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Canadian Meteorological and Oceanographic Society

La Société canadienne de météorologie et d'océanographie

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Broken Arctic Sea Ice

Glace de l'océan Arctique morcelée

....from the President's Desk

Friends and colleagues:

As I write this article in the first few days of this new year of 2011, we extend our welcome to the Honourable Peter Kent, the new Canadian Minister of the Environment. In making the announcement of Mr. Kent's appointment, the Prime Minister highlighted the need for "*... advancing efforts to protect Canada's environment and address climate change at home and abroad*." In my own opinion, one excellent way for Minister Kent to address climate change would be to provide renewed support for the Canadian Foundation for Climate and Atmospheric Sciences (CFCAS). In the ten years since CFCAS was created, it has funded over $117 million for research on air quality and extreme weather, climate models and predictions and maritime conditions. This funding has levered an additional $158 million in cash or in-kind support, enabling the involvement of many distinguished researchers in the academic community across Canada, 140 federal scientists and a total of 1,200 students and research personnel. The accomplishments of the CFCAS research are most impressive as seen in journal publications and inputs to public policy issues. Renewed support for CFCAS is needed very soon to continue its vital role in contributing towards developing the knowledge required for Canada to effectively address climate change issues.

David Fissel
CMOS President
Président de la SCMO

Atmosphere-ocean interactions are also vital in understanding climate change. Canadian meteorologists and oceanographers are playing a leading role in developing understandings of these very important linkages. Moreover, the importance of oceanography issues in Canada has recently been underscored in the CBC's List of the Top Ten Science Stories for 2010. Of the top stories, three involve the oceans: the Gulf oil spill (number 1), the Neptune Canada underwater observatory deployed in 2010 (number 4) and the Census of Marine Life project (number 10).

The upcoming CMOS Annual Congress in Victoria BC (June 5-9, 2011) provides a great opportunity to hear about the leading edge meteorological and oceanographic research being conducted in Canada on topics described above in addition to many others.

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Cover page: Although sea ice is a ubiquitous feature of the Arctic Ocean, its character and regional extent have undergone dramatic change as a result of Polar warming. Research taking place in Canada's Arctic is endeavouring to better understand the role of sea ice cover in mediating the seasonal transfer of CO_2 between the atmosphere and the surface Arctic Ocean as this environment experiences rapid change. To learn more, please read the article written by Kristina Brown on **page 4**. The picture is courtesy of Kristina.

Page couverture: Quoique la glace soit un phénomène omniprésent de l'océan Arctique, son caractère et son étendue régionale ont subi des changements dramatiques à cause du réchauffement des pôles. La recherche entreprise dans l'Arctique canadien est un effort pour mieux comprendre le rôle du couvert de la glace de mer dans le transfert saisonnier du CO_2 entre l'atmosphère et la surface de l'océan Arctique alors que son environnement change rapidement. Pour en apprendre plus, prière de lire l'article de Kristina Brown en **page 4**. La photo est une gracieuseté de Kristina.

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

The Call for Papers for the Congress will be closing very soon [see page 36], so please encourage your friends, colleagues and students to submit abstracts and to register for the Congress. This can be done through the first link ("Congresses") on the CMOS web site.

Our CMOS Council has recently approved an initiative to encourage more papers in our Congresses by highlighting the importance of poster papers. For the 2011 Victoria Congress, we will have ample and prominent space to present more poster papers than at the past Congresses. To recognize the importance of poster papers, three prizes will be awarded for poster papers in Victoria rather than the one prize awarded in past years.

Also, please consider nominating a colleague for a CMOS prize or award. Although the February 15th deadline will be fast approaching by the time that you receive this, there is still an opportunity to nominate candidates for the various prizes or awards [listed on page 28]. Nominations received by 15 February by the CMOS Executive Director will be forwarded to the CMOS Prizes and Awards Committee. Another date to remember is the March 15 deadline for the nomination of CMOS Fellows.

Finally, I would like to thank Paul-André Bolduc and Dorothy Neale for their excellent work in producing another very interesting volume of six *CMOS Bulletin SCMO* issues in 2010 and this first new issue for the year 2011. And I wish to acknowledge the contributions of Dr. Richard Asselin, CMOS Director of Publications for his leadership in the exciting new changes to our flagship journal, *Atmosphere-Ocean* and to the *Atmosphere-Ocean* Co-Editors, Drs. William Hsieh and Guoqi Han, and the highly qualified Technical Editor, Sheila Bourque, Associate Editors and many reviewers of this world-class scientific journal.

David Fissel
CMOS President
Président de la SCMO

Dernière heure - Dernière heure

Oumarou Nikiema, qui a partagé le prix de l'étudiant gradué au dernier congrès de la SCMO à Ottawa, est parmi les 10 finalistes d'un concours organisé par le magazine *Québec Science*. Maître du chaos, à coup d'équations mathématiques, ce jeune étudiant a été capable de décrire la part imprévisible du système climatique. Étudiant au niveau de la maîtrise à l'UQAM sous la direction du professeur René Laprise, il a publié dans la revue *Climate Dynamics* une formule qui décrit l'imprévisible. Histoire à suivre...

Highlights of the November Executive and December Council Meetings

Victoria Congress 2011
Speakers have been confirmed for eight plenary and two public lectures, and several sponsors have been identified. There will be a Special Session in memory of Dan Wright.

Montréal Congress 2012
The American Meteorological Society has confirmed that it will co-sponsor the 2012 Congress, with its main participation being in the Scientific Programme Committee.

Saskatoon Congress 2013
Arrangements for accommodation have been made with Saskatoon hotels, and the Congress dates have been confirmed.

Other General Issues
David Fissel helped to prepare a business case for the Canadian Foundation for Climate and Atmospheric Science, which was sent to Ottawa in October.

Preparations for Tom Pedersen's CMOS speaking tour this spring are proceeding, with Centres being contacted to confirm dates.

The next National Executive will likely be based in Montréal. See proposed 2011/2012 slate in this issue of the Bulletin [on page 35].

Council has approved an increase to the reserve fund of $50,000. The reserve fund acts as insurance against a future disaster, such as a cancelled Congress.

New and renewing members can access *Atmosphere-Ocean* online and order a print subscription at a reduced rate. Remember to renew your CMOS membership for 2011!

Sophia Johannessen,
Recording Secretary / Secrétaire d'assemblée

ARTICLES

Measuring CO_2 in the Arctic

by Kristina Brown[1]

Even at midnight, the brightness of the polar sun distorts the brain's sense of time and it is easy to understand the ecological impact of its re-emergence after a long, dark winter. It's spring time in Resolute Bay, a small community on the southern tip of Cornwallis Island, smack in the centre of the Canadian Arctic Archipelago, Nunavut. Our field camp is situated on a slab of 145 cm thick landfast sea ice that currently fills a small bay west of the hamlet, and we have been travelling here daily by skidoo to monitor the changes occurring in the ice pack, atmosphere and underlying water column as the spring thaw commences.

Kristina measuring the CO_2 concentration within "peepers", in situ semi-permeable gas samplers which have been frozen into the sea ice at the Allen Bay field site. (Photo: Cole Moszynski, June 2010).

We've had a string of calm weather nights, where the blustery wind and blowing snow flurries of mid-day have had a chance to die down, renewing the ability to see past arm's length. Under these clear sky conditions the landscape opens up, and one is instantly hit with the overwhelming feeling of smallness in this vast, white desert. Despite the background hum of the diesel generator, which keeps our core program elements - the eddy covariance and meteorological towers – recording 24/7, the image before me is peaceful, serene. A small automated infrared sensor is sitting beside me, carefully measuring the CO_2 content of the *in situ* collectors we have deployed throughout the ice pack. As I disconnect and reconnect to each sampler, I have a new 10 minute window to sit and admire the beautiful snowscape around me.

Until fairly recently, sea ice had been presumed to act primarily as a cap on the ocean, reducing gas transfer at the ice-water interface simply by providing a barrier to this exchange. However, recent work investigating CO_2 dynamics in ice-covered regions has begun to illustrate a much more complex story. Field studies in Canada's Arctic have suggested that sea ice actively mediates CO_2 movement between the ocean and the atmosphere, through complex biogeochemical dynamics involving the interaction between gaseous, aqueous, and solid forms of carbon at different stages of the sea ice life cycle.

As sea water freezes, salts are pushed out of the forming ice crystals and accumulate in a saline solution termed brine. While much of this brine is imparted back to the surface mixed layer, a portion of it is also retained within channels in the freezing ice pack, further concentrating as more and more water is removed through freezing. Such high concentrations of the ocean's major ions can result in the inorganic precipitation of minerals such as mirabilite, hydrohalite, and, most interestingly, calcium carbonate. The precipitation of calcium carbonate not only acts to remove major ions from brine, but it also results in the addition of aqueous CO_2 to solution

$$Ca^{2+} + 2HCO_3^- = CaCO_3 + CO_2 + H_2O$$

increasing the partial pressure of gaseous CO_2 (pCO_2) in brine channels. These channels then act as conduits for

[1] *Kristina Brown holds the two-year CNC-SCOR Scholarship Supplement in Ocean Sciences for 2009 and 2010; Kristina is a PhD student at University of Brisith Columbia, Vancouver, BC.*

CO_2 diffusion through the ice pack, either to the atmosphere above or to the underlying water below. It has been proposed that this mechanism of inorganic $CaCO_3$ precipitation could serve as a source of CO_2 to the atmosphere and underlying water column in winter, as sea ice forms and grows, and potentially act as a sink of CO_2 in spring, when sea ice has the opportunity to melt, and $CaCO_3$ dissolves. However, the net impact of these processes to act as sources or sinks of atmospheric CO_2 over the seasonal sea ice life cycle is still not adequately characterized.

Through the use of a "tool kit" of naturally occurring geochemical tracers, my PhD research is attempting to investigate the pathways of carbon cycling as sea ice forms, grows, and ultimately, melts. In addition to direct measurements of dissolved inorganic carbon, alkalinity, and pCO_2, I will attempt to utilize stable carbon isotopes as a natural tracer to tease apart the contributions of biotic and abiotic players that can act as both sources and sinks of CO_2 in this multi-component system.

The most challenging aspect of this research is that we are still at the very beginning of understanding the mechanisms involved in sea ice carbon cycles, especially from an abiotic perspective. While it was predicted from empirical models decades ago that carbonate mineral precipitation occurs as sea ice forms, actual examples of precipitates have only recently been isolated from the field, leading to a new series of questions concerning the role of inorganic mineral precipitation in this system. Through the combination of pCO_2 measurements within the sea ice (via *in situ* pCO_2 collectors and discrete samples of sea ice cores and brine), in the surface water below (through niskin bottle samplers), and in the atmosphere above (using eddy covariance CO_2 flux measurements), we are hoping to better characterize the pathways of CO_2 movement within the ice pack, and further understand its response to periods of intense change, for instance during the spring melt. Ultimately, it is hoped that this information will lend insight toward understanding the link between the cryosphere and atmospheric CO_2 concentrations, allowing us to more accurately predict how this system will respond to changing sea ice conditions in a warming polar climate.

Source: Canadian Ocean Science Newsletter, # 54, December 2010. Reproduced here with the written authorization of the author and the editor.

A-O Special Section on Canadian Ocean Studies Conducted During International Polar Year

Preface by Robie W Macdonald[2]

International Polar Year (IPY; 2007–2008) comprised 160 endorsed projects among which Canadian ocean studies figured prominently. The last such effort, International Geophysical Year (1957–1958) saw the launch of Sputnik and the signing of an Antarctic Treaty. The latter had a large consequence for the conduct of science at the South Pole, but perhaps the most relevant consequence for Canada was the introduction of a space technology that has shown so clearly the loss of the permanent pack ice in the Arctic Ocean during the past two decades. Fifty years from now, what will be remembered from this IPY?

The findings from Canadian studies are beginning to emerge in the literature, and in this issue of *Atmosphere-Ocean*, three papers are presented that open the window on two monumental Canadian ocean projects: *Canada's Three Oceans* (C3O) and the *Circumpolar Flaw Lead* (CFL) *System Study*. The perspectives that underpin these two projects differ as much as those between the Lagrangian view of following the fluid where it takes you and the Eulerian one of watching the fluid move past. These differences are not simply interesting facets providing contrast between projects: they go to the heart of the decisions we must make in the coming years of how to observe and understand biogeochemical change in Canada's ocean real estate generally and in the Arctic seas in particular. As Canada considers how best to collect ocean time series that will contribute to international efforts like Sustaining Arctic Observing Networks (SAON;

http://www.arcticobserving.org/),

or how such observations might fit with the Canadian High Arctic Research Station (CHARS) planned for Cambridge Bay, it seems crucial at this moment to ask what we need to do during the coming decade to extract the most value from our recent IPY investment, and the type of observation effort needed to lead us toward the next IPY in 2057 — a time when the Arctic Ocean will likely have no ice cover in summer.

The C3O study (Carmack et al., 2010) provides a breathtaking multidisciplinary section from the west coast to the east coast of Canada via the Arctic Ocean, constructed from parallel cruises by two Canadian Coast Guard ships, the *Louis S. St. Laurent* and the *Sir Wilfrid Laurier*. As net recipients of fresh water distilled globally, the North Pacific, the Arctic and the North Atlantic oceans are all salt stratified instead of heat stratified. The requirement to balance the Earth's hydrological system

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creates what is predominantly a Canadian Ocean Highway along which freshened Pacific surface water enters the western Arctic surface ocean where it gathers more fresh water, transits through the complex channels of the Archipelago and then passes down the Canadian east coast. The C3O section along this highway is proposed as a baseline against which future change should be evaluated. The concept of the long ocean section is that change occurs in the ocean not only as altered properties (temperature, salinity and biota) within domains, but also as change in the position of boundaries between ocean domains (Sarmiento et al., 2004). As such, one needs the long section to identify the movement of domain boundaries and the invasion of species enabled by ocean change (e.g., Occhipinti-Ambrogi, 2007; Grebmeier et al., 2006).

The CFL system study (Barber et al., 2010; Pućko et al., 2010), while mobile within the Cape Bathurst polynya and associated flaw-lead system, is firmly planted in the southern Beaufort Sea, a waypoint along the Canadian Ocean Highway. The study builds on previous work conducted in the western Arctic under several programs, the most recent being the *Canadian Arctic Shelf Exchange Study* (CASES). In particular, the contention underpinning the CFL study is that flaw-lead polynyas are regions of critical importance to biota and are also likely to be the regions of greatest change in ice climate. To understand what change means to these flaw leads, the CFL study proposes the Cape Bathurst polynya system as an observatory within which time series are collected through multidisciplinary surveys. The ensuing understanding provides the basis to produce physical and biogeochemical models while at the same time securing validation data. Polar seas are among the most seasonal due to the large annual range in incident solar radiation. An important mechanism of change lies, therefore, in the alteration of ocean seasonality. To address seasonality, CFL fieldwork overwintered the CCGS *Amundsen* in the polynya to provide a full year's data, something that cannot be captured by long sections conducted only during navigable ice conditions. The study by Pućko et al. (2010), who looked at contaminant cycling in ice, provides one illustration of how cameo studies have been embedded in the greater context of CFL.

It is instructive to compare the focus of the two studies as presented in this issue of *Atmosphere-Ocean*, albeit these presentations will likely not reflect the body of work that will emerge over the coming decade. The C3O paper is centered within the water while the two CFL papers are more firmly planted on ice and in the atmosphere. It seems clear that these studies are presently "two solitudes". It is to be hoped that in the future one may have a better appreciation of how the Cape Bathurst polynya fits into the domains along the Canadian Ocean Highway and how the domains adjacent to the Cape Bathurst polynya affect its internal functioning. As a final comment, both studies argue for better engagement and dialogue with northern communities with the expressed intent that northerners take a more prominent role in the activity of observing the Arctic and understanding what change means. It is they, after all, who are the first to feel the effects of change. For IPY we have arrived only at the end of the beginning.

Section spéciale de A-O sur les études océaniques canadiennes menées durant l'Année polaire internationale

Preface by Robie W Macdonald[3]

L'Année polaire internationale (API; 2007–2008) a soutenu 160 projets parmi lesquels les études océaniques canadiennes ont occupé une place de premier plan. Le dernier effort de ce genre, l'Année géophysique internationale (1957–1958), a été témoin du lancement du Spoutnik et de la signature d'un Traité sur l'Antarctique. Cet effort a eu des conséquences considérables sur les activités scientifiques menées au pôle Sud, mais la conséquence sans doute la plus importante pour le Canada a été l'inauguration d'une technologie spatiale qui a montré à l'évidence la diminution de la banquise permanente dans l'océan Arctique au cours des deux dernières décennies. Dans cinquante ans d'ici, qu'aura-t-on retenu de cette API?

Les résultats des études canadiennes commencent à émerger dans la littérature, et le présent numéro d'*AtmosphereOcean* publie trois articles à propos de deux projets canadiens de premier plan portant sur les océans : Les trois océans du Canada (C3O) et L'étude sur le système du chenal de séparation circumpolaire (CSC). Les points de vue qui caractérisent ces deux projets diffèrent comme le point de vue lagrangien — se déplacer avec le fluide — diffère du point de vue eulérien — regarder le fluide passer. Ces distinctions ne sont pas simplement des facettes intéressantes faisant ressortir les différences entre les projets. Elles touchent directement aux décisions que nous devrons prendre dans les années à venir sur la facon d'observer et de comprendre le changement biogéochimique dans les étendues océaniques canadiennes en général et dans les mers arctiques en particulier. Au moment où le Canada cherche à déterminer la meilleure facon de rassembler les séries temporelles océaniques devant contribuer à des efforts internationaux comme Sustaining Arctic Observing Networks (SAON;

http://www.arcticobserving.org/)

ou comment ces observations pourraient servir à la Station de recherche dans l'Extreme-Arctique du Canada (SREAC) planifiée pour Cambridge Bay, il semble primordial à ce moment-ci de s'interroger sur ce que nous devons faire durant la prochaine décennie pour extraire la meilleure valeur de notre investissement récent dans l'API et sur le type d'effort d'observation nécessaire pour nous amener jusqu'à la prochaine API en 2057 — un moment où il n'y aura probablement plus de couverture de glace sur l'océan Arctique en été.

