Paris, Dr.Ehrlich Desa, Head Capacity-Building Section at E.Desa@unesco.org .

Two New Elected RSC Fellows

Two CMOS Members have been elected Fellows of the Royal Society of Canada. The presentation took place November 28, 2009, in Gatineau.

MCELROY, Charles – Experimental Studies, Environment Canada

Dr. McElroy is one of Canada's foremost atmospheric scientists. He is a co-inventor of the Brewer ozone spectrophotometer, now used for ozone measurements world-wide, and the UV index, which is used to inform the public of the safety of remaining outside in sunlight. He has developed techniques for measuring ozone and other gases from the ground, from aircraft and from space. He has developed instruments used by astronauts on the space shuttle and the MAESTRO instrument on Canada's SCISAT satellite. He has sat on numerous national and international committees, and received numerous awards.

STEWART, Ronald – Department of Environment and Geography, University of Manitoba

Professor Stewart is a global leading expert on precipitation processes within winter storms. As the scientific leader for the Canadian Atlantic Storms Program, the Beaufort and Arctic Storms Experiment and the Mackenzie GEWEX Study and now co-lead for the Storm Studies in the Arctic experiment and the Drought Research Initiative, he has led the way in Canadian research with extensive publications, special issues of journals and books, and supervision of graduate students. He has been President of the Canadian Meteorological and Oceanographic Society in 2001. He plays leading roles internationally, including the Global Energy and Water Cycle Experiment and now its new initiative on climate extremes.

WMO Research Award for Young Canadian Scientist

The 61st session (3-12 June 2009) of the WMO Executive Council conferred the 2009 WMO Research Award for Young Scientists upon Alex J. Cannon (Canada) for his paper entitled "Probabilistic multi-site precipitation downscaling by an expanded Bernoulli-gamma density network" published in the December 2008 issue of the *Journal of Hydrometeorology.* Demonstrated on a dataset from coastal British Columbia, Canada, the study explored the capability to analyze several facets of precipitation distribution, including predicting precipitation amounts in excess of those in the observational record. Source: WMO press release No. 851.

Alex is also the recipient of the CMOS Tertia M.C. Hughes Memorial Prize, 2008, for his outstanding and innovative Ph.D. dissertation at the University of British Columbia, consisting of five refereed journal publications. Each paper consists of a distinct new statistical model tackling the challenging problems of seasonal climate prediction and/or climate downscaling.

Letter to the US Senators

October 21, 2009

Dear Senator:

As you consider climate change legislation, we, as leaders of scientific organizations, write to state the consensus scientific view.

Observations throughout the world make it clear that climate change is occurring, and rigorous scientific research demonstrates that the greenhouse gases emitted by human activities are the primary driver. These conclusions are based on multiple independent lines of evidence, and contrary assertions are inconsistent with an objective assessment of the vast body of peer-reviewed science. Moreover, there is strong evidence that ongoing climate change will have broad impacts on society, including the global economy and on the environment. For the United States, climate change impacts include sea level rise for coastal states, greater threats of extreme weather events, and increased risk of regional water scarcity, urban heat waves, western wildfires, and the disturbance of biological systems throughout the country. The severity of climate change impacts is expected to increase substantially in the coming decades. [Note 1]

If we are to avoid the most severe impacts of climate change, emissions of greenhouse gases must be dramatically reduced. In addition, adaptation will be necessary to address those impacts that are already unavoidable. Adaptation efforts include improved infrastructure design, more sustainable management of water and other natural resources, modified agricultural practices, and improved emergency responses to storms, floods, fires and heat waves.

We in the scientific community offer our assistance to inform your deliberations as you seek to address the impacts of climate change.

Letter signed by:

- American Association for the Advancement of Science
- American Chemical Society
- American Geophysical Union
- American Institute of Biological Sciences
- American Meteorological Society
- American Society of Agronomy
- American Society of Plant Biologists
- American Statistical Association
- Association of Ecosystem Research Centers
- Botanical Society of America
- Crop Science Society of America
- Ecological Society of America
- Natural Science Collections Alliance
- Organization of Biological Field Stations
- Society for Industrial and Applied Mathematics
- Society of Systematic Biologists
- Soil Science Society of America
- University Corporation for Atmospheric Research

Note 1: The conclusions in this paragraph reflect the scientific consensus represented by, for example, the Intergovernmental Panel on Climate Change and U.S. Global Change Research Program. Many scientific societies have endorsed these findings in their own statements, including the American Association for the Advancement of Science, American Chemical Society, American Geophysical Union, American Meteorological Society, and American Statistical Association.