L'étude C3O (Carmack et coll., 2010) fournit une section multidisciplinaire stupéfiante allant de la côte ouest à la côte est en passant par l'océan Arctique, construite lors de

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campagnes parallèles de deux navires de la Garde côtière canadienne, le *Louis S. St. Laurent* et le *Sir Wilfrid Laurier*. Comme ils sont les destinataires nets de l'eau douce distillée sur le globe, le Pacifique Nord, l'Arctique et l'Atlantique Nord présentent une stratification haline plutôt qu'une stratification thermique. L'exigence d'équilibrer le système hydrologique de la Terre crée ce qui est principalement une route océanique canadienne le long de laquelle les eaux de surface adoucies du Pacifique pénètrent dans les eaux de surface de l'Arctique de l'Ouest où elles recueillent plus d'eau douce pour ensuite cheminer à travers les chenaux complexes de l'Archipel et aboutir sur la côte est du Canada. Il est proposé de faire de la section C3O le long de cette route une base de référence devant permettre d'évaluer le changement futur. L'idée de la longue section océanique vient de ce que le changement qui se produit dans l'océan ne consiste pas seulement en une modification des propriétés (température, salinité et biote) à l'intérieur de domaines, mais aussi en un changement dans la position des frontières entre les domaines océaniques (Sarmiento et coll., 2004). Ainsi donc, la longue section est nécessaire pour identifier le mouvement des frontières des domaines et l'invasion des espèces consécutive au changement dans l'océan (p. ex., Occhipinti-Ambrogi, 2007; Grebmeier et coll., 2006).

L'étude sur le système du CSC (Barber et coll., 2010; Pućko et coll., 2010), bien que mobile à l'intérieur du système de la polynie du cap Bathurst et du chenal de séparation associé, est fermement installée dans le sud de la mer de Beaufort, un point de cheminement le long de la route océanique canadienne. L'étude s'appuie sur des travaux antérieurs menés dans l'ouest de l'Arctique dans le cadre de différents programmes, le plus récent étant le Canadian Arctic Shelf Exchange Study (CASES). En particulier, la thèse qui sous-tend l'étude sur le CSC est que les polynies de séparation sont des régions d'une importance cruciale pour le biote et qu'elles sont probablement aussi les régions où le changement dans la climatologie des glaces sera probablement le plus marqué. Pour comprendre ce que le changement signifie pour ces chenaux de séparation, l'étude sur le CSC propose que le système de la polynie du cap Bathurst soit un observatoire dans lequel des séries temporelles sont recueillies lors de campagnes multidisciplinaires. La compréhension qu'elles procurent constitue la base à partir de laquelle des modèles physiques et biogéochimiques sont construits tout en fournissant des données de validation. Les mers polaires connaissent des saisons très marquées en raison de la grande variabilité annuelle du rayonnement solaire incident. La modification de la saisonnalité de l'océan est donc en soi un important mécanisme de changement. Pour composer avec cette saisonnalité dans le cadre de l'étude du CSC, le NGCC Amundsen a passé tout l'hiver dans la polynie afin de fournir une année complète de données qui ne pouvaient pas être obtenues par de longues sections effectuées seulement en période de conditions de glace navigables. L'étude de Pućko et coll. (2010), qui s'est intéressé au recyclage des contaminants dans la glace, donne un exemple de la façon dont des études ponctuelles ont été intégrées dans le contexte plus large de l'étude sur le CSC.

Il est révélateur de comparer le point focal des deux études publiées dans ce numéro d'*Atmosphere-Ocean*, même si ces présentations ne refléteront probablement pas l'ensemble des travaux qui seront entrepris au cours de la décennie à venir. L'étude C3O est centrée sur l'eau alors que les deux études sur le CSC sont davantage implantées sur la glace et dans l'atmosphère. Il apparait clairement que ces études sont actuellement << deux solitudes >>. Il est à espérer que l'on puisse éventuellement mieux comprendre comment la polynie du cap Bathurst s'intègre dans les domaines longeant la route océanique canadienne et comment les domaines adjacents à la polynie du cap Bathurst influencent son fonctionnement interne. Et comme commentaire final, les deux études proposent de mieux mobiliser les communautés du Nord en dialoguant davantage avec elles et expriment le souhait que les gens du Nord aient un role plus important à jouer dans les activités d'observation de l'Arctique et de compréhension de ce que le changement signifie. C'est eux, après tout, qui sont les premiers à ressentir les effets du changement. Avec l'API, nous n'en sommes arrivés qu'à la fin du commencement.

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2010 in the top three warmest years, 2001-2010 warmest 10-year period
2010 au nombre des trois années les plus chaudes 2001-2010: la décennie la plus chaude

Résumé: 2 décembre 2010 - Cancún/Genève (OMM) - L'année 2010 fera presque certainement partie des trois années les plus chaudes jamais enregistrées depuis 1850, date à laquelle ont débuté les relevés instrumentaux, d'après les données compilées par l'Organisation météorologique mondiale (OMM). La température moyenne combinée de l'air à la surface des terres et de la mer, en 2010 (janvier-octobre), présente actuellement une anomalie positive estimée à 0,55°C ± 0,11°C (0,99°F ± 0,20°F) par rapport à la normale calculée pour la période 1961-1990 (14°C/57,2°F). L'année 2010 se classe provisoirement au premier rang des années les plus chaudes, juste devant 1998 (anomalie positive de 0,53 °C pour la période janvier-octobre) et 2005 (+ 0,52 °C). Les données de réanalyse «ERA-Interim» révèlent elles aussi que les températures afférentes à la période janvier à octobre 2010 atteignent des niveaux quasi records. On ne connaîtra le rang auquel se classera en définitive 2010 qu'au début de l'année prochaine, lorsque pourront être analysées les données relatives à novembre et décembre. D'après les données préliminaires relevées entre le 1er et le 25 novembre, les températures mondiales relatives à novembre 2010 sont analogues à celles de novembre 2005, ce qui confirme pour l'instant que les températures mondiales pour l'ensemble de l'année avoisineront des niveaux records.

December 2, 2010 - Cancún/Geneva (WMO) - The year 2010 is almost certain to rank in the top 3 warmest years since the beginning of instrumental climate records in 1850, according to data sources compiled by the World Meteorological Organization (WMO). The global combined sea surface and land surface air temperature for 2010 (January–October) is currently estimated at 0.55°C ± 0.11°C [Note 1] (0.99°F ± 0.20°F) above the 1961–1990 annual average of 14.00°C/57.2°F. At present, 2010's nominal value is the highest on record, just ahead of 1998 (January-October anomaly +0.53°C) and 2005 (0.52°C) [Note 2]. The ERA-Interim [Note3] reanalysis data are also indicating that January-October 2010 temperatures are near record levels. The final ranking of 2010 will not become clear until November and December data are analysed in early 2011. Preliminary operational data from 1-25 November indicate that global temperatures from November 2010 are similar to those observed in November 2005, indicating that global temperatures for 2010 are continuing to track near record levels.

Over the ten years from 2001 to 2010, global temperatures have averaged 0.46°C above the 1961-1990 average, 0.03°C above the 2000-09 average and the highest value ever recorded for a 10-year period. Recent warming has been especially strong in Africa, parts of Asia, and parts of the Arctic; the Saharan/Arabian, East African, Central Asian and Greenland/Arctic Canada sub-regions have all had 2001-10 temperatures 1.2 to 1.4°C above the long-term average, and 0.7°C to 0.9°C warmer than any previous decade.

Surface air temperatures over land were above normal across most parts of the world. The most extreme warm anomalies occurred in two major regions. The first extended across most of Canada and Greenland, with mean annual temperatures 3°C or more above normal in parts of west Greenland and the eastern Canadian Arctic and sub-Arctic. The second covered most of the northern half of Africa and south Asia, extending as far east as the western half of China, with annual temperatures 1 to 3°C above normal over most of the region. Many parts of both regions had their warmest year on record, including large parts of northern Africa, the Arabian Peninsula and southwest Asia (with Turkey and Tunisia having their warmest year on record), as well as much of the Canadian Arctic and coastal Greenland. Four of the five sub-regions [Note 4] which are wholly or partly in Africa (West and Southern Africa, the Saharan/Arabian region and the Mediterranean) are on course for their warmest year on record, along with South and Central Asia, and Greenland/Arctic Canada. Temperatures averaged over Canada have also been the highest on record.

Only limited land areas had below-normal temperatures in 2010, the most notable being parts of western and central Siberia in Russia, parts of southern South America, interior Australia, parts of northern and western Europe, eastern China and the southeast United States. It was the coolest year since 1996 for the northern European region, and since 1998 for northern Asia, due mainly to below-normal temperatures during the winter. A number of northern European countries are also likely to have their coolest year since 1996, including the United Kingdom, Germany, France and Norway.

Sea surface temperatures were below normal over most of the eastern half of the Pacific Ocean as a result of the La Niña event which developed during the year, but were well above normal over most parts of the Indian and Atlantic Oceans. The tropical North Atlantic was especially warm with temperatures at record levels over most of the area east of longitude 55°W.

Major regional climate events in 2010

1) Extreme Asian summer monsoon in some regions

Pakistan experienced the worst flooding in its history as a result of exceptionally heavy monsoon rains. The event principally responsible for the floods occurred from 26-29 July, when four-day rainfall totals exceeded 300 millimetres over a large area of northern Pakistan centred on Peshawar. There were additional heavy rains further south from 2-8 August which reinforced the flooding. More than

1500 lives were lost, and over 20 million people were displaced as large parts of Pakistan's agricultural land were inundated. In terms of the number of people affected, the United Nations rated the flood as the greatest humanitarian crisis in recent history. The total monsoon season rainfall for Pakistan was the fourth-highest on record, and the highest since 1994.

Summer rainfall was also well above normal in western India, and China experienced its most significant monsoon flooding since 1998, with south-eastern China and parts of the northeast most severely affected. The latter floods also extended to the Korean Peninsula. A number of these floods led to significant loss of life, directly as well as through landslides in China, which claimed more than 1400 lives in Gansu Province. However, monsoon season rainfall averaged over India was only 2% above normal, and it was well below normal in north-eastern India and Bangladesh, which had its driest monsoon season since 1994.

2) Extreme summer heatwaves in Russia and other regions

The Northern Hemisphere summer saw exceptional heatwaves in several parts of Eurasia. The most extreme heat was centred over western Russia, with the peak extending from early July to mid-August, although temperatures were well above normal from May onwards. In Moscow, July mean temperatures were 7.6°C above normal, making it the city's hottest month on record by more than 2°C, and similar anomalies continued until cooler conditions developed in the last 10 days of August. A new record high temperature for the city of 38.2°C was set on 29 July, and it reached 30°C or above on 33 consecutive days (in comparison, there were no days at all above 30°C in the summer of 2009). About 11,000 excess deaths during the summer were attributed to the extreme heat in Moscow alone [Note 5]. Some parts of central European Russia had average temperatures more than 5°C above normal for the summer. The heat was accompanied by destructive forest fires, while severe drought, especially in the Volga region, led to widespread crop failures. Neighbouring countries were also affected, with extreme high maximum temperatures recorded in Finland, Ukraine and Belarus, and record high numbers of extreme warm nights in parts of south-eastern Europe, including Serbia.

It was also a very hot summer in many other parts of Eurasia and northern Africa. The Russian Far East had temperatures well above normal, which combined with the extreme heat in the west to result in the hottest summer on record averaged over Russia as a whole. Japan and China also had their hottest summers on record. Earlier in the year, there was exceptional pre-monsoon heat in southern Asia, which included a temperature of 53.5°C at MohenjoDaro on 26 May, a national record for Pakistan and the highest temperature in Asia since at least 1942. Extreme heat affected northern Africa and the Arabian Peninsula at times during the summer, with notable readings including 52.0°C at Jeddah (Saudi Arabia), 50.4°C at Doha (Qatar) and 47.7°C at Taroudant (Morocco).

3) An abnormal winter in many parts of the Northern Hemisphere

The normal mid-latitude westerly flow was unusually weak during the 2009-10 northern hemisphere winter, which resulted in many substantial climate anomalies in various parts of the hemisphere. In particular, it was a rather cold winter over most of Europe (except the Mediterranean region), the Asian part of Russia (except for the Far East) and Mongolia. The peak winter temperature anomalies (below −4°C) were in central Russia, but in a historical context the most unusual conditions were on the western periphery of Europe, with Ireland and Scotland both experiencing their coldest winter since 1962-63. Many other parts of northern and central Europe had their coldest winter since 1978-79, 1986-87 or 1995-96, although the temperatures were generally not exceptional in a long-term historical context. The lack of the normal winter westerlies also resulted in dry conditions in normally high-rainfall coastal areas, with western Norway having its driest winter on record (72% below normal). While strong westerly winds were infrequent for most of the winter, a severe winter storm (Xynthia) crossed northwestern Europe at the end of February, causing widespread wind and storm surge damage, especially in France where wind speeds exceeded 150 km/h on the west coast. Further south in Europe, it was a very wet winter, with precipitation widely 100% or more above normal over Spain, Portugal, Italy and south-eastern Europe.

Northern Africa recorded warm conditions during winter. February temperatures averaged 3.7°C above the long-term average over the Saharan/Arabian region, the largest anomaly on record for any month. In late February temperatures reached between 30 and 36°C in northern Algeria, the highest for February since 1980. Winter temperatures were also well above normal over Turkey and the Middle East.

In North America the normal north-south gradient of temperature was much weaker than normal. Canada had its warmest winter on record, with national temperatures +4.0°C above the long-term average; winter temperatures were 6°C or more above normal in parts of the country's north. (It went on also to have its warmest spring on record, with temperatures +4.1°C above the long-term average). The warm conditions extended further east in the Arctic to cover Greenland and Spitsbergen. Canada also had its driest winter on record, with especially abnormal dry conditions in British Columbia (which combined with unusually high temperatures to cause poor snow conditions for some events at the Winter Olympics in Vancouver). In contrast, most of the continental United States (except for the far northwest and northeast) was colder than normal. For the United States as a whole it was the coldest winter since 1984-85, and most southern areas from Texas eastwards had one of their 10 coldest winters on record. These cold conditions were accompanied by unusually extensive snow cover, and very heavy seasonal snowfall amounts in some eastern cities, including a record seasonal total in Washington D.C.

Heavy rains and flooding

Large parts of Indonesia and Australia experienced heavy rains in 2010 as a La Niña event developed, with particularly unusual rains from May onwards (normally the driest time of the year). In Indonesia, at least double the normal monthly rainfall fell in each of the months from June to October in most of Java, the islands east of Java and southern Sulawesi. The May-October period was the wettest on record for northern Australia with rainfall 152% above normal, while above-normal rains further south contributed to an easing of long-term drought in parts of the southeast. The spring was especially wet, and, averaged over Australia, was the wettest on record.

Whilst seasonal rainfall was not as persistently above normal further north in southeast Asia, both Thailand and Vietnam experienced major floods in October with significant loss of life and economic damage.

Many other parts of the world were affected by significant floods during 2010. An active wet summer monsoon season in the West African Sahel was accompanied by floods from time to time, with Benin and Niger the countries most severely affected. In Benin, this caused the worst flooding on record in terms of impact, causing severe losses to the agriculture sector and severe disturbances to public services, including cutting access to health centres, although rainfall amounts themselves were mostly not record-breaking.

Central Europe had major floods in May, particularly in eastern Germany, Poland and Slovakia; in late June flooding occurred in Romania, Ukraine and Moldova, and later Germany had its wettest August on record. Bursa (Turkey) had its wettest January-October on record (1152 mm, 132% above normal), while precipitation averaged over Romania for the January-October period was 34% above normal, and the northern Bohemia region (Czech Republic) had its wettest year since 1981.

In South America, Colombia had its most severe floods in more than 30 years in November. More localised flash floods caused severe damage and loss of life in numerous other locations, including Rio de Janeiro, Brazil (April), Madeira (February), Arkansas, United States (June) and southern France (June).

Drought in the Amazon and elsewhere

Parts of the Amazon basin were badly affected by drought during the later part of 2010. An unusually dry July-September period in northwestern Brazil resulted in sharply reduced streamflow in many parts of the Amazon catchment, with the Rio Negro, a major Amazon tributary, falling to its lowest level on record. Earlier in the year, Guyana and the eastern Caribbean islands were badly affected by drought, with rainfall for the period from October 2009 to March 2010 widely in the driest 10% of recorded years.

In Asia, parts of southwestern China experienced severe drought through late 2009 and early 2010. Yunnan and Guizhou provinces both had their lowest rainfalls on record during the period from September 2009 to mid-March 2010 with totals widely 30% to 80% below normal. The dry conditions were also accompanied by above-normal temperatures and numerous forest fires. Conditions there eased with good rains during the summer. Pakistan also experienced drought in the early months of 2010 before the onset of the monsoon. Summer rains also eliminated developing drought conditions in parts of western Europe, where the United Kingdom had its driest January-June period since 1929.

Some other parts of southern Asia, including northeastern India, Bangladesh, and parts of Thailand and Vietnam, were relatively dry during the main monsoon season, although Thailand and Vietnam were then hit by floods in October. Whilst widespread above-normal rains eased long-term drought in many parts of Australia, the southwest was a marked exception, with January-October 2010 being the region's driest such period on record.

El Niño, La Niña and other major large-scale climate drivers

2010 began with an El Niño event well established in the Pacific Ocean. This broke down quickly in the early months of the year. A rapid transition took place and La Niña conditions were in place by August. By some measures the La Niña event in progress in late 2010 is the strongest since at least the mid-1970s. The atmospheric response has been especially strong, with the Southern Oscillation Index (SOI) reaching its highest monthly value since 1973 in September. The El Niño-to-La Niña transition is similar to that which occurred in 1998, another very warm year, although in 2010 the El Niño was weaker, and the La Niña stronger, than was the case in 1998.

The eastern tropical Indian Ocean was also significantly warmer than normal during the second half of 2010 (negative Indian Ocean Dipole), in contrast with the previous La Niña event in 2007-08 when it was generally cooler than normal. The Arctic Oscillation (AO) and North Atlantic Oscillation (NAO) were in a negative phase for most of the year, exceptionally so in the 2009/10 Northern Hemisphere winter, which on most indicators had the most strongly negative seasonal AO/NAO on record. The Antarctic Oscillation (AAO) (also known as the Southern Annular Mode (SAM)) was in positive mode for most of the year, reaching its highest monthly values since 1989 in July and August.

Tropical cyclone activity well below normal, except in the North Atlantic

Global tropical cyclone activity was well below normal in 2010, except in the North Atlantic. A total of 65 tropical cyclones have been observed so far in 2010, of which 35 have reached hurricane/typhoon intensity as of 30 November. These are both well short of the long-term averages of 85 and 44 respectively. It is likely that the final total for the year will be the lowest since at least 1979.

Tropical cyclone activity was especially sparse in the North Pacific Ocean. Only 7 cyclones occurred in the Northeast Pacific and 14 in the Northwest Pacific (long-term averages 17 and 26 respectively). Both the Northeast and Northwest Pacific totals were the lowest on record for January-November. In contrast, the North Atlantic had a very active season with 19 named storms and 12 hurricanes, which is equal second highest behind the record of 15 set in 2005 (long-term averages 10 and 5 respectively).

The strongest tropical cyclone of the year was Supertyphoon *Megi*, which crossed the northern Philippines in October after reaching a minimum central pressure of 885 hPa, making it the strongest tropical cyclone in the world since 2005 and the strongest in the Northwest Pacific since 1984. *Megi* caused widespread damage to infrastructure and agriculture in the northern Philippines, Taiwan and Fujian province in China, but only limited casualties. *Tomas* (North Atlantic, November) reached category 2 intensity, but its associated rains contributed to the spread of a cholera epidemic in Haiti.

Polar regions: third-lowest Arctic summer sea ice minimum on record

Arctic sea-ice extent was again well below normal in 2010. The minimum extent of Arctic sea ice was reached on 19 September with an area of 4.60 million square kilometres, the third-lowest seasonal minimum in the satellite record after 2007 and 2008, and more than 2 million square kilometres below the long-term average. The autumn 2010 freeze-up has also been abnormally slow, with the ice cover as of 28 November being the lowest on record for the time of year. The Canadian sector had its lowest summer ice extent on record. The low ice cover was consistent with well above normal temperatures over most of the Arctic, with numerous stations in Greenland, as well as the Greenland/Arctic Canada region as a whole, having their warmest year on record with annual mean temperatures 3-4°C above normal.

In contrast, Antarctic sea ice extent was generally slightly above normal in 2010, with the lowest monthly average being 3.16 million square kilometres in February, 0.22 million square kilometres above the long-term average. Temperatures averaged over the Antarctic region were also slightly above normal.

Background to data used in this statement

This preliminary information for 2010 is based on climate data from networks of land-based weather and climate stations, ships and buoys, as well as satellites. The data are continuously collected and disseminated by the National Meteorological and Hydrological Services (NMHSs) of the 189 Members of WMO and several collaborating research institutions. The data continuously feed three main depository global climate data and analysis centres, which develop and maintain homogeneous global climate datasets based on peer-reviewed methodologies. The WMO global temperature analysis is thus principally based on three complementary datasets. One is the combined dataset maintained by both the Hadley Centre of the UK Met Office and the Climatic Research Unit, University of East Anglia, United Kingdom. Another dataset is maintained by the National Oceanic and Atmospheric Administration (NOAA) under the United States Department of Commerce, and the third one is from the Goddard Institute of Space Studies (GISS) operated by the National Aeronautics and Space Administration (NASA). Preliminary November 2010 information is drawn from the ERA-Interim reanalysis-based data set maintained by the European Centre for Medium-Range Weather Forecasts (ECMWF). The content of the WMO statement is verified and peer-reviewed by leading experts from other international, regional and national climate institutions and centres before its publication.

Final updates and figures for 2010 will be published in March 2011 in the annual WMO Statement on the Status of the Global Climate.

Note 1. The +/- 0.11°C uncertainty has been calculated from the HadCRU data set only. It is likely that the uncertainty for the three data sets combined is marginally lower than this but this has not been quantified.

Note 2. Uncertainty margins for 2005 and 1998 are +/- 0.10°C

Note 3. The ERA-Interim reanalysis is produced by the European Centre for Medium-Range Weather Forecasts (ECMWF).

Note 4. The sub-regions used in this report are those defined by the IPCC (available at http://www.ipcc.ch/ipccreports/tar/wg1/fig10-1.htm with some regional names slightly modified. Sub-regional temperature anomalies are drawn from the HadCRU data set.

Note 5. According to a Moscow city health official quoted by the AFP news agency http://www.terradaily.com/reports/Russian_heatwave_caused_11000_deaths_in_Moscow_official_999.html

Source: WMO Website http://www.wmo.int visited on December 04, 2010. WMO Press Release # 904.

The World Meteorological Organization is the United Nations' authoritative voice on weather, climate and water.

Top 10 Canadian Weather Stories for 2010

by David Phillips[1]

Abstract

Mother Nature reminded the world who's boss in 2010. From devastating killer earthquakes to menacing volcanoes and ever-frightening tsunamis, her wrath was widespread and powerful. When it came to the weather, relentless, unstoppable extremes wreaked havoc everywhere. Thousands of people lost their lives and millions more were left homeless and out of work. Among this year's worst weather disasters were: a millennium-record heat wave and massive wildfire in Russia; the worst monsoonal flooding in Pakistan's history; rain-induced landslides and the worst floods in decades in China; severe drought in sub-Saharan Africa and the Amazon basin; and the calving of the largest iceberg in nearly 50 years in Greenland. Unbelievably, these weather events all happened over a one-month period!

Canadians were left in awe of the power and force of Nature, but also quietly thankful for living in a country that – while not immune from Nature's wrath – remains fairly unscathed and slightly off her radar. Complaints about frostbite, humidity, potholes, slush and brownouts seemed to pale in comparison to the deadly weather outside our borders. However, with or without climate change, weather extremes are becoming increasingly catastrophic for modern society as a whole.

While 2010 left Canadians largely spared for the most part, we still experienced a good dose of extreme weather. There were forest fires, "weather bombs", big snows and expensive hailers. Property damage from weather cost Canadian insurers and governments millions of dollars and the economy billions. Vancouver played host to this year's number one weather story – the good, the bad and the ugly at the Vancouver 2010 Olympic and Paralympic Winter Games. After a promising start to winter, things took a turn for the worse as mild, rainy weather leading up to the Opening Ceremonies and into the first three days of competition owned the podium. Fortunately, the weather changed and so did the mood, with Canadians basking in the success of the Games despite the horrendous early weather. Newfoundland and Labrador claimed the number two weather story after facing the frightening force of Hurricane Igor. In a province that is no stranger to storms, vigorous Igor was the most destructive in Newfoundland's history. For Canadian farm producers, this year's weather offered the wettest growing season ever and some of the best growing weather ever. Prairie farmers and ranchers struggled during a record wet spring and summer, but the weather turned out to be their best ally when fall warmth, dryness and abundant sunshine helped to salvage what would have been a disastrous harvest. Canada was spectacularly warm in 2010 – the 14th in a row. In 63 years of weather reporting, 2010 was the nation's warmest ever with milder weather throughout the year. It featured the warmest winter and spring ever, the third warmest summer and the second warmest fall. Every region felt the warmth. One of the impacts of these warmer seasons is that ice that has covered the top of the planet for thousands and thousands of years continues to disappear. And not just in the Arctic. This year, it was practically ice-free in Atlantic Canada and the Gulf of St. Lawrence. Globally, it was the third warmest year on record over the past 160 years according to the World Meteorological Organization. Further, 2001-2010 culminated in the highest temperature average for a 10-year period.

Other top Canadian weather stories for 2010 included: a welcomed warm summer in eastern Canada that left us sweaty and wet but not smoggy; frequent spring-summer severe weather in Saskatchewan that led to extreme flooding and record property losses; wild November gales around Manitoba and the Great Lakes; and a brief but record costly Calgary hailstorm. In addition, the year had a cancelled winter and a summer of summers. And the forest fire season was one of contrasts: generally quiet across Canada with the exception of British Columbia, where huge tracts of valuable timber burned in one of the most expensive years ever for fighting fires.

Among the runner-up stories this year was a marine "weather bomb" in the Gulf of St. Lawrence, London's "Snowmageddon", tornadoes in Leamington and Midland, a month of spring snows on the Prairies, frequent summer (not spring) flooding in Manitoba, a welcomed warm summer in eastern Canada with sweat and wet but no smog, and huge gully washers in both the driest and wettest parts of Canada.

The following **Top Canadian Weather Stories for 2010** are rated from one to ten based on factors that include the impact they had on Canada and Canadians, the extent of the area affected, economic effects and longevity as a top news story.

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Top Ten Canadian Weather Stories for 2010

1	**Spring Weather for the Olympic Winter Games**
2	**Vigorous Igor**
3	**From Dry to Drenched on the Prairies**
4	**Canada's a "Hottie"!**
5	**Storm for the Ages: "Flurries", Fury and Floods**
6	**Saskatchewan's Summer of Storms**
7	**British Columbia Forest Fires ... Costly and Smoky**
8	**El Niño Cancels Winter**
9	**Freak Canada-U.S. "Weather Bomb"**
10	**Canada's Most Expensive Hailstorm**

1. Spring Weather for the Olympic Winter Games

The Vancouver Organizing Committee (VANOC) promised the XXI Vancouver 2010 Olympic and Paralympic Winter Games would be the "greenest on record". Oh, were they right! But never could they have anticipated that the Olympic city would experience its mildest winter ever and one that was practically snow-free – far worse than the 1-in-100-year winter organizers feared. One of the biggest worries for officials was the possibility of El Niño, an episodic warming of the equatorial Pacific Ocean that occurs every two to five years. There have been 17 El Niño events over the last 60 years and, of those, Vancouver experienced 14 warmer than normal (3 colder) and 14 with less snow than normal (3 with more snow). Unfortunately, El Niño emerged in the summer of 2009, grew in strength and followed the majority of its predecessors in regard to its impact. While organizers and volunteers prepared for every eventuality at the Winter Games, including the weather, the reality is that no-one can control Mother Nature. Climatologically, Vancouver was the warmest bid city in history. The risk was high; the pressure at home and abroad was enormous.

Weather conditions leading up to the Olympic year couldn't have been better. Vancouver's International Airport reported 11 cm of snow in October 2009 – five times more than the previous record for October and more snow in that month than any other major Canadian city. December was colder than average by about 1.5°C. At Whistler-Blackcomb, home to the downhill ski events, November set a record of over five metres of snow in the alpine area of the mountain – almost four times the average monthly total. Cold temperatures also made the snow dense and perfect for sliding. The resort opened November 14, nearly two weeks before the official opening date and the second earliest opening ever. Snow covered the slopes at Grouse and at Cypress Mountain near Vancouver – site of the snowboarding and freestyle skiing events. On January 1, 108 cm of "white gold" lay on the ground at the Cypress Bowl – quieting fears that an emerging El Niño might create havoc for the Games.

But with the New Year, conditions abruptly changed as a strengthening El Niño combined with soaking Pineapple Express storms. At times in Vancouver, January was looking and feeling more like April. A warming and drenching January-February set the stage for frantic preparations at what was now snow-starved Cypress Mountain, where the slopes looked better suited for mud wrestling than snowboarding. Up to 300 workers toiled around the clock, moving 9,000 cubic metres of snow by hand-shovelling, trucking, bulldozing and choppering it in from stockpiles up to 250 km away. They brought in straw bales and wood to shape the course, used dry ice embedded in the moguls and aerials' ramp to impede the melting, and spread urea on the snow surface to preserve and bind it, only to have a continuous onslaught of heavy rain and warm winds eat away at the fruits of their efforts. The following are examples of some of the weather impediments leading up to the Games:

- Vancouver's temperatures in January soared above 10°C for 13 days, far more than the 3-day average. The mercury rose as high as 14.1°C and did not fall below -2.7°C. There were only two freeze days (five hours in total) – far below the twelve days below freezing normally seen in Vancouver for that month.

- Vancouver has never seen a warmer stretch of winter weather than the 31-day period ending on February 9, with records dating back 114 years. For 40 consecutive days between January 8 and February16, the average temperature at Vancouver stayed above 5.2°C; the previous string of days above 5.2°C was 18 in 1998.

- The city did not get any snow after December 14, while it normally averages 35 cm. In the 50 days prior to the opening ceremonies, Vancouver experienced only 7 dry days, no snow and a total of 247.2 mm of rain.

Organizers at Whistler had their own weather challenges: heavy wet snow on the top part of the downhill course, thick fog in and out of the middle sections, and rain and warm temperatures at the bottom. At times, too much snow was a problem and it had to be scraped off and runs watered to keep them icy, hard and fast.

The day before the opening ceremonies, weather further decimated Cypress Mountain. Wind and relentless rains pounded the course before the afternoon qualifying session, leaving doubt as to whether the event would take place. Weather conditions on Day 1 were hugely disappointing. It was 10°C in Vancouver with a soaking rainstorm heading toward the Lower Mainland. On the barren slopes of Cypress Mountain, spectators huddled in driving rain to watch skiers compete on mushy snow in and out of the fog. Major news outlets and prominent websites around the world featured Vancouver's spring-like weather conditions and its new moniker, the "Rain Games", as doubt turned to ridicule.

By the beginning of the first full week of the Winter Olympics, the stubborn Pacific low moved south and was replaced by a blocking high pressure system with its bright, clear skies and mild, dry weather for seven straight days. Finally, the Olympic spirit started catching on. Spectators from around the world partied it up. Stadiums filled and competitions got exciting. British Columbia became beautiful again with the sun shining, cherry trees blossoming, and daffodils blooming. The international media, which had largely savaged the Vancouver Games, focussed on the competitions and not the weather. In the final days, however, the blocking pattern broke and cloudy, showery weather took hold once again.

Less than two weeks after the end of the Olympic Games and just prior to the start of the Paralympic Games at Whistler, winter returned producing some of the best snow conditions all winter. Of course, there were some weather moments. On the opening day of the Paralympic Games, persistent thick fog and heavy snow created poor visibility, forcing postponement of the alpine ski events. Ironically, on April 1, five weeks following the Olympic Games, Cypress Mountain was waist deep in fluffy snow. Cold air and lots of white stuff transformed the once-bare slopes of Cypress into a winter playground.

In spite of the horrendous weather leading up to the Opening Ceremonies and continuing through the first three days of the Winter Games, the event was a renowned success. When the weather changed, so did the mood, culminating in an emotional uniting of the entire nation.

2. Vigorous Igor

Meteorologists foresaw an active hurricane season in the Atlantic Ocean in 2010. As it happened, 19 named storms from Alex to Tomas formed in the Atlantic Ocean, Caribbean Sea and Gulf of Mexico – well above the long-term average of 11 and the third highest total on record. Twelve full-blown hurricanes occurred compared to a normal of six storms, with five logged as major at Category 3 or higher. Key to the busy season was the emergence of La Niña in July, which gathered strength as the year rolled on. La Niña favours lower wind shear over the Atlantic Ocean, allowing storm clouds to grow and organize. Other climate factors included warmer-than-average water temperatures in the tropical Atlantic and Caribbean, and the tropical multi-decadal trend that has brought favourable ocean and atmospheric conditions in unison since 1995.

September was the busiest month with eight storms, tying 2002 for the record number of named storms forming that month. It started with Hurricane *Earl* heading hard and fast for the Canadian Maritimes at the beginning of the Labour Day weekend. Early on September 4, the storm made landfall along the south shore of Nova Scotia west of Halifax as a low Category 1 hurricane with sustained winds of 119 km/h. *Earl* was soon downgraded to a tropical storm but remained intense as it swept northeast across the province before moving into the Northumberland Strait and across eastern Prince Edward Island. The region around Halifax took a hard, wet hit with wind gusts reaching 120 km/h and rainfalls exceeding 50 mm. In eastern Quebec, heavy rains around 85 mm fell between Sept-Îles and Manicouagan, while the northern coast of Gaspésie received 40 to 50 mm of rain in less than six hours. The majority of the storm rain was not tropical in origin but came from an extratropical system entering from the west. Besides driving rain, *Earl* generated 25 m peak waves west of the Scotian Slope. It also kicked up some dangerous riptides along the coast. The storm's strong winds pulled several boats from their mooring and dashed a few smaller boats against the rocks. One man died as a result of the storm. *Earl* also left Halifax streets, beaches and parks littered with downed branches and foliage, and more than 220,000 customers in the Maritimes without power. The wind rattled apples in the Annapolis Valley but little of the bumper crop got bruised or banged. Orchardists felt lucky because they were spared the peak winds that were forecasted. Instead, they got needed rains.

On September 20, Hurricane *Igor* brushed northwest past tiny Bermuda, whipping the territory with fierce winds and rain but sparing it a devastating direct hit. *Igor* was still a hurricane the next day as it tracked just offshore of the Avalon Peninsula but was soon to become a post-tropical storm. Initially, models had *Igor* bypassing Canada. However, as the storm moved further north, it failed to steer as far east as expected. Hurricane-force winds ripped across eastern Newfoundland with a savagery that forced 22 flooded and wind-battered towns to declare states of emergency. Over 150 communities became isolated when swollen rivers washed away the only roads into town and all connecting bridges.

Maximum winds circulating around the storm's centre increased from about 120 km/h to 140 km/h as it approached the province. Adding to Igor's strength and moisture content was a sharp upper weather front that tracked slowly eastward across Newfoundland. The complex weather system, with bands of heavy rain, had a huge circulation and reach. A peak wind speed of 172 km/h was recorded at Cape Pine in southeastern Newfoundland and Labrador – rare for September and the broad expanse of extreme winds even rarer for that time of year. Rainfall records were set in several places. The highest was at St. Lawrence, on the Burin Peninsula, where an unprecedented 239 mm drenched the community in about

20 hours. Many other stations reported in excess of 150 mm, breaking century-old records.

Newfoundlanders appeared dazed by the degree of the damage and extent of the storm's impact. The storm was the province's worst by far. In addition to taking out power for 70,000 hydro customers, water flowed everywhere, overwhelming culverts, filling basements, destroying homes, wharfs and boats, and eroding road beds. *Igor's* drenching also caused rivers to swell, leading to more than 150 ruptures in roads and bridges. The Insurance Bureau of Canada says insurable claims related to *Igor* amounted to $65 million – only a fraction of the total losses – yet the biggest weather-related insurance claim in Newfoundland and Labrador in recent history. Non-insured costs exceeded $120 million.

The worst of the rainfall from *Igor* missed St. John's, but the winds were fierce. In countless communities, boil water advisories were in place and food and fuel ran short. Heavy rain turned roads into rivers and tore out chunks of asphalt. Washouts closed the Trans-Canada Highway and the main access roads to the Bonavista and Burin peninsulas for several days where towns and outports were the hardest hit. Miraculously, there was only one storm-related death. The Canadian military quickly moved in to help in the restoration work. The mission involved more than 1,000 soldiers and military engineers and heavy equipment, along with navy ships and Sea King helicopters. Further, thousands of workers and volunteers toiled tirelessly to restore a sense of normalcy in short order, though it will be well into 2011 before damaged infrastructure, such as roads, is completely restored. In many ways *Igor* was a life changer. Communities will never be the same, Newfoundland geography was destroyed or altered forever. Families lost everything. And moreso, it changed the psyche of the people forever. While not a major killer storm, *Igor* was a destroyer – the worst in a province famous for its storms.

In early November, a large trough and front over eastern North America drew loads of moisture and tropical rains northward from Hurricane *Tomas*. Six-day rainfall amounts over southern New Brunswick and western Nova Scotia caused the worst flooding in a century, with dozens of road washouts and bridge collapses like the 20-m Tusket River bridge in Nova Scotia. The flooding was the worst in over 100 years for some areas. Continuous rains swamped homes and cottages, turned farmers' fields into lakes and chewed away roads. Property damages covered by insurance approached $100 million; double that for infrastructure costs. The slow motion storm swooped over the Maritimes leaving thousands without power and disrupting all forms of travel. Storm rainfall totals were unbelievable, even if they were for six days, and included: Yarmouth 215 mm; Halifax International Airport 172 mm; Kejimkujik National Park 222 mm; Mechanic Settlement (near Bay of Fundy National Park) 339 mm; Saint John 167 mm; and Charlottetown 107 mm.