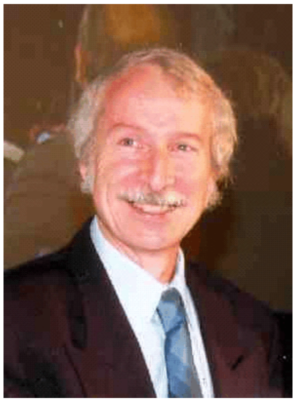
CMOS Members honoured at JCOMM III in Marrakech

On November 4, three Certificates of Outstanding Services were awarded to individuals who have made significant contributions to the work of the WMO-IOC Joint Commission for Oceanography and Marine Meteorology. The recipients are:

John Falkingham

1) John Falkingham, recently retired from the Meteorological Service of Canada, for his outstanding contributions over more than 30 years to the collection, processing, management and delivery to users of sea ice data and metadata, and especially to the development and fostering of international cooperation, procedures,

formats and standards in sea ice data exchange, management and delivery;


Bob Keeley

2) Bob Keeley, Department of Fisheries and Oceans, Canada, received the award in recognition of his outstanding contributions over more than 25 years to the collection, processing, management and delivery to users of ocean data and metadata, and especially to the development and fostering of international cooperation, procedures, formats and standards in oceanographic data exchange and management; and

3) Mike Johnson of US NOAA.

The awards were signed by Michel Jarraud, Secretary General of WMO, Patricio Bernal, Executive Secretary of the UNESCO-IOC and the Co-Presidents of JCOMM, Jean Louis Fellous and Peter Dexter. Bob Keeley, present as a member of the Canadian Delegation to JCOMM III, was able to accept his award while the award for John Falkingham was accepted by Mr. Al Wallace, Director, MSC Operations Pacific and Yukon Region and the co-head of delegation for Canada at JCOMM III.

Sylvie Gravel
International Affairs, Meteorological Service of Canada

Andrew Weaver on Climate Change

The Ondaatje Hall in the McCain building of Dalhousie University was filled to capacity when Dr. Andrew Weaver delivered his message that global climate change is a life-threatening problem, but it can be resolved. First though, he said, countries like Canada will need to do more. Dr. Weaver, Canada Research Chair in Climate Modelling and Analysis at the University of Victoria, was invited to Dalhousie University this fall to deliver what was both the opening lecture in this year's Killam Lecture Series focussing on "Oceans and Climate Change" and also the second annual Ransom Myers Lecture in Science and Society. Using slides and graphics, Dr. Weaver made his point amidst occasional breakouts of cheers and laughter from the crowd, admitting that "*scientists as communicators are horribly, horribly bad. We need journalists to help us get the message out about this stuff, but the problem is journalists can only write what they understand and right now we're just not making this stuff easy enough for them*". Dr. Weaver's talk was seen as very engaging and entertaining. "*He struck a perfect balance between confronting his audience of approximately 400 people with evidence for the seriousness of global warming and assuring them that it is not too late for action*," said Dr. Fennel, assistant professor in Dalhousie's Department of Oceanography. Dr. Weaver said governments need to invest in new technologies that will help ease the effects of climate change and to adopt "**carbon neutral**" policies. "*People always say that doing these kinds of things is bad for the economy – it's not*," he argued. "*More of the same just brought us into a global economic recession, so maybe the argument that investing in green technology is bad for the economy isn't all that strong*." He concluded his talk by previewing the United Nations conference on climate change taking place this December in Copenhagen. "*It's really very important that we get a new plan this December in Copenhagen. Our world leaders have to realize that we can do something about this but we all have to get on the same page and get moving before it's too late*".

Based on a report written by Chad Bowie, "*Before it's too late*", October 15, 2009, Dalhousie University News website (http://www.dalnews.dal.ca).

Canada to Host SCOR Meeting in 2012

On behalf of Canada, the Department of Fisheries and Oceans (DFO) and the National Research Council of Canada (NRC) recently offered to host the Annual General Meeting of Scientific Committee on Oceanic Research (SCOR) in 2012. This invitation has just been accepted at the October 2009 SCOR Executive Committee Meeting in Beijing, China. The venue and timing of the 2012 meeting will be worked out in the coming months. Canada last hosted the SCOR Annual Meeting in 1994.

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2010

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44th Annual CMOS Congress / 36th Annual Scientific Meeting of CGU / 3rd Joint CMOS-CGU Congress
44e Congrès annuel de la SCMO / 36e Rencontre scientifique annuelle de l'UGC / 3e Congrès organisé conjointement par la SCMO et l'UGC

Canadian Meteorological and Oceanographic Society / La Société canadienne de météorologie et d'océanographie
Canadian Geophysical Union / Union géophysique canadienne

www.cmos.ca/congress2010