3. From Dry to Drenched on the Prairies

Before the growing season started, Western ranchers said they had never seen such a dry spring. In Camrose, Alberta a drought was declared before April and, across the Prairies, agricultural producers hoped and prayed for rain. A decade-long drought, however, had most convinced it would be another dry growing season. With minimal snow cover and record low precipitation between January and March, winter 2010 gave growers little optimism.

Above-normal temperatures in spring meant an early start to planting in southern and western growing areas, and in mid-April – almost miraculously – it started to rain. But when the precipitation refused to let up, drought worries became flood worries. By mid-May, farmers were begging for dry weather so they could at least get onto their fields. There was twice as much rain and snow as normal during April and May, making 2009 (the driest spring in 51 years) and 2010 (the wettest ever) complete opposites. The weather circulation over the West was sluggish and monotonous, with one or two storms a week keeping the southern Prairies cool and moist in a northwesterly flow. As the rains persisted into June, farmers grew more concerned. Nearly a quarter of the Prairie grain crop had yet to be sown or was under water by mid-month. The Canadian Wheat Board estimated that between 3 and 5 million hectares went unseeded – the largest abandoned hectarage in Western Canada since 1971. Summer brought no change. If spring was too wet to seed, summer was too wet to grow. With a scarcity of hot days and sunshine, water was not evaporating and crops were not maturing. But lukewarm temperatures in July offered just enough warmth to trigger thunderstorms and hailers. Calgary had just one day above 30°C and that didn't happen until August 26. Edmonton had only one day above 30°C and it was on May 18.

Never-ending rains continued into the critical harvest months with huge tracts of land receiving double the average rainfall between mid-August and mid-September when the spring wet weather pattern was re-established. To some producers, September was the cruelest month. Heavy trucks and combines couldn't manoeuvre waterlogged fields. Never had so much crop been out so late into the harvest. To add more woe, in mid-September a severe frost with temperatures dipping as low as -5°C struck Alberta and western Saskatchewan. The freeze lasted for over 10 hours, severely downgrading the quality and value of the crop. Fortunately, growers finally got a break on the first day of the fall season when warm, dry and sunny conditions set in and prevailed through October. The perfect weather enabled farmers to make up for time lost earlier. Almost every day over four weeks had maximum temperatures above normal and it was thankfully dry. Growers worked night and day and, incredibly, harvested a record 70 per cent of the crop in three weeks.

While most of the southern wheat-growing area was a soggy mess, Alberta's northwest experienced a prolonged drought that left many growers with bone-dry pastures and stunted crops. Because of critically low precipitation, a third of normal since mid-May, the County of Grande Prairie declared itself an agricultural disaster zone for the third straight year – only getting this dry once in the last 25 years. The river gauge at the town of Peace River showed water levels in July at their third-lowest in 70 years.

In Saskatchewan, growing season rainfall totals were unbelieveable in places – none more incredible than at Saskatoon where the total April-to-September precipitation was 645 mm. The previous wettest period was in 1923, when 420 mm fell, making 2010 an astounding 54 per cent wetter than the record with observations dating back to 1892. Rosetown also had the wettest April-to-August period on record with double the norm. Regina's total rainfall was 517 mm compared to a normal of 287 mm, which beat the record wettest growing season of 503 mm set in 1954 (records date back to 1883). Along with the rain, it experienced five consecutive months of cooler-than-normal temperatures. Not to be outdone, Winnipeg recorded its wettest growing season ever at 630.5 mm with records dating back to 1873.

Crop yields were down and so was the quality. Statistics Canada reported 15 per cent less wheat harvested than in 2009 (21 million tonnes and an average yield of 40 bushels per acre). Nearly 40 rural municipalities declared themselves agricultural disaster areas, and the entire farm economy – from fertilizer, seed and pesticide sales to farm equipment purchases – suffered. To top it off, bank economists projected that wet weather could wash away up to $3 billion from the pockets of Prairie farmers.

4. Canada's a "Hottie"!

If you were to stick a thermometer into Canada at any time this year, it was sure to say "well done". That the year began with the mildest winter on record was remarkable in its own right. But what followed was truly phenomenal – we had the warmest spring, the third warmest summer and the second warmest fall on record, making 2010 the warmest year in 63 years.

Temperatures for the 12-month period spanning December 2009 to November 2010 averaged 2.9°C warmer than normal and almost a half degree higher than the previous warmest years (2006 and 1998). It was also the 14th consecutive year with above-normal temperatures. The story was similar across the country. Every region was warmer than normal, with the Arctic, Atlantic Canada and the eastern Canadian boreal forest being the warmest on record and the Great Lakes/St. Lawrence, northern British Columbia and Yukon being the second warmest. This year's El Niño accounted for much of the warmth in 2010, but La Niña's emergence before August didn't seem to subtract from the year's record warmth.

Winter 2009-2010 was the warmest in Canada since nationwide records began in 1948, logging in at 4.0°C above normal. The national average temperature for spring 2010 was 4.1°C above normal, which was the greatest temperature departure of any season in 63 years of records. The season's temperature records were shattered across the Canadian North, with some more than 6.0°C higher in certain Arctic areas. Summer was also warm, with the national average 1.3°C above normal, making it the third warmest on record. As the year-end approached, weather data showed that the average temperature from January 1 to November 31 was 2.9°C warmer than normal – the warmest first 11 months on record. Several places registered their warmest year on record in 2010. Most noteworthy were several weather stations in the North. For example, at Iqaluit, the average daily temperature was -4.2ºC, almost 5 degrees warmer than normal and 2.4 degrees warmer than the previous record in 2006. Credit a couple of factors for the warmth in 2010, including a moderate to strong El Niño (a warm Pacific current that lingered for the first few months), less ice in the Arctic and, likely, climate change.

There is no question that the Canadian climate is changing, as all seasons have shown a warming trend since 1948. Change in the Canadian Arctic is the most pronounced as it could eventually leave the Arctic ice-free in the summer months. That's not likely just a result of warmer Arctic temperatures. It's not inconceivable that unusual and extreme weather occurring anywhere in the Northern Hemisphere might be linked to the vanishing of ice at the top of the world. Polar ice is one of the major forces that controls and drives climate across the world.

With consistently warmer temperatures, it is becoming increasingly more difficult to grow sea ice in the Arctic Ocean. With one of the warmest fall-winter-springs on record, sea ice never grew thick, hard and far. For example, in January, sea ice grew an average 34,000 square km a day, which is slightly more than one-third the pace of ice growth during the 1980s. Further, with more storms (in part because of more open water), ice now forms less readily. Also of note, new-year ice in the North is increasingly thinner. Multi-year ice – the thick, hard stuff that stops ships – now comprises only 18 per cent of the Arctic ice pack; 30 years ago it was 90 per cent.

According to Environment Canada's Canadian Ice Service, sea ice in northern Canadian waters started to melt in the spring two to three weeks earlier than normal. The melt continued through the summer, resulting in a record low total ice concentration, with records dating back to 1971. Total accumulated ice in the summer covered about 33 per cent of northern Canadian waters – about 7 per cent less than that of the previous record in 1998 and about 28 per cent less than that of the long-term average from 1971-2000. On September 10, the low point of the ice season in terms of coverage, the ice extent was almost half that of the long-term average (748,100 square km vs. 1,544,800 square km).

For the Arctic Ocean, data from the United States National Snow and Ice Data Center indicated that ice cover was retreating fast in May, an average of 68,000 square km a day and more than in any previous May since satellite monitoring began over 30 years ago. However, 2010 did not produce a record meltdown in the Arctic Ocean. Still, by mid-September, minimum Arctic sea ice levels had reached 4.76 million square km – their third-lowest ice extent in the last 30 years and close to the stunning retreat that occurred in 2007 when ice shrank to 4.28 million square km. Also noteworthy: the minimum ice extent in 2010 occurred on September 19, which was eight days later than average; sea ice volume plunged to a new record low in 2010 according to the University of Washington's Polar Science Centre; and, for the first time, both Canada's Northwest Passage and Russia's Northeast Passage were ice-free at the same time.

Looking back at the year, a warmer Canada is in step with what is happening across the world as reported by the UN's World Meteorological Organization. Globally, 2010 was the 32nd consecutive year with above-normal temperatures and was also in the top three of the warmest years since observations began 160 years ago. The ten warmest years globally have all occurred since 1990; the top three since 1998. Further, 2001-2010 was the warmest ever for a ten-year period.

5. Storm for the Ages: "Flurries", Fury and Floods

Two weeks before Christmas, a massive and powerful storm crawled across the eastern half of North America inflicting death, destruction and extreme hardship on thousands of people. The intense system originated west of the Great Lakes, but its reach and misery were felt everywhere in the East. It will be best remembered for the snow and wind that took down the inflatable roof of the Metrodome in Minneapolis. But it also generated a freeze scare in Florida's vegetable fields and delayed a scheduled test of the space shuttle Discovery. In the central U.S., it clogged countless highways and delayed thousands of flights. At least 15 deaths were attributed to the storm.

In Canada, the historic storm was even meaner and more punishing but much less deadly. Across Ontario, the storm brought the usual mix of rain, snow and freezing rain, but it was on exiting the province on December 13 that it had the greatest impact. Following a fresh deposit of 15 cm of snow, cold air and strong winds raced across the relatively warm open waters of Lake Huron brewing up a new batch of lake-effect snow that headed west of London into Lambton County and Sarnia. Driven by wind gusts of 80 km/h, it dropped up to 40 cm along the way creating total whiteouts and hip-height drifts on roads that soon became impassable. The blinding blizzard trapped hundreds of motorists along 30 km of Highway 402 between Sarnia and Strathroy. Authorities declared a state of emergency and quickly closed the highway and county roads and suspended traffic between Canada and the United States at the Blue Water Bridge. (Among the many impacts of the border closure and road shutdowns was a parts shortage for manufacturers in Ontario and Michigan, especially among auto makers.) Lines of stranded traffic seemed endless. Jackknifed trailers and buried cars littered both sides of the highway. In total, over 200 tractor trailers and 100 cars were stopped dead in walls of snow. For 300 isolated souls, their vehicles became the only shelter against zero visibility and in cold that felt like -25 with the wind chill. Several dozen stranded motorists trudged to emergency warming centres and farm houses along the highway. In a Herculean rescue effort, local residents, farmers, volunteers from snowmobile clubs, tow truck operators, 100 provincial police and 20 Canadian Forces military personnel worked to ensure the stranded were taken to safety or reunited with their vehicles by afternoon the next day. Unfortunately – despite this tremendous effort – one motorist died of exposure just 50 m from his car.

The potent storm waited until the end to unleash its greatest fury on already weather-beaten residents in eastern Quebec and the Maritime provinces. On December 13, the storm swept into the Maritimes and slowed right down over western New Brunswick. Re-supplied with energy and moisture from the Atlantic Gulf Stream, it drenched and buffeted Eastern Canada with humongous rainfalls and hurricane-like winds. On the first day, temperatures in New Brunswick soared to record highs around 15°C and the winds were powerful, gusting between 80 and 120 km/h, with even stronger winds across Cape Breton Island and in western Newfoundland and Labrador. Some buildings lost their roofs and hundreds of hydro poles were left leaning or severed, resulting in a loss of power to more than 100,000 residents. In the Annapolis Valley, some homes and businesses were without power for four days. High winds also forced restrictions on travel. Copious amounts of rain, in excess of 175 mm in less than 24 hours (incredible for December), fell near St. Stephens, New Brunswick on ground already saturated from heavy rains in the fall. In Bayside 185 mm of rain fell, making it the wettest day in New Brunswick weather history. The previous record was 179.1 mm in Alma on April 1, 1962. In Fredericton, 105 mm of rain on December 13 was one of ten wettest days ever in the capital with records dating back to 1871. The flooding was worse in St. George and Bonny River on the south coast. Waters flowed out of the woods, across fields, into parking lots, onto road surfaces and into basements. Rescue teams used boats to bring residents to the nearest shelters in the middle of the night. There were countless road and bridge washouts, rail beds undermined and power disruptions. Between Saint John and Fredericton, over 100 roads were barricaded. In the wake of the torrential rains, officials issued flood warnings and states of emergency in St. Stephen and several other towns and villages. The spring season River Watch was put into effect – something practically unheard of in the fall – as water along the Saint John River exceeded flood levels by a metre.

On Cape Breton Island, torrential rains also took out roads, bridges and concrete culverts, and caused rock and mudslides. High winds and rain prompted the closure of roads along the famous Cabot Trail. By the middle of the month, 251.5 mm of rain had fallen at Sydney, which is three times the city's normal accumulation for the first half of December.

In Quebec, the town of Gaspé was declared a flood zone after two days of driving rainfalls exceeding 200 mm – clearly the wettest two days in its history and one of the greatest rainfalls in the province's history. Unbelievable rains fell in the first two weeks of December, almost six months worth or 357 mm, with half of the month still to come. It had already been the wettest fall on record, with a September-to-November total of 505 mm – 178 per cent of normal – and it was taking its toll on the ground and river courses. In the Gaspésie, rising waters forced hundreds of people to flee their homes. Along the coast, storm surges whipped up waves as high as 10 m. One resident said it was the worst flooding that he had seen since the 1970s. Roads were washed out and 500 homes were flooded in what a local official called a "catastrophic and historic" storm. The flooding caused millions of dollars in damage to local infrastructure and rendered some homes and businesses beyond repair. When water submerged railway tracks in the area, Via Rail suspended train service to and from Gaspé. Additionally, heavy rain north of Sept-Îles caused a landslide that affected the delivery of materials to Schefferville and Labrador.

6. Saskatchewan's Summer of Storms

From microbursts, hailers, twisters and gully washers to funnel clouds and plough winds, Saskatchewan experienced almost everything nature could possibly throw at it this summer. Residents seemed to be in a constant state of clean-up and worry about what would come next. What is typically the driest province was never wetter. Property and auto insurance claims from the summer's incessant wild weather reached well over $100 million – the highest on record. And Saskatchewan Emergency Services estimated that the government-run Provincial Disaster Assistance Program probably dealt with as many claims this year as it did in its first 30 years of existence. To top it off, private insurers reported their worst year ever. Crop hail claims in Saskatchewan exceeded $100 million – four times the payouts in 2009. As Saskatchewan Premier Brad Wall said, "*The one thing the province cannot control is the weather*." What stood out and made clean-up and emergency services so challenging was that extreme weather occurred from one side of the province to the other, with more than 175 Saskatchewan communities declaring states of emergency.

Between June 14 and 18, a slow-moving weather system dumped in excess of 100 mm of rain over southwestern Saskatchean and Alberta. Maple Creek recorded in excess of 100 mm; even more occurred at Cypress Hills Park. Torrents of water rushed down the streets of Maple Creek washing piles of debris and thick muck into homes, reaching levels as high as a kitchen counter. The torrential rains washed out both westbound lanes and one east bound lane of the Trans-Canada Highway just west of town. The highway opened to four lanes more than five months later after a $10 million repair. Residents said river levels were the highest they'd seen in 50 years. Yorkton residents celebrated Canada Day holding back floodwaters caused by a deluge of 125 mm, with most of it falling in a violent thunderstorm that lasted 45 minutes. Within minutes, water was running across five blocks of homes and apartments in the low-lying city core. The flood turned streets into canals and yards into lakes. In many homes, water filled basements to the rafters and started flowing upstairs. About 20 per cent of the dwellings in Yorkton suffered some water damage in what was one of the worst floods in the city's history. Insurance claims in the area topped $14 million. The next day, active weather developed south of Swift Current and tracked northeastward spawning a tornado on the Kawacatoose First Nation reserve near Raymore. The tornado featured golf-ball-sized hail, heavy rains and winds over 250 km/h that obliterated five homes and damaged fifteen others on the reserve, along with five nearby farms. The tornado was ranked a F3 (less than five per cent of all tornadoes are that strong or stronger). Remarkably, no-one was seriously hurt, but three months later families were still living in temporary trailers waiting re-location.

North of the tornado, fierce plough winds and heavy rains pelted Prince Albert late in the day. Winds damaged several homes and businesses and ripped the roof off a high school. In Saskatoon, the ground was already soaked by a rainstorm three days earlier that had dumped 85 mm in less than three hours, causing extensive flooding in what the mayor called "one of those one-in-100-year floods." Unfortunately, another storm on July 2 also reached "century-storm" status by dumping 80 mm of rain on the city that flooded basements and knocked down trees and power lines. On July 22, yet another vicious rain and hail storm struck, this time in the Battlefords. A month's worth of rain in a day and nickel-sized chunks of hail damaged up to 200 homes. The ensuing flood backed up the town's sewer system with water rising to the door handles of vehicles. On August 8, a major hail storm along a line from Kindersley to west of Saskatoon resulted in the highest number of damage claims in the province this year. Two days later, heavy intense rains, much of it in less than four hours, fell on Hudson Bay – a community about 325 km northeast of Saskatoon – prompting yet another state of emergency and more provincial disaster assistance. September brought more of the same with heavy rains falling on much of Saskatchewan over the course of the month, including a one-day deluge in Regina on September 6 that left some motorists stranded on the tops of their vehicles submerged in underpasses.

There is no simple explanation for the stormy season. Severe storms were simply more frequent and moved more slowly than usual. And while there have been worse years for hail, flooding and tornadoes in Saskatchewan, the combined assault of severe weather on the province made it hard to imagine a more crippling, destructive and expensive year.

7. British Columbia Forest Fires … Costly and Smoky

The 2010 fire season across British Columbia was short but expensive. Given the dry winter and early spring, forecasters predicted a busy season. But once the spring rain started, it didn't stop until the province was well watered. Moving into summer, conditions changed with hot and sunny weather in July drying out forest fuels quickly. Minimal lightning activity kept fire starts down, but the fire threat grew as the month wore on. Vancouver recorded its second driest July on record, with less than 1 mm of rain, and campfire bans were in place across about 70 per cent of the province. On July 28 fire danger ratings were at high to extreme when lightning storms hit the central interior. Within four days, the number of fires almost doubled from 600 to 1,100. Fire crews and officials scrambled as fires rapidly consumed valuable forests, forcing evacuations in several locations. Conditions started to calm in mid-August but only for a few days. At the end of a period of scorching temperatures in the mid- to high- 30°C range, a weather front with strong gusts passed through the central interior, causing significant and unprecedented fire growth. Nearly 100,000 hectares (one-third of the entire season's total) burned in only 24 hours. But as quickly as fires ignited, the fire season ended. At the end of August, cooler temperatures and timely rains reduced fire activity province-wide. By the first week of September, all remaining evacuation orders and alerts had been rescinded and the 1,100 firefighters from out-of-province returned home. Officials described it as one of the most concentrated fire seasons in recent history. The hardest hit areas were in the central interior around Williams Lake, through the Chilcotin, and the area south of Houston, Burns Lake and Fraser Lake. The B.C. Wildfire Management Branch reported that the province spent about $230 million fighting fires this year – only 2009 and 2003 were costlier. In total, British Columbia had 1,678 wildfire starts (15 per cent fewer than normal) but the most forest area consumed in at least 10 years – nearly three-and-a-half times the norm. Sadly, two air tanker pilots lost their lives in the line of duty on August 1.

An aside to the wildfire season was the thick smoke that affected air quality as far west as Vancouver and as far east as Northern Ontario. On August 20, authorities issued an air quality warning for Metro Vancouver and the Fraser Valley. Smoke advisories were also issued for communities closer to the flames, including Terrace, Quesnel, Prince George, and Williams Lake. Excess smoke made it difficult for aircraft and ground crews fighting fires. Clouds of stinking smoke stained the air over much of Western Canada, reducing visibility and sparking province-wide air quality/health advisories in Alberta and Saskatchewan. It was the first time on record that Saskatchewan issued a health advisory because of forest fires in B.C. Some hospital emergency departments saw up to a 20 per cent increase in the number of respiratory complaints. In Calgary, the air pollution soared to concentrations not seen in seven years with the city skyline barely visible beneath the haze.

8. El Niño Cancels Winter

For many Canadians winter 2010 never really happened. While parts of Asia, Europe and the United States shivered through and shovelled out of freak winter storms, Canada was left out of the cold. From the balmy Arctic, snowless Rockies and bare pavement of Montreal to the open waters of the Labrador Sea, Canada experienced the warmest and driest winter in recorded history. Nationally, December 2009 to February 2010 averaged 4°C above normal, making it the warmest since countrywide records were first kept in 1948. Most of Canada was at least 2°C above normal, with some areas of the Arctic and northern Quebec more than 6°C above normal. A snow drought prevailed from British Columbia to Quebec. And if you define winter by the snow on the ground, it arrived a month late for most of the country and ended six weeks early.

El Niño got much of the credit for our missing winter. A shift in trade winds to a westerly direction and the arrival of warm ocean currents in the eastern Pacific Ocean is part of an El Niño episode. When El Niño's influence arrived at the end of 2009, it stayed the course. Another consideration was the shrinking Arctic ice pack, which has thinned and retreated to record levels in recent years. Also a contributing factor was the Arctic and North Atlantic Oscillations that worked in concert to bring cold to Europe and most regions of the United States, and mild weather to traditionally cold areas such as Labrador, Quebec and the Arctic. Canadians were left to collectively muse that winters just aren't what they used to be and the statistics certainly back that up. Winter's positive anomaly of +2.5 degrees nationally over 60 years exceeds any other season and is evident in every region across the country.

On the plus side, the mild, snowless weather resulted in huge savings for governments and offered a reprieve to the environment from tonnes of sand and salt. Montreal, alone, spent nearly $30 million less than average on snow clearing. Public works also logged fewer complaints about bumpy roads, potholes and ploughed snow blocking the ends of driveways. With less winter, productivity was undoubtedly higher with fewer commuting problems and infrequent snow days for students, teachers and anxious parents. But prolonged balminess also left parkas and shovels gathering dust on store shelves. Skiers, snowmobilers and tobogganists accepted their fate and spent time reminiscing about near-record snowfall amounts the previous two winters. The unprecedented mildness led to the cancellation of winter carnivals, dogsled races, ice fishing derbies, pond hockey tournaments, and created snow too soggy for sculpting. On the other hand, the unseasonably mild weather was welcomed for its huge energy savings (15 per cent) but regretted by energy utilities for much lower revenues. In Ottawa, the Rideau Canal skateway didn't open until January 14, and closed 41 days later – 10 days shorter than average. Fortunately, the weather at the city's Winterlude celebration was near-perfect – no rain, traces of snow, only three days when the wind chill fell below -20 and average afternoon temperatures of -3°C.

For most of the country, spring flooding was a non-threat. And on the environment front, migratory birds returned weeks earlier than usual due to friendly spring weather, although at times it created a mismatch with the available food supply. Additionally, no ice in the Gulf of St Lawrence meant mortality rates were extremely high for seal pups unable to survive their first year.

Among the weather's more spectacular superlatives:

● It was the winter with the least snowfall ever recorded at Toronto city (46.2 cm) and Pearson International Airport (52.4 cm) since snowfall observations began in 1843 and 1937 respectively. No measurable snow fell in either location in November or March (both months have never been snow-free before), and the first significant snowfall downtown did not occur until February 22 when 9.8 cm fell.

● Ottawa might be the snowiest national capital in the world but the city had less snow than Washington, D.C., and less than 60 per cent of its annual normal snowfall.

● Calgary recorded its lowest March snowfall total in 118 years.

● Vancouver's 11.4 cm of snow before October 31 smashed previous records for early snowfall – a sign of great things to come that didn't pan out when only 2.4 cm fell the rest of winter.

● Montreal had a meagre 3.6 cm in March, almost breaking the record of 2.6 cm set last year. In January, the city had a record of 21 days with less than 1 cm of snow per day.

● In Quebec – Canada's coldest province – Quebec City, Roberval, Bagotville, Mont-Joli, Gaspé, La Grande and Kuujjuaq had their mildest winter ever. For Sept-Iles, one of the snowiest cities in Canada, not only was it the first green Christmas ever, but the entire winter featured less snow than ever with records going back to 1944. Absence of snow on Quebec's Lower North Shore between Natashquan and Blanc Sablon was unprecedented, putting snowmobiles on blocks and creating long bouts of isolation. In early February, unsafe ice halted fishing on the Saguenay River. Sadly, there were more deaths of snowmobile drivers on Quebec lakes and rivers because of thinner ice.

● In Fredericton, the average temperature from November to March was 3.4°C warmer than normal making it the warmest winter on record. Further, snowfall totals were only half of normal.

A major impact of the record mild winter was the extraordinarily short ice road season. Mild weather and scanty snow across Manitoba forced more than half of the province's ice roads to close after less than a month, cutting off the winter lifelines for countless northerners. Many isolated First Nations' communities were unable to get all of their fuel, building supplies and other materials, forcing them to declare a state of emergency. And muddy ice roads stranded dozens of drivers in the wilderness. In Churchill, there were only 20 days when the minimum temperature fell below -30°C compared to a normal 55 days. Unfortunately, this year was not an anomaly. During the past decade, cold days averaged 47 per year compared to 55 to 60 days during the decades from 1940 to 1999. At Yellowknife, days with ideal temperatures for building ice roads (-30°C or lower) numbered only 29 for the entire winter compared to a normal number of 55 days. Twenty years ago winter roads could be counted on to stay open for nearly two months, but in some recent years they've been open only half that time.

As remarkable as the absence of winter was for Canada – the second coldest and snowiest country globally – our citizens seemed to relish the unusual balminess. In fact, residents of "The Great White North" took great joy in reports of snowbirds freezing in Florida and the fact that on February 12 there was snow on the ground in all 50 states south of the border.

9. Freak Canada-U.S. "Weather Bomb"

For three days during the last week of October, a massive and powerful fall storm muscled its way across North America from the Dakotas to the Great Lakes and beyond. The unusual system fascinated meteorologists because its strength was similar to a Category 3 hurricane. Weather advisories were issued for 31 states and six provinces for a buffet of severe weather: tornadoes, blustery blizzards, powerful gales, wind-driven rains, heavy snows and thunderstorms. Lumped together, the ugly mix was called a "weather bomb" because of a central pressure drop of 28 millibars in 24 hours, which is a hallmark of this type of storm. Most "bombings" in North America occur over water, commonly along the U.S. Eastern seaboard and in Atlantic Canada, while land bombs are rare. Yet this was one of the most intense storms ever to form over mid-continent – second to the Great Ohio Blizzard in January 1978, but more powerful than both the storm that sank the Edmund Fitzgerald freighter on Lake Superior in November 1975 and the March 1993 "Storm of the Century".

The fall storm blew in from the Pacific Northwest on the strength of a jet stream that was about one-third stronger than normal for this time of year. As the system moved eastward, it drew in warm, moist air from the American south that collided with the season's first cold air from the North creating a supercharged storm that exploded over Minnesota. In Canada, the storm generated blizzards in the West with 20 to 30 cm of snow near the Saskatchewan-Manitoba border, storm surges on Manitoba lakes, and heavy rains and strong winds in Ontario and Quebec. Additionally, parts of southwestern Ontario near Windsor and Sarnia came under a tornado watch. And many roads in the eastern Prairies became ice covered and slippery from the snow that first melted on warm highway surfaces, only to freeze into black ice under a thin cover of blown snow.

Across North America, the storm snapped trees and power lines, closed highways, ripped away roofs and delayed flights. But it was in Manitoba where the storm had its greatest impact. Old-timers said it was the worst they'd seen in about 60 years. As a mark of the storm's intensity, Winnipeg set an all-time record for its lowest-ever barometric pressure. Total storm rainfall in the province ranged from 50 to 100 mm, along with some big snows. The Manitoba lakes, already at record-high levels, rose more than a metre under the wind and pressure stress. Northerly winds blew down the lake for more than 100 km, piling water on the south shore. The set-up forced the overnight evacuation of several low-lying areas where access roads flooded. Huge waves chewed up sand dunes and scoured the fragile shoreline for hundreds of kilometres and up to 10 m from shore in some places. Waves crashed over 40-year old earth dikes and rock breakwaters, landing in the yards of lakefront homes and cottages and leaving debris, uprooted trees and dead fish, as waters retreated. Rocks were tossed on shore as frantic volunteers trenched and sandbagged. States of emergency were declared in several communities. In Gimli, 100 km/h winds generated two-metre waves that pushed waters up and over cottages, and washed out roads. At the Sagkeeng First Nation, wind-driven waters came crashing through windows. On Lake Winnipegosis, winds of 110 km/h pushed the Mossey River backwards and forced the evacuation of several residents. The boardwalk at popular Grand Beach Provincial Park was damaged and will have to be rebuilt in places. Officials worry that the "weather bomb" might set the stage for one of the most destructive and disastrous spring floods on record given that several Manitoba lakes and rivers are near their highest levels ever. Normal or above-normal snowpack combined with a quick thaw could only worsen a bad situation.

10. Canada's Most Expensive Hailstorm

Calgary again lived up to its reputation as the hailstorm capital of Canada. The Insurance Bureau of Canada sees hail as such a threat there that it operates a cloud-seeding program in order to diminish the size of hailstones falling over the city – a pea-size stone does much less damage than one the size of a golf ball. Hard hail is also more damaging than soft hail. On July 12, just before 2 p.m., a fierce 30-minute storm pelted the Stampede city with large hail balls – some that approached baseball size – along with heavy rain, gusty winds and some background thunder and lightning. In a flash, streets turned into ponds, basements and intersections flooded, and manhole covers lifted. The brief but noisy hailstorm shattered glass, mangled outdoor furniture and storage sheds, and stripped trees. At the University of Calgary, a rooftop greenhouse lost three-quarters of its windows. The mid-afternoon timing only added to the storm's destruction as streets were busy and parking lots full. Pedestrians ran for cover as hail harder than normal bounced a metre off the ground.

Outside the city, the massive hailstorm decimated over 90,000 hectares of cropland near Strathmore and Hussar, spurring crop damage claims totaling $18.5 million. The huge number of claims forced insurers and auto body shops to bring in field adjusters and dent technicians from other provinces and the United States and Europe. When all was said and done, Canadian insurers estimated the dollar value of total claims at about $400 million, making it the costliest hailer in Canadian history. The previous claims record of $340 million, set in 1991, was also in Calgary.

Source: "Top 10 Canadian Weather Stories for 2010", Meteorological Service of Canada - Environment Canada - Government of Canada. http://www.ec.gc.ca/meteo-weather visited 30 December 2010 at 10:00 a.m. (EST).

CMOS 2011 Photo Contest

All members with a photographic bent are invited to participate in the 2011 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, 2011.** If you have any questions please contact Bob Jones at webmaster@cmos.ca.

Les dix événements météorologiques canadiens les plus marquants de 2010

par David Phillips[2]

En 2010, Dame nature a rappelé au monde entier qui est le maître. Des tremblements de terre meurtriers et dévastateurs aux volcans menaçants et aux tsunamis sans cesse terrifiants, son immense colère s'est déchaînée dans le monde entier. Quant aux conditions météorologiques, des phénomènes exceptionnels constants et irrépressibles ont causé des ravages partout sur la planète. Des milliers de personnes ont perdu la vie et des millions d'autres se sont retrouvées sans abri et sans travail. Parmi les pires catastrophes météorologiques de cette année, on compte : la plus forte vague de chaleur depuis mille ans et d'immenses feux de forêt en Russie; les pires inondations provoquées par la mousson de l'histoire du Pakistan; les glissements de terrain induits par la pluie et les pires inondations depuis des décennies en Chine; les graves sécheresses en Afrique subsaharienne et dans le bassin de l'Amazone; et le vêlage du plus gros iceberg depuis près de 50 ans au Groenland. Étonnamment, tous ces événements météorologiques se sont produits au cours d'un seul mois!

Les Canadiens ont été subjugués par la force et le pouvoir de la nature, mais sont aussi simplement reconnaissants de vivre dans un pays qui, même s'il n'échappe pas totalement à la colère de Dame nature, est passablement épargné et échappe au radar. Les plaintes à propos du froid, des nids de poule, de la neige fondante et des pannes d'électricité localisées semblent anodines en comparaison avec les événements météorologiques meurtriers survenus à l'extérieur de nos frontières. Toutefois, avec ou sans changements climatiques, les phénomènes météorologiques exceptionnels sont en voie de devenir de plus en plus catastrophiques pour les sociétés modernes.

Bien que dans l'ensemble, l'année 2010 a grandement épargné les Canadiens, nous avons tout de même vécu une bonne dose de phénomènes météorologiques exceptionnels. Il y a eu des feux de forêt, des « bombes météorologiques », de grandes quantités de neige et des averses de grêles ruineuses. Les pertes matérielles causées par de mauvaises conditions météorologiques ont coûté des millions de dollars aux compagnies d'assurances canadiennes et aux gouvernements, et des milliards à l'économie. C'est à Vancouver que s'est produit l'événement météorologique le plus marquant : le bon, le mauvais et le pire aux Jeux olympiques et paralympiques d'hiver de 2010 à Vancouver. Après un début d'hiver prometteur, les choses se sont mises à mal tourner quand la température douce et pluvieuse a occupé le premier rang jusqu'aux cérémonies d'ouverture et pendant les trois premiers jours de compétition. Heureusement, les conditions ont changé de même que l'ambiance, alors que les Canadiens savouraient la réussite des Jeux en dépit des conditions météorologiques initiales épouvantables. La province de Terre-Neuve-et-Labrador mérite la deuxième place des événements météorologiques les plus marquants après avoir affronté la force effroyable de l'ouragan Igor. Dans une province où l'on a l'habitude des tempêtes, le puissant Igor a été le plus destructeur de l'histoire de Terre-Neuve. Pour les producteurs agricoles canadiens, les conditions météorologiques de cette année auront été, selon les régions, les plus humides ou bien celles de la meilleure saison de végétation de tous les temps. Les agriculteurs et les grands éleveurs des Prairies ont connu des difficultés au cours d'un printemps et d'un été les plus humides jamais enregistrés, mais la température s'est avérée leur meilleure alliée quand le soleil chaud, sec et abondant de l'automne a contribué à sauver les récoltes qui s'annonçaient désastreuses. Le mercure au Canada a été particulièrement élevé en 2010, et ce, pour la quatorzième année consécutive. En 63 ans de relevés météorologiques, l'année 2010 a été la plus chaude jamais enregistrée au Canada en raison d'une température plus douce tout au long de l'année. L'hiver et le printemps ont été les plus chauds jamais connus, l'été occupe le troisième rang de ceux les plus chauds et l'automne occupe le deuxième rang de ceux les plus chauds. Toutes les régions ont été touchées par la chaleur. La glace qui recouvre les pôles de la planète depuis des milliers et des milliers d'années et qui continue de disparaître constitue une des répercussions de ces saisons plus chaudes. Et pas seulement en Arctique. Cette année, dans le Canada atlantique et le golfe du Saint-Laurent il n'y avait presque pas de glace. À l'échelle planétaire, ce fut la troisième année la plus chaude enregistrée depuis les 160 dernières années selon l'Organisation météorologique mondiale. De plus, la période de 2001-2010 a atteint la moyenne la plus élevée de température en comparaison à toutes les autres les décennies.

Parmi les autres événements météorologiques marquants survenus en 2010 au Canada, mentionnons : de fréquents épisodes de temps violent au printemps et à l'été en Saskatchewan qui ont mené à des inondations exceptionnelles et à des pertes matérielles record; une énorme tempête en décembre qui a enterré sous la neige certaines régions de l'Ontario et inondé des parties du Québec et des provinces maritimes; des coups de vent violents en novembre qui ont balayé les environs du Manitoba et des Grands Lacs; et une brève tempête de grêle mais fort coûteuse qui s'est abattue sur Calgary. L'année 2010 a été, de plus, une année de contrastes. Il n'y a pratiquement pas eu d'hiver, puis on a connu un été mémorable. Heureusement, on n'a pas eu grand chose à rapporter au pays pendant la saison des incendies de forêt, à l'exception de la Colombie-Britannique, où quantité de précieux bois d'œuvre a brûlé au cours de l'une des années les plus coûteuses au chapitre de la lutte contre les incendies de forêt.

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[2] Climatologue principal, Service météorologique du Canada, Environnement Canada, Downsview, Ontario, Canada

Parmi les histoires finalistes de cette année, on compte celle de la «bombe météorologique» maritime dans le golfe du Saint-Laurent, la gigantesque tempête de neige de London, les tornades à Leamington et à Midland, le mois de neige printanière dans les Prairies, les fréquentes inondations en été (et non au printemps) au Manitoba, un été chaud des plus apprécié dans l'est du Canada accompagné d'humidité mais d'aucun smog, et des pluies diluviennes dans les régions du Canada qui ont connu les précipitations les moins abondantes et les plus abondantes.

Les dix événements météorologiques canadiens les plus marquants en 2010 énumérés dans le tableau ci-dessous ont été sélectionnés en fonction de certains facteurs comme l'impact qu'ils ont eu sur le Canada et les Canadiens, l'étendue de la région touchée, les répercussions sur l'économie et le temps durant lequel l'événement a fait les grands titres des médias.

Dix événements météorologiques canadiens les plus marquants en 2010

1	**Météo printanière pour les jeux olympiques d'hiver**
2	**Le puissant Igor**
3	**De la sécheresse aux inondations dans les Prairies**
4	**Le Canada en chaleur**
5	**Tempête historique: neige, vents violents et inondations**
6	**Un été d'orages et de tempêtes en Saskatchewan**
7	**Feux de forêt en Colombie-Britannique: beaucoup d'argent parti en fumée**
8	**El Niño annule l'hiver**
9	**Une «bombe météorologique» déclenche la panique au Canada et aux États-Unis**
10	**La tempête de grêle la plus coûteuse de l'histoire du Canada**

N° 1 Météo printanière pour les Jeux olympiques d'hiver: Le Comité des Jeux olympiques de Vancouver avait promis que ces Jeux seraient « les plus verts de tous les temps ». Mais, en aucun cas, il n'aurait pu prédire que Vancouver connaîtrait son hiver le plus doux jamais enregistré.

N°2 Le puissant Igor: En 2010, la saison des ouragans dans l'océan Atlantique a été très active avec ses 19 tempêtes nommées. En septembre, Igor et Earl ont laissé une impression durable dans l'Est.

N° 3 De la sécheresse aux inondations dans les Prairies: Avant le début de la période de végétation, les grands éleveurs de l'Ouest canadien ont dit n'avoir jamais vu un printemps aussi sec. Mais, à la mi-avril, la pluie est arrivée et elle n'est partie qu'en septembre.

N° 4 Le Canada en chaleur: L'année a commencé par l'hiver le plus doux, suivi du printemps le plus chaud, du troisième été le plus chaud et du deuxième automne le plus chaud jamais enregistrés, faisant de 2010 la plus chaude des 63 dernières années.

N° 5 Tempête historique : neige, vents violents et inondations: Au cour du mois de décembre des centaines d'automobilistes ont été bloqués dans leurs voitures par un blizzard, entre Sarnia et Strathroy, en Ontario, tandis que des résidents de l'est du Québec et des provinces maritimes ont été frappés par de forts vents et une pluie battante qui ont causé d'importantes inondations.

N° 6 Un été d'orages et de tempêtes en Saskatchewan: Que ce soit des microrafales, de la grêle, des tornades, des inondations, des nuages en entonnoir et des vents dévastateurs (derechos), la Saskatchewan a subi presque tout ce que Dame nature pouvait lui envoyer cet été.

N° 7 Feux de forêt en Colombie-Britannique : beaucoup d'argent parti en fumée: La saison des feux de forêt de l'année 2010 en Colombie-Britannique a été brève, mais a coûté cher. En mai et juin les 1 678 incendies de forêt ont ravagé plus de régions boisées que tout autre incendie depuis au moins les dix dernières années.

N° 8 El Niño annule l'hiver: Pendant l'hiver 2010, pour la majeure partie du Canada, la température a été d'au moins 2 °C au-dessus de la normale, avec quelques régions de l'Arctique et du Nord du Québec où elle est montée à plus de 6 °C au-dessus de la normale. Une sécheresse de neige prédominait entre la Colombie-Britannique et le Québec.

N° 9 Une «bombe météorologique» déclenche la panique au Canada et aux États-Unis: Pendant trois jours au cours de la dernière semaine d'octobre, une tempête d'automne violente et massive par son ampleur a traversé l'Amérique du Nord.

N° 10 La tempête de grêle la plus coûteuse de l'histoire du Canada: Le 12 juillet, une terrible tempête de grêle, dont les grêlons atteignaient parfois la taille de balles de baseball a frappé durement Calgary pendant 30 minutes.

Source: **"Les dix événements météorologiques les plus marquants de 2010", Service Météorologique du Canada - Environnement Canada - Gouvernement du Canada http://www.ec.gc.ca/meteo-weather visité le 30 décembre 2010 à 10 h (HNE).**

CLIMATE CHANGE / CHANGEMENT CLIMATIQUE

More words - What really was achieved in Cancun

by John Stone[1]

For two weeks in December 2010 some 5200 government officials together with an almost equal number of observers and members of the press gathered in Cancun, Mexico, for the latest episode in the attempt to negotiate a new global treaty to address the threat of climate change. Officially this was known as the sixteenth session of the Conference of the Parties under the UN Framework Convention on Climate Change (UN/FCCC). Thus, it has been sixteen years since the governments began to meet to collectively agree on actions to "avoid dangerous interference with the climate system". During this time the root cause of the threat, the increase in the atmospheric concentrations of greenhouse gases, has risen from 340 to 390 ppm. Not a great success.

The previous Conference held last year in Copenhagen in an atmosphere of great expectation, some would say of hubris, ended in failure (stronger words have been used), a failure which to some extent traumatized many of the participants who saw the real possibility of the collapse of the multilateral approach. Copenhagen did real damage to the UN/FCCC process; it left behind a deep sense of loss of mutual trust and no clarity on how to proceed. The recognition by negotiators that they had taken the process, in which many had invested several years of effort, almost to the brink of collapse persuaded them that Cancun had to be seen to succeed. As some negotiators suggested: "Cancun was the last chance".

In addition to the crucial breakdown of trust and process in Copenhagen, the Accord that was produced in Copenhagen had two major problems, one procedural and the other substantive. Procedurally, since the Accord was negotiated outside the formal UN/FCCC process, it had no legal status. This has now been righted to some extent by incorporating some of the Accord's elements into the agreed outcome of the Cancun meeting. What this has done, for example, is to formally create the Green Climate Fund, provided by new and additional monies ($100 billion a year from 2012) from industrialized countries, to assist developing countries in addressing climate change. It also made progress on encouraging poor countries to preserve their forests through the creation of "credits" for reducing emissions from deforestation and forest degradation. This will require developing countries to put in place systems for monitoring and calculating national totals for emissions from forest loss. If this succeeds then presumably it can be adopted by other countries with extensive forests like Canada. Scientifically, the problem is that we still cannot separate the natural and anthropogenic contributions to carbon stock changes.

The other problem has to do with the commitments governments made in Copenhagen and afterwards to reduce their emissions. While it is true that these commitments represent a larger proportion of global emissions than under the Kyoto Protocol, collectively they are insufficient, by almost 5 Gigatonnes of CO_2 equivalent, to meet the stated target of avoiding an increase in global temperatures of 2°C above pre-industrial levels. For comparison, under a business-as-usual scenario, annual emissions of greenhouse gases could be around 56 Gigatonnes of CO_2 equivalent by 2020. Thus, the text agreed in Cancun urges all countries to increase their level of ambition. The current "emissions gap" has been usefully analysed by UNEP and is available from their web-page: http://www.unep.org/publications/ebooks/emissionsgapreport/. The analysis assumes, however, governments fully meet their commitments (which are not always easily comparable as different baselines and target dates are used).

The success that was achieved in Cancun owed a great deal to the Mexican hosts who not only avoided the logistic problems of Copenhagen, but through careful, transparent and inclusive leadership, provided a constructive atmosphere for the negotiations. This was particularly evident during the "high level segment" when Ministers were present. The Mexican President of the Conference, Patricia Espinosa, whose day job is Foreign Minister, performed brilliantly.

She established a series of open negotiating sessions chaired by two Ministers, one from the industrialized and the other from the developing World. These not only produced useful outcomes but in a surprising break from past practice, governments put aside the mantra that nothing is agreed until everything is agreed – a tried and true recipe for gridlock. The result was that the President was able to bring to the plenary session a package of

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Note from the Editor: Dr. Stone has been selected as a Canadian Expert for the IPCC Fifth Assessment Report (See *CMOS Bulletin SCMO*, Vol.38, No.5, page 196).

agreements that had the approval of most of the delegations - but not all. The one hold-out was the government of Bolivia. In the past it has been possible for one delegation to deny consensus. On this occasion the President ruled that "consensus does not mean that one country has the right of veto and can prevent 193 others from moving forward after years of negotiations on something that our societies and future generations expect".

What made the Cancun Agreements acceptable was the notion of "balance". As in much of the climate change negotiations, a coded language has developed. This language, however, is subject to different interpretations (in part as a result of the use of the flexibilities of the English language - the vernacular of the negotiations). Thus "balance" meant for some, equal attention to the Convention and Kyoto Protocol processes. For others, it meant comparable efforts subject to "national circumstances" being demanded of developed and developing countries. Yet for others, it meant balancing financing from industrialized countries and the reporting and verification of actions by developing countries. And still for others it meant comparable attention to mitigation and adaptation.

Similarly, one of the other phrases that came to dominate the negotiations was the notion of a second Kyoto commitment period which is envisaged in the Protocol. However, once again, what is meant by this varies. For some the essential point is to continue the division between developed and developing countries where only the former are subject to quantified emission reductions. The basis for this is the recognition at the time of Kyoto of the "historical responsibility" of industrialized countries for past emissions that dominated atmospheric concentrations – what some refer to as the environmental debt. Since then, several developing countries' emissions have grown significantly (although still lower in terms of per capita emissions). Another interpretation is the continuance of the flexibility mechanisms such as the use of carbon "sinks" and the Clean Development Mechanism.

Where does this leave us in getting real action on addressing the increasing urgency of the threat of climate change? The many interpretations of agreed language typically allow delegations to leave feeling they have achieved their objective and facilitates reaching consensus. However, it can lead to a lawyers' paradise (or morass), one that is out of touch with reality in a similar manner to how bankers recently manipulated the financial system to achieve virtual growth. To some extent this seems to reflect an apparent desire to "fudge" solutions rather than face the reality of the challenge. It is perhaps of little surprise that many of the negotiators are in fact lawyers (forever quoting legal precedents). The fact that there is still no agreement on the legal form of the outcome of this current process speaks volumes.

Some are beginning to question if complete success can ever come out of a process involving almost 200 sovereign countries on a subject that has such deep consequences for their societies, economies and ecosystems. Perhaps the existing process cannot bear the weight of expectations; perhaps it is just too complex an issue. The science shows clearly that the threat is real and will not go away. Solutions must be found.

Sub-national levels of government are beginning to act both individually and together. We can see this in the European Emission Trading Scheme and the Regional Greenhouse Gas Initiative involving States and Provinces in North America. The private sector, impatient for policy signals, is also moving on its own. This includes such initiatives as the Carbon Disclosure Project in which investors attempt to shape the activities of other companies, as well as the HSBC's Climate Partnership and the International Investors Group on Climate Change – evidence that financial players can have considerable power in the politics of climate change.

That economic growth and tackling climate change are incompatible is a flawed premise. Smart companies who have figured out that they can generate long-term growth for their stakeholders by tackling climate change are getting ahead of the curve. Others such as the National Roundtable on the Environment and the Economy also have recognized this with their new initiative on Climate Prosperity. The UN/FCCC process will continue but there will be alternative approaches. The trick will be to ensure that they can work together cooperatively so that in the end we do have a truly global response. But time is running out.

Next Issue *CMOS Bulletin SCMO*

Next issue of the *CMOS Bulletin SCMO* will be published in **April 2011.** Please send your articles, notes, workshop reports or news items before **March 4, 2011** to the address given on page 198. We have an URGENT need for your written contributions.

Prochain numéro du *CMOS Bulletin SCMO*

Le prochain numéro du *CMOS Bulletin SCMO* paraîtra en **avril 2011.** Prière de nous faire parvenir avant le **4 mars 2011** vos articles, notes, rapports d'atelier ou nouvelles à l'adresse indiquée à la page 198. Nous avons un besoin URGENT de vos contributions écrites.

CMOS BUSINESS / AFFAIRES DE LA SCMO

Atelier d'été en météorologie
Projet Atmosphère 2011

Demande de candidats enseignants de niveau pré-collégial

Comme par les années passées, la Société canadienne de météorologie et d'océanographie (SCMO) a été invitée à choisir un enseignant canadien qui participera au PROJET ATMOSPHÈRE. Il s'agit d'un atelier d'été à l'intention des enseignant(e)s de niveau pré-collégial spécialistes en sciences atmosphériques; cet atelier est parrainé par l'American Meteorological Society (AMS) et la National Oceanic and Atmospheric Administration (NOAA) américaine. Il aura lieu du **17 au 29 juillet 2011** au centre de formation du National Weather Service à Kansas City au Missouri.

Les dépenses de l'enseignant(e) choisi(e) seront assumées par l'AMS et la NOAA, avec une contribution financière de la SCMO et du Conseil canadien pour l'enseignement de la géographie (CCEG). Ceci n'inclus pas les déplacements à destination et au retour de Kansas City pour lesquels la SCMO et le CCEG offrent chacun 300 $ (canadiens), soit un total de 600 $, au participant(e) canadien(ne) choisi(e).

Les ancien(ne)s participant(e)s du Canada ont trouvé leur expérience très enrichissante et stimulante. Les exposés de l'atelier sont présentés par des experts américains les plus réputés dans les sciences atmosphériques et océanographiques. Les enseignant(e)s sont revenu(e)s avec du matériel, des ressources et des modules didactiques qu'ils peuvent facilement adapter dans leurs cours. Le candidat choisi devra écrire un court rapport pour la SCMO de son expérience estivale qui pourra être publié dans le Bulletin de la SCMO.

Les enseignant(e)s intéressé(e)s peuvent obtenir plus d'information en visitant le site de la SCMO sur la toile à www.scmo.ca/ProjectAtmosphre.html où ils peuvent obtenir un formulaire d'application. Ils peuvent également obtenir un formulaire en le téléchargeant du site web de la SCMO ou en le demandant à l'adresse ci-dessous.

Les formulaires dûment remplis doivent être envoyés par courrier ou télécopieur à l'adresse ci-dessous au plus tard le **15 mars 2011.** Les candidat(e)s sont encouragé(e)s à soumettre leur formulaire dès que possible.

SCMO - Atelier Projet Atmosphère
Casier postal 3211, Station D
Ottawa, ON K1P 6H7
Téléphone: (613) 990-0300 / Télécopie: (613) 990-1617
courriel: education@scmo.ca

Summer Meteorology Workshop
Project Atmosphere 2011

Call for Applications by Pre-College Teachers

As in previous years, the Canadian Meteorological and Oceanographic Society (CMOS) has been invited to select a Canadian teacher to participate in PROJECT ATMOSPHERE. This is a summer workshop for pre-college teachers of Atmospheric Science topics sponsored by the American Meteorological Society (AMS) and the National Oceanic and Atmospheric Administration (NOAA) of the United States. It will take place from **17 to 29 July 2011** at the National Weather Training Center, Kansas City, Missouri.

The essential expenses for the participating teacher are paid by AMS/NOAA, with a financial contribution from CMOS and the Canadian Council for Geographic Education (CCGE). This does not include the travel to and from Kansas City for which CMOS and CCGE provide $300 (Canadian) each (total of $600) to the selected Canadian participant.

Previous Canadian participants have found their attendance a very rewarding and significant experience. Presentations are made at the Workshop by some of the most respected American Scientists in the fields of atmospheric and oceanographic sciences. Participants have returned with material, resources and teaching modules readily adaptable to classroom presentations. The successful candidate will provide CMOS with a short report on his/her summer experience which may be published in the CMOS Bulletin.

Interested teachers can obtain more information on the workshop and an application form on the CMOS website (www.cmos.ca/ProjectAtmosphere.html). An application form can downloaded from the CMOS website or requested by writing to the address below.

Completed application forms can be mailed or faxed to the address below no later than **March 15, 2011**. Applicants are encouraged to submit their forms as soon as possible.

CMOS - Project Atmosphere Workshop
P.O. Box 3211, Station D
Ottawa, ON K1P 6H7
Telephone: (613) 990-0300 / Fax: (613) 990-1617
e-mail: education@cmos.ca

Notez que le cours et le formulaire d'application ne sont disponibles qu'en anglais.

Atelier d'été en océanographie Projet Maury 2011

Demande de candidats enseignants de niveau pré-collégial

Comme par les années passées, la Société canadienne de météorologie et d'océanographie (SCMO) a été invitée à choisir un enseignant canadien qui participera au PROJET MAURY. Il s'agit d'un atelier d'été à l'intention des enseignant(e)s de niveau pré-collégial spécialistes en sciences océanographiques; cet atelier est parrainé par l'American Meteorological Society (AMS) et le US Naval Academy. Il aura lieu du **11 au 22 juillet 2011** au US Naval Academy à Annapolis au Maryland.

À l'exception des frais de déplacements à destination et au retour de Annapolis, toutes les dépenses de l'enseignant(e) choisi(e) seront assumées par l'AMS, qui recevra aussi une contribution de la SCMO et du Comité national canadien / Comité scientifique de la recherche océanographique (CNC/SCOR) à cette fin. La SCMO et le CNC/SCOR offrent aussi à l'enseignant choisi 300 $ (canadiens) chacun, soit au total 600 $, pour les déplacements.

Les ancien(ne)s participant(e)s du Canada ont trouvé leur expérience très enrichissante et stimulante. Les exposés de l'atelier sont présentés par des experts américains les plus réputés dans les sciences atmosphériques et océanographiques. Les enseignant(e)s sont revenu(e)s avec du matériel, des ressources et des modules didactiques qu'ils peuvent facilement adapter dans leurs cours.

Le lauréat devra écrire un court rapport pour la SCMO de son expérience estivale qui pourra être publié dans le Bulletin de la SCMO.

Les enseignant(e)s intéressé(e)s peuvent obtenir plus d'information en visitant le site web http://www.cmos.ca/ProjectMaury.html. Si vous êtes intéressés, vous devez télécharger le formulaire de candidature (en format pdf) et, une fois rempli, le poster ou le télécopier à l'adresse donnée ci-bas avant le **8 mars 2011.** Les candidat(e)s sont encouragé(e)s à soumettre leur formulaire dès que possible.

SCMO - Atelier Projet Maury
Casier postal 3211, Station D
Ottawa, ON K1P 6H7
Téléphone: (613) 990-0300 / Télécopie: (613) 990-1617
courriel: education@cmos.ca

Prière de noter que vous ne pouvez pas enregistrer votre formulaire rempli sur votre ordinateur mais vous pouvez le compléter sur l'écran et imprimer des copies par la suite.

Summer Oceanography Workshop Maury Project 2011

Call for Applications by Pre-College Teachers

The Canadian Meteorological and Oceanographic Society (CMOS) has been invited to select a Canadian teacher to participate in THE MAURY PROJECT. This is a summer workshop for pre-college teachers of Oceanographic topics sponsored by the American Meteorological Society (AMS) and the US Naval Academy. This year's workshop is on **11-22 July 2011** at the US Naval Academy, Annapolis, Maryland.

The essential expenses for the participating teacher are paid by AMS, with a contribution from CMOS and the Canadian National Committee / Scientific Committee on Oceanic Research (CNC/SCOR). This does not include the travel to and from Annapolis for which CMOS and CNC/SCOR provide $300 (Canadian) each (for total $600) to the selected Canadian participant.

Previous Canadian participants have found their attendance a very rewarding and significant experience. Presentations are made at the Workshop by some of the most respected American Scientists in the fields of atmospheric and oceanographic sciences. Participants have returned with material, resources and teaching modules readily adaptable to classroom presentations.

The successful candidate will provide CMOS with a short report on his/her summer experience which may be published in the CMOS Bulletin.

For further details about the Workshop, please visit http://www.cmos.ca/ProjectMaury.html

Interested teachers should download the application form (in pdf format) and mail or fax the filled form as soon as possible not later than **8 March 2011** to the address given below. Applicants are encouraged to submit their forms as soon as possible.

CMOS - The Maury Project Workshop
P.O. Box 3211, Station D
Ottawa, ON K1P 6H7
Telephone: (613) 990-0300 / Fax: (613) 990-1617
e-mail: education@cmos.ca

Please note that you cannot save a completed copy of this form on your computer, but you can fill it on-screen and print copies afterward.

Notez également que le cours et le formulaire d'application ne sont disponibles qu'en anglais.

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.

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
- The Rube Hornstein Medal in Operational Meteorology
- The Tertia MC Hughes Memorial Graduate Student Prize
- The Roger Daley Postdoctoral Publication Award
- The Neil J. Campbell Medal for Exceptional Volunteer Service
- Citations
- Fellows and Honorary Fellows

Nominations received by 15 February by the Executive Director at the address shown on page 2 will be forwarded to the Committee. See www.cmos.ca/callfornomination.pdf

Fellows and Honorary Fellows nominations will be accepted until **March 15**.

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.

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:

- Le Prix du président
- La Médaille de J.P. Tully en océanographie
- Le 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
- Membres émérites et honoraires

Les soumissions reçues au plus tard le 15 février par le Directeur exécutif à l'adresse mentionnée à la page 2 seront transmises au Comité. Voir: www.cmos.ca/callfornominations.pdf

Les nominations pour les membres émérites et honoraires seront acceptées jusqu'au **15 mars.**

CMOS Tour Speaker 2011

Climate Change and the Pacific Institute for Climate Solutions: Blending Science, Social Science, Politics and Opportunity

Thomas F. Pedersen, Executive Director, Pacific Institute for Climate Solutions, University of Victoria

Abstract: Global warming caused by human activities is happening. It is scientifically well understood and, as will be discussed in the lecture, it presents a serious challenge to human societies. But in that challenge lies an opportunity for us to do things better, to unleash a new era of creativity, to improve the stewardship of our natural environment, and to revitalize our economy while generating new, cleaner industrial activity.

Taking such action demands concerted political leadership and policy development informed by high-quality interdisciplinary research. The latter requirement led the Government of British Columbia to create in 2008 the Pacific Institute for Climate Solutions (PICS), an endowed four-university consortium hosted and led by the University of Victoria that focusses on blending the social and physical sciences and engineering to provide best-practice policy pathways that the provincial government can follow.

The role PICS is now playing in contributing to British Columbia's response to the climate-change challenge will be described and set within the larger North American context. But there remains a problem: most 'climate solutions' are not of provincial scale, and many span, if not the full globe, at least the scale of the nation or continents. 'Solutions' case studies that span both the science-policy

intersection and large spatial scales will be presented. For example, the directive to enhance corn-ethanol production in the U.S. has reinforced unwelcome, distal oceanographic impacts that might have been curbed had science and interdisciplinary discussion been used more effectively in the policy design. And in Canada, our provincially-controlled electrical grid system hampers our ability to accommodate renewable energy, thereby limiting the scope we have to reduce CO_2 emissions. Europe is taking a collective, aggressive and different tack that will be contrasted to the current situation in Canada.

Finally, it is increasingly clear that Canada could take steps that would simultaneously allow us to reduce carbon emissions — an imperative that climate science tells us is a must — while yielding significant new economic value. Getting there will require recognition by the Canadian public (and its mirror – our politicians) of both need *and* opportunity. Therein lies another challenge—one which PICS is also addressing—that is rooted in the communication of science, economic perceptions and economic reality, and human behavioural psychology.

Short Biography: Born and raised on an orchard in British Columbia's verdant Okanagan Valley, Tom Pedersen completed an undergraduate degree in Geology at the University of British Columbia in 1974 and began his professional career as an Exploration Geologist, searching for ore deposits in Canada's north. Curiosity about the earth, and particularly the ocean, propelled him back to graduate school two years later and in 1979 he graduated from the University of Edinburgh with a Ph.D. in Marine Geochemistry. He joined the University of British Columbia as a post-doctoral fellow that year. UBC subsequently appointed him to faculty and in 1994 he was promoted to Professor. He served as Associate Dean, Research, for the Faculty of Graduate Studies at UBC from 2000 to mid-2002 before joining the University of Victoria in 2002 as Director of the School of Earth and Ocean Sciences. In 2003, he took on the role of Dean of Science at UVic and, in September 2009, became Director of the Pacific Institute for Climate Solutions. He has published extensively in the field of Paleoceanograhy (the history of the oceans), and uses geochemical and isotopic measurements of marine sediments as fingerprints of physical, biological and chemical oceanic processes.

Pedersen has received several honours for his scholarship including a UBC Killam Outstanding Teaching Award in 1990, a Killam Faculty Research Fellowship in 1997, and the Michael J. Keen Medal of the Geological Association of Canada in 2002. He was elected to Fellowship in the Royal Society of Canada in 2002, and Fellowship in the American Geophysical Union in 2006. Although he enthusiastically enjoys his academic role, he remains in his heart a farmer who is still very curious about the ocean.

Note: The conferences will take place between January and April 2011. Please visit CMOS website (http://www.cmos.ca/tourspkr.html) to find the exact date and time of the conference in your region.

Conférencier Itinérant 2011 de la SCMO

Les changements climatiques et le Pacific Institute for Climate Solutions : mélanger la science, les sciences sociales, la politique et les possibilités

Thomas F. Pedersen, Directeur général, Pacific Institute for Climate Solutions, Université de Victoria

Résumé: Le réchauffement climatique causé par l'activité humaine existe. Cela est scientifiquement bien connu, et sera discuté durant la conférence. Cela présente aussi un défi sérieux pour les sociétés. Mais, dans ce défi réside une occasion pour nous de mieux faire les choses, de dégager une nouvelle ère de créativité, d'améliorer la gérance de notre environnement naturel, et de revitaliser notre économie tout en générant de nouvelles activités industrielles plus propres.

Prendre de telles mesures demande un leadership politique concerté et le développement d'une politique soutenue par une recherche interdisciplinaire de haute qualité. Cette dernière exigence a mené le gouvernement de la Colombie-Britannique à créer en 2008 le Pacific Institute for Climate Solutions (PICS), un consortium de quatre universités érigé par donation, hébergé et dirigé par l'Université de Victoria qui met l'accent sur le mélange des sciences sociales, physiques et du génie, afin de fournir une politique des meilleures pratiques que le gouvernement provincial pourra suivre.

Le rôle que le PICS joue maintenant pour contribuer à la réponse de la Colombie-Britannique au défi des changements climatiques sera décrit dans le contexte nord-américain. Mais un problème demeure : la plupart des «solutions climatiques» ne sont pas provinciales, et plusieurs concernent, sinon le monde entier, au moins les nations ou les continents. Des études de cas de «solutions», qui couvrent l'intersection sciences et politique, et de larges échelles spatiales seront présentées. Par exemple, la directive d'améliorer la production d'éthanol de maïs aux États-Unis a renforcé les impacts océanographiques à distance qui pourraient avoir été freinés si la science et la discussion interdisciplinaire avaient été utilisées plus efficacement dans la conception de la politique. Au Canada, notre réseau électrique est contrôlé par les provinces et ralentit notre habileté à nous adapter aux énergies renouvelables, limitant ainsi le champ d'application pour réduire les émissions de CO_2. L'Europe adopte une approche collective, agressive et différente qui contraste avec la situation actuelle au Canada.

Finalement, il est de plus en plus clair que le Canada devra prendre des mesures qui nous permettraient simultanément de réduire les émissions de carbone – un impératif, comme nous le dit la science du climat – tout en produisant une nouvelle valeur économique significative. Pour y arriver, cela exigera la reconnaissance des besoins et des possibilités par le public canadien (et son miroir – nos politiciens). À cet égard, il existe un autre défi – auquel le PICS s'attaque – enraciné dans la communication de la science, les perceptions économiques, la réalité économique, et la psychologie comportementale.

Biographie courte: Né et élevé sur un verger dans la vallée verdoyante de l'Okanagan en Colombie-Britannique, Tom Pedersen a obtenu un diplôme de premier cycle en géologie de l'Université de Colombie-Britannique en 1974. Il a commencé sa carrière professionnelle comme géologue prospecteur en cherchant des gisements de minerais au nord du Canada. Sa curiosité à propos de la Terre et particulièrement de l'océan l'a ramené aux études supérieures deux ans plus tard. En 1979, il a obtenu un doctorat en géochimie marine de l'Université d'Édimbourg. Il est entré à l'Université de Colombie-Britannique en tant que boursier de recherches postdoctorales cette année-là. Par la suite, la UBC l'a nommé à la Faculté et en 1994, il a été promu professeur. Il a servi comme doyen associé à la recherche pour la Faculté des Études supérieures à la UBC de 2000 jusqu'au milieu de 2002 avant de joindre l'Université de Victoria en 2002 en tant que directeur de l'École des Sciences de la Terre et de l'Océan. En 2003, il a pris le rôle de doyen de la Faculté des Sciences à la UVic, et en septembre 2009 il est devenu directeur du Pacific Institute for Climate Solutions. Il a beaucoup publié dans le domaine de la paléocéanographie (l'histoire des océans), et il utilise des mesures géochimiques et isotopiques des sédiments marins comme empreintes des processus océaniques physiques, biologiques et chimiques.

Pedersen a reçu plusieurs honneurs, y compris le Prix d'enseignement Killam de la UBC en 1990, une bourse Killam de recherches professorales en 1997, et la médaille Michael J. Keen de l'Association géologique du Canada en 2002. Il a été élu chargé de cours à la Société royale canadienne en 2002, et à la American Geophysical Union en 2006.

Note: Les conférences se tiendront entre janvier et avril 2011. Prière de consulter le site web de la SCMO (http://www.cmos.ca/tourspkr.html) pour connaître la date et l'heure exactes de la présentation dans votre région.

Submit to *Atmosphere-Ocean*

Now that CMOS has acquired considerably more capacity by entering into a partnership agreement with major publisher Taylor & Francis, *Atmosphere-Ocean* (http://informaworld.com/tato) is ready to receive more submissions. The content of our journal is generalist, but being Canadian, papers focusing on the Arctic and Northern latitudes are especially welcome. Thanks to our new online manuscript submission and review system, the processing time is expected to be significantly reduced.

Note that all members of CMOS have free access to the electronic version and may purchase a print subscription at a much reduced price. We also have a special incentive for new authors: see

http://www.cmos.ca/Ao/waivingpagecharges.html.

Soumettez à *Atmosphere-Ocean*

Maintenant que la SCMO a considérablement augmenté sa capacité grâce au partenariat avec la grande maison d'édition Taylor & Francis, *Atmosphere-Ocean* (http://informaworld.com/tato) est prêt à recevoir plus de manuscrits. Quoiqu'elle couvre tous les sujets, en tant que canadienne la revue aimerait inviter tout spécialement les articles touchant l'Arctique et les latitudes septentrionales. Les articles en français sont aussi bienvenus. Grâce à notre nouveau système de soumission et de révision en ligne, le délai de traitement des manuscrits sera considérablement réduit.

Notez que tous les membres de la SCMO jouissent de l'accès gratuit à la version électronique et peuvent aussi s'abonner à la version imprimée à un prix très réduit. De plus, nous exonérons de frais les nouveaux auteurs, voir :

http://www.cmos.ca/Ao/waivingpagecharges.html.

Richard Asselin
Director of Publications / Directeur des publications

A-O Abstracts Preview

Avant Première des résumés de A-O

The following abstracts are published in your *ATMOSPHERE-OCEAN* publication 48-4.

Les résumés qui suivent sont publiés dans votre revue *ATMOSPHERE-OCEAN* 48-4.

Structures and Property Distributions in the Three Oceans Surrounding Canada in 2007: A Basis for A Long-Term Ocean Climate Monitoring Strategy

by EDDY C. CARMACK, FIONA A. MCLAUGHLIN, SVEIN VAGLE, HUMFREY MELLING and William J. Williams

Abstract

The pan-Arctic is tightly connected to the Subarctic by through-flowing Atlantic and Pacific water masses and, as such, local changes in ice cover, ocean properties and ecosystem dynamics cannot be fully understood separately from large-scale oceanographic structures and advective processes. The Canadian International Polar Year (IPY) project Canada's Three Oceans (C3O) and the related Joint Ocean Ice Study (JOIS) have collected oceanographic data along a transit extending around northern North America to establish an initial, large-scale baseline against which present and future changes can be gauged. Special focus was given to the shelf and the basin regions of the Canada Basin and the Canadian Arctic Archipelago. This paper presents the first results from physical and geochemical data obtained during summer, 2007, to discuss linkages between the Arctic and Subarctic domains and trace the cascade of key processes that affect contemporary ocean structure. A review of the literature, combined with these observations, is used to identify early signs of ongoing change throughout the three oceans surrounding northern North America including ocean warming and freshening, sea-ice melting, increased hypoxia, reduced pH and altered biogeography.

Résumé

L'Arctique boréal est étroitement raccordé au Subarctique par des flux transversaux de masses d'eau atlantique et pacifique et, de ce fait, on ne peut pas expliquer complètement les changements locaux dans la couverture de glace, dans les propriétés de l'océan et dans la dynamique des écosystèmes sans tenir compte des structures et des processus d'advection océanographiques à grande échelle. Le projet canadien Les trois océans du Canada (C3O) de l'Année polaire internationale (API) et la Joint Ocean Ice Study (JOIS) connexe ont recueilli des données océanographiques le long d'un trajet contournant le nord de l'Amérique du Nord afin d'établir une base de référence initiale à grande échelle pouvant permettre d'évaluer les changements présents et futurs. On a porté une attention spéciale aux régions de plate-forme continentale et de bassin du Bassin Canada et de l'archipel Arctique canadien. Cet article présente les premiers résultats des données physiques et géochimiques obtenues durant l'été 2007 pour expliciter les liens entre les domaines arctiques et subarctiques et décrire la cascade de processus clés qui influencent la structure océanique contemporaine. Nous examinons la documentation, que nous utilisons de pair avec ces observations, pour identifier les signes avant-coureurs des changements en cours dans les trois océans bordant le nord de l'Amérique du Nord, notamment le réchauffement et le refroidissement des océans, la fonte de la glace de mer, l'accroissement de l'hypoxie, la réduction du pH et la modification de la biogéographie.

The International Polar Year (IPY) Circumpolar Flaw Lead (CFL) System Study: Overview and the Physical System

by D.G. BARBER, M.G. ASPLIN, Y. GRATTON, J. LUKOVICH, R. GALLEY, R. L. RADDATZ and D. LEITCH

Abstract

The Circumpolar Flaw Lead (CFL) system study is a Canadian-led International Polar Year (IPY) initiative with over 350 participants from 27 countries. The study is multidisciplinary in nature, integrating physical sciences, biological sciences and Inuvialuit traditional knowledge. The CFL study is designed to investigate the importance of changing climate processes in the flaw lead system of the northern hemisphere on the physical, biogeochemical and biological components of the Arctic marine system. The CFL is a perennial characteristic of the Arctic throughout the winter season and forms when the mobile multi-year (MY) pack ice moves away from coastal fast ice, creating recurrent and interconnected polynyas in the Norwegian, Icelandic, North American and Siberian sectors of the Arctic. The CFL study was 293 days in duration and involved the overwintering of the Canadian research icebreaker CCGS *Amundsen* in the Cape Bathurst flaw lead throughout the annual sea-ice cycle of 2007- 2008.

In this paper we provide an introduction to the CFL project, and then use preliminary data from the field season to describe the physical flaw lead system, as observed during the CFL overwintering project. Preliminary data show that ocean circulation is affected by eddy-propagation into Amundsen Gulf (AG). Upwelling features arising along the ice edge and along abrupt topography are also detected and identified as important processes that bring nutrient rich waters up to the euphotic zone. Analysis of sea-ice relative vorticity and sea-ice area by ice type in the AG during the CFL study illustrates increased variability in ice vorticity in late autumn of 2007 and an increase in new and young ice areas in the AG during winter. Analysis of atmospheric data shows that a strong northeast-southwest pressure gradient present over the AG in autumn may be a synoptic-scale atmospheric response to sensible and latent heat fluxes arising from areas of open water persisting into late November 2007. The median atmospheric boundary layer

temperature profile over the Cape Bathurst flaw lead during the winter season was stable but much less so when compared to Russian ice island stations.

Résumé
L'étude du système du chenal de séparation circumpolaire (CSC) est une initiative de l'Année polaire internationale (API) menée par le Canada et à laquelle 350 participants provenant de 27 pays ont pris part. L'étude, de nature multidisciplinaire, fait appel aux sciences physiques et biologiques ainsi qu'au savoir traditionnel Inuvialuit. L'étude du CSC vise à examiner les répercussions des processus climatiques changeants dans le système du chenal de séparation de l'hémisphère Nord sur les composantes physiques, biogéochimiques et biologiques du système marin arctique. Le CSC est une caractéristique permanente de l'Arctique durant la saison d'hiver et se forme quand la banquise mobile de glace de plusieurs années s'éloigne de la banquise côtière fixe en créant des polynies récurrentes et interconnectées dans les secteurs norvégien, islandais, nord-américain et sibérien de l'Arctique. Pour mener l'étude du CSC, qui a duré 293 jours, le brise-glace de recherche canadien *NGCC Amundsen* est demeuré dans le chenal de séparation du cap Bathurst tout l'hiver, c'est-à-dire pendant tout le cycle annuel des glaces de mer de 2007 - 2008.

Dans cet article, nous fournissons une introduction au projet du CSC, puis nous utilisons les données préliminaires de la saison sur le terrain pour décrire le système physique du chenal de séparation, tel qu'observé durant l'hiver du projet du CSC. Les données préliminaires montrent que la circulation océanique est influencée par la propagation de tourbillon dans le golfe d'Amundsen (GA). Des caractéristiques de remonté d'eau le long de la lisière des glaces et le long d'éléments topographiques abrupts ont aussi été observées et identifiées comme des processus importants apportant des eaux riches en nutriants jusqu'à la zone euphotique. L'analyse du tourbillon relatif de la glace de mer et de la superficie de la glace de mer par type dans le GA durant l'étude du CSC révèle une variabilité accrue dans le tourbillon de la glace à la fin de l'automne 2007 et un accroissement des superficies de nouvelle et de jeune glace dans le GA durant l'hiver. L'analyse des données atmosphériques montre que la présence d'un fort gradient de pression nord-est – sud-ouest au-dessus du GA en automne peut être une réponse atmosphérique d'échelle synoptique aux flux de chaleur sensible et latente à partir des zones d'eaux libres qui ont persisté jusque vers la fin de novembre 2007. Le profil thermique de la couche limite atmosphérique médiane au-dessus du chenal de séparation du cap Bathurst durant la saison hivernale était stable, mais beaucoup moins que les profils observés aux stations des îles de glace russes.

The International Polar Year (IPY) Circumpolar Flaw Lead (CFL) System Study: The Importance of Brine Processes for α- and γ-Hexachlorocyclohexane (HCH) Accumulation or Rejection in Sea Ice

by M. PUĆKO, G. A. STERN, D. G. BARBER, R. W. MACDONALD and B. ROSENBERG

Abstract
We present evidence that both geophysical and thermodynamic conditions in sea ice are important in understanding pathways of accumulation or rejection of hexachlorocyclohexanes (HCHs). α- and γ-HCH concentrations and α-HCH enantiomer fractions have been measured in various ice classes and ages from the Canadian High Arctic. Mean α-HCH concentrations reached 0.642 ±0.046 ng L^{-1} in new and young ice (<30 cm), 0.261 ±0.015 ng L^{-1} in the first-year ice (30-200 cm) and 0.208 ±0.045 ng L^{-1} in the old ice (>200 cm). Mean γ-HCH concentrations were 0.066 ±0.006 ng L^{-1} in the new and young ice, 0.040 ±0.002 ng L^{-1} in the first-year ice and 0.040 ±0.007 ng L^{-1} in the old ice. In general, α-HCH concentrations and vertical distributions were highly dependent on the initial entrapment of brine and the subsequent desalination process. γ-HCH levels and distribution in sea ice were not as clearly related to ice formation processes. During the year, first-year ice progressed from freezing (accumulation) to melting (ablation). Relations between the geophysical state of the sea ice and the vertical distribution of HCHs are described as ice passes through these thermodynamic states. In melting ice, which corresponded to the algal bloom period, the influence of biological processes within the bottom part of the ice on HCH concentrations and α-HCH enantiomer fraction is discussed using both univariate and multivariate approaches.

Résumé
Nous présentons des faits montrant que tant les conditions géophysiques que les conditions thermodynamiques dans la glace de mer sont importantes pour la compréhension des voies d'accumulation ou de rejet des hexachlorocyclohexanes (HCH). Nous avons mesuré les concentrations de α-HCH et de γ-HCH ainsi que les fractions des énantiomères α-HCH dans diverses classes et divers âges de la glace de l'Arctique septentrional canadien. Les concentrations moyennes de α-HCH ont atteint 0,642 ±0,046 ng L^{-1} dans la nouvelle glace et la jeune glace (<30 cm), 0,261 ±0,015 ng L^{-1} dans la glace de première année (30-200 cm) et 0,208 ±0,045 ng L^{-1} dans la vieille glace (>200 cm). Les concentrations moyennes de γ-HCH étaient de 0,066 ±0.006 ng L^{-1} dans la nouvelle glace et la jeune glace, 0,040 ±0,002 ng L^{-1} dans la glace de première année et 0,040 ±0,007 ng L^{-1} dans la vieille glace. En général, les concentrations et les distributions verticales de α-HCH étaient fortement liées au piégeage initial de la saumure et au processus de dessalement subséquent. Les niveaux et la distribution de γ-HCH dans la glace de mer n'étaient pas clairement liés aux processus de formation de

la glace. Au cours de l'année, la glace de première année a progressé de la congélation (accumulation) à la fonte (ablation). Nous décrivons les relations entre l'état géophysique de la glace de mer et la distribution verticale des HCH au fur et à mesure que la glace passe par ces états thermodynamiques. Dans la glace fondante, c'est-à-dire pendant la période de prolifération des algues, nous étudions l'influence des processus biologiques dans la partie inférieure de la glace sur les concentrations de HCH et la fraction des énantiomères α-HCH, tant au moyen d'approches à une variable que d'approches à plusieurs variables.

The First Coupled Historical Forecasting Project (CHFP1)

by WILLIAM J. MERRYFIELD, WOO-SUNG LEE, GEORGE J. BOER, VIATCHESLAV V. KHARIN, BADAL PAL, JOHN F. SCINOCCA and GREGORY M. FLATO

Abstract
A set of retrospective multiseasonal ensemble predictions based on a coupled global atmosphere-ocean model is described. These predictions, designated as the first coupled Historical Forecasting Project or CHFP1, are produced with the climate model CGCM3.1 of the Canadian Centre for Climate Modelling and Analysis using a very simple initialization procedure in which model sea surface temperatures (SSTs) are nudged toward the observed values during a multi-year period preceding the beginning of a forecast. This procedure, in addition to constraining initial SSTs to be close to observations, initializes equatorial Pacific zonal wind stress and thermocline depth with some skill. The ability of the subsequent forecasts to predict the evolution of SSTs, particularly in the equatorial Pacific, and surface air temperatures globally and in Canada is assessed. The results are compared with those of the second Historical Forecasting Project or HFP2, which uses a two-tier strategy in which model SSTs are externally specified. Skill of CHFP1 forecasts, though generally modest, exceeds those of HFP2 in some cases, despite the larger multi-model ensemble used in HFP2. CHFP1 represents an initial step in development directed toward a coupled operational seasonal prediction system for Canada.

Résumé
Nous décrivons une série de prévisions d'ensemble multisaisonnières rétrospectives basée sur un modèle couplé global atmosphère–océan. Ces prévisions, que l'on désigne sous le nom de Premier Projet de prévisions historiques (PPH1), sont produites à l'aide du modèle climatique MCCG3.1 du Centre canadien de la modélisation et de l'analyse climatique en utilisant une procédure d'initialisation très simple dans laquelle les températures de surface de la mer (TSM) du modèle sont poussées vers les valeurs observées durant une période de plusieurs années précédant le début d'une prévision. Cette façon de procéder, en plus de forcer les TSM initiales à être proches des valeurs observées, initialise la tension du vent zonal et la profondeur de la thermocline dans le Pacifique équatorial avec une certaine adresse. Nous évaluons l'habileté des prévisions subséquentes à prévoir l'évolution des TSM, en particulier dans le Pacifique équatorial, ainsi que les températures de l'air à la surface pour tout le globe et au Canada. Nous comparons les résultats à ceux du Deuxième Projet de prévisions historiques (PPH2), qui emploie une stratégie en deux étapes dans laquelle les TSM du modèle sont spécifiées de l'extérieur. L'habileté des prévisions du PPH1, quoique généralement modeste, dépasse celle des prévisions du PPH2 dans certain cas, malgré l'ensemble multimodèle plus grand utilisé dans le PPH2. Le PPH1 constitue une étape initiale dans les travaux visant à doter le Canada d'un système couplé opérationnel de prévisions saisonnières.

Derivation of an Adjustment Factor Map for the Estimation of the Water Equivalent of Snowfall from Ruler Measurements in Canada

by ÉVA MEKIS and ROSS BROWN

Abstract
This paper provides an updated fresh snowfall water equivalent adjustment factor (ρ_{swe}) map for Canada to allow the estimation of solid precipitation amount from ruler measurements of the depth of freshly fallen snow, which has been the standard method for measuring snowfall since Canadian climate measurements began in the middle of the nineteenth century. The ρ_{swe} map is created based on the comparison of corrected solid Nipher gauge precipitation to snowfall ruler depth measurements at 175 stations with more than 20 years of concurrent observations. The Nipher gauge correction process involved a careful analysis of station metadata to obtain precise information on anemometer heights and the dates that Nipher gauges were activated. The updated fresh snowfall water equivalent adjustment factor map allows estimates of ρ_{swe} to be obtained for all long-term climate stations in Canada. The spatial pattern is consistent with processes influencing the density of fresh snowfall and its initial settling with values ranging from more than 1.5 over the Maritimes to less than 0.8 over southern-central British Columbia.

Résumé
Cet article fournit une carte révisée des facteurs d'ajustement (ρ_{swe}) de l'équivalent en eau de la neige fraîche pour le Canada afin de permettre l'estimation des quantités de précipitations solides à partir des mesures d'épaisseur de la neige fraîche faites avec une règle, ce qui constitue la méthode normalisée de mesure des chutes de neige depuis que les mesures climatiques ont débuté au Canada au milieu du dix-neuvième siècle. La carte ρ_{swe} est basée sur la comparaison des précipitations solides corrigées obtenues du nivomètre de Nipher aux mesures d'épaisseur de neige faites avec une règle à 175 stations où l'on dispose de plus de 20 années d'observations concurrentes. Le processus de correction des données des nivomètres de Nipher comprenait une analyse minutieuse

des métadonnées des stations afin d'obtenir des renseignements précis sur la hauteur des anémomètres et les dates auxquelles les nivomètres de Nipher ont été mis en service. La carte des facteurs d'ajustement de l'équivalent en eau de la neige fraîche permet d'obtenir des estimations de ρ_{swe} pour toutes les stations climatiques à long terme au Canada. La configuration spatiale correspond aux processus qui influencent la densité de la neige fraîche et son tassement initial, avec des valeurs allant de plus de 1,5 dans les Maritimes à moins de 0,8 dans le centre-sud de la Colombie-Britannique.

Potential and Limitations of Using Satellite Data to Evaluate the Spatial Detail in Climatological Air Temperature Maps

by N. BUSSIÈRES and E. MILEWSKA

Abstract
Detailed patterns of spatial variability in surface temperature can be observed with the use of thermal infrared data from satellites. A method is developed to use clear-sky thermal infrared satellite data to evaluate traditional monthly average maximum air temperature maps interpolated from observations at surface stations using a statistical thin plate smoothing spline method. Results of comparisons over Alberta, Manitoba and Saskatchewan from June to October, for the years 2001 to 2005 are presented. The satellite data allow identification of some limitations in the interpolation technique at high altitudes in mountain ranges and in data-sparse areas due to low station density. In the data-sparse areas, the highest discrepancies could be linked to the unrepresentativeness of the stations because of different land cover or the presence of water bodies. Conversely, the interpolated air temperature maps allow the identification of problems with using thermal infrared data to estimate near-surface air temperatures in areas of significant moisture deficit and at the locations of water bodies.

Résumé
On peut observer des configurations détaillées de la variabilité spatiale de la température de surface au moyen des données infrarouge thermique des satellites. Nous mettons au point une méthode permettant d'utiliser les données satellitaires infrarouge thermique par ciel clair pour évaluer les cartes conventionnelles de température maximale moyenne mensuelle de l'air, interpolées d'après les observations aux stations de surface selon une méthode statistique de splines de lissage « plaque mince ». Nous présentons les résultats comparatifs au-dessus de l'Alberta, du Manitoba et de la Saskatchewan de juin à octobre pour les années 2001 à 2005. Les données satellitaires permettent l'identification de certaines limites dans la technique d'interpolation aux altitudes élevées dans les chaînes de montagnes et dans les régions pauvres en données à cause de la faible densité de stations. Dans les régions pauvres en données, les divergences les plus marquées pourraient s'expliquer par la non-représentativité des stations attribuable à des couvertures terrestres différentes ou à la présence de masses d'eau. Réciproquement, les cartes de température de l'air interpolées permettent l'identification de problèmes quand on utilise les données infrarouge thermique pour estimer les températures de l'air près de la surface dans les régions où le déficit d'humidité est important et aux endroits où se trouvent des masses d'eau.

Atmosphere-Ocean 48-4 Paper Order

Special Section: Canadian Ocean Studies Conducted during International Polar Year / Section spéciale sur les études océaniques canadiennes menées durant l'Année polaire internationale

Preface / Préface by ROBIE W. MACDONALD

[You may read the English version on **page 5** in this issue; pour lire la version française, voir à la **page 6** de ce numéro.]

Structures and Property Distributions in the Three Oceans Surrounding Canada in 2007: A Basis for A Long-Term Ocean Climate Monitoring Strategy, by EDDY C. CARMACK, FIONA A. MCLAUGHLIN, SVEIN VAGLE, HUMFREY MELLING and WILLIAM J. WILLIAMS

The International Polar Year (IPY) Circumpolar Flaw Lead (CFL) System Study: Overview and the Physical System by D.G. BARBER, M.G. ASPLIN, Y. GRATTON, J. LUKOVICH, R. GALLEY, R. L. RADDATZ and D. LEITCH

The International Polar Year (IPY) Circumpolar Flaw Lead (CFL) System Study: The Importance of Brine Processes for α- and γ-Hexachlorocyclohexane (HCH) Accumulation or Rejection in Sea Ice, by M. PUĆKO, G. A. STERN, D. G. BARBER, R. W. MACDONALD and B. ROSENBERG

Regular Section / Section régulière

The First Coupled Historical Forecasting Project (CHFP1) William J. M erryfield, Woo-Sung Lee, George J. Boer, Viatcheslav V. Kharin, BADAL PAL, JOHN F. SCINOCCA and GREGORY M. FLATO

Derivation of an Adjustment Factor Map for the Estimation of the Water Equivalent of Snowfall from Ruler Measurements in Canada by ÉVA MEKIS and ROSS BROWN

Potential and Limitations of Using Satellite Data to Evaluate the Spatial Detail in Climatological Air Temperature Maps N. BUSSIÈRES and E. MILEWSKA

Report of the Nominating Committee for CMOS Council

Rapport du Comité de mise en candidature pour le conseil de la SCMO

The Nominating Committee consisting of Past-President and Chair, Bill Crawford, President David Fissel and Vice-President Norman McFarlane recommends the following candidates for the CMOS Council for 2011-12, all of whom have agreed to stand for office:

Le Comité de mise en candidature composé du Président sortant et Président du Comité Bill Crawford, du Président de la Société David Fissel et du Vice-président Norman McFarlane recommande les candidats suivants pour le conseil de la SCMO pour l'année 2011-2012. Tous ont accepté d'être nominés:

President Président	**Norman McFarlane**, Term Professor, University of Victoria, Emeritus Scientist, Canadian Centre for Climate Modelling and Analysis (CCCma)
Vice-President Vice-président	*** Peter Bartello**, Associate Professor, Dept. of Atmospheric & Oceanic Sciences and Dept. Mathematics & Statistics, McGill University
Treasurer Trésorier	**Rich Pawlowicz**, Associate Professor, University of British Columbia
Corresponding Secretary Secrétaire correspondant	**Jane Eert**, Research Scientist, Institute of Ocean Sciences, Fisheries and Oceans Canada
Recording Secretary Secrétaire d'assemblée	**Sophia (Sophie) Johannessen**, Research Scientist, Institute of Ocean Sciences, Fisheries and Oceans Canada
Past President Président d'office	**David Fissel**, President and CEO, ASL Environmental Sciences Inc.
Councillors-at-Large (3) Conseillers (3)	**Charles Lin**, (term ends June 2012. *** Denis Gilbert** (term ends June 2013 *** Kimberley Strong** (terms ends June 2014.

* New nominations; * nouveaux nominés.

It has been a long-time tradition for CMOS executive to be located in one geographical area for a three-year cycle. Our present executive on the West Coast will be finishing their third year in June 2012. Previous executives were on the Prairies, in Halifax and in Toronto.

New nominees were selected by polling members of CMOS Council, which is comprised of Chairs of all Local Centres, Chairs of CMOS Committees and the present Executive. During these discussions the Montreal Centre volunteered to "host" the CMOS executive for the next three-year cycle. This plan was endorsed by CMOS Council. The Montreal Centre then asked Peter Bartello to be the first Vice-President from this region.

Bill Crawford
Chair, Nominating Committee

C'est une vieille tradition pour la SCMO que l'Exécutif soit localisé dans une région géographique pour un cycle de trois ans. Le présent Exécutif de la côte Ouest terminera sa troisième année en juin 2012. Les exécutifs antérieurs venaient des Prairies, d'Halifax et de Toronto.

Les nouveaux nominés furent choisis par consultation des membres du Conseil de la SCMO qui comprend les Présidents des Centres locaux, les Présidents des Comités ainsi que l'Exécutif. Durant ces discussions, le Centre de Montréal s'est porté volontaire pour "héberger" l'Exécutif durant le prochain cycle de trois ans. Ce plan fut approuvé par le Conseil de la SCMO. Le Centre de Montréal a par la suite demandé à Peter Bartello d'être le premier Vice-président de cette région.

Bill Crawford
Président, Comité de mise en candidature

Additional Nominations
In accordance with By-Law 9, additional nominations in writing from the membership will be accepted by the Recording Secretary up to March 15, provided:

i) that the nominee is eligible for the office for which he/she is nominated;

ii) that the nominee acknowledges, by signing the nomination form, his willingness to accept office if elected; and

iii) that the nomination is signed by nine members, in addition to the nominee and the member making the nomination.

Nominations additionnelles
En accord avec le règlement 9, le secrétaire accepte jusqu'au 15 mars les mises en candidature des membres soumises par écrit, pourvu que:

i) le candidat soit éligible au poste auquel il/elle est proposé;

ii) le candidat exprime son consentement d'accepter le poste s'il est élu en signant le formulaire de mise en candidature; et

iii) la mise en candidature soit signée par neuf membres autres que le candidat et le membre proposant sa candidature.

Call for Papers: 2011 CMOS Congress

The 45th CMOS Congress will be held on June 5-9, 2011 in Victoria, British Columbia at the Victoria Conference Centre.

Please submit abstracts electronically to

https://www1.cmos.ca/abstracts/

after **January 7, 2011** and before the deadline of midnight EST on **February 11, 2011**. You will be asked to submit your abstract to one of the sessions listed on the website and to specify your preference for either an oral or a poster presentation. (Poster submissions are especially encouraged: posters will be displayed in a spacious location close to where coffee is served, and at least two substantial prizes for posters will be awarded at this year's Congress).

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 2011**. Details for your oral or poster presentation will be provided by **17 March 2011**.

CMOS 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://www.cmos.ca/congress2011/en/students

and the deadline for the application is **February 25, 2011**.

Bill Merryfield
Chair, Scientific Program Committee

Appel de soumission de résumés: Congrès SCMO 2011

Le 45e Congrès de la SCMO aura lieu du 5 au 9 juin 2011 à Victoria, Colombie Britannique, au Centre des conférences de Victoria.

Veuillez soumettre vos résumés électroniquement en utilisant le lien

https://www1.cmos.ca/abstracts/

entre le **7 janvier** et minuit HNE le **11 février 2011**. Vous devrez soumettre votre résumé à une des sessions affichées sur le site et spécifier votre préférence pour une présentation orale ou une présentation affichée. (Nous recommandons particulièrement les présentations affichées: les affiches seront en montre dans une vaste salle adjacente à l'endroit où le café sera servi, et au moins deux prix de valeur seront accordés pour une affiche à ce congrès).

Des frais de $50 seront exigés 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 2011**. Les détails pour votre présentation orale ou affichée vous seront communiqués le **17 mars 2011**.

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

http://cmos.ca/congress2011/fr/etudiants

La date limite pour les demandes est le **25 février 2011**.

Bill Merryfield, Président, Comité programme scientifique

Proposed Amendments to the CMOS Constitution and By-Laws

At its meeting on 8 December 2010, the Council agreed to put forward to all members the following Council-proposed amendments, in accordance with Art. 5:

BY-LAW 1 - Membership

b) Regular and Sustaining membership categories are open to individuals. Each Sustaining Member is entitled to receive all publications of the Society [*add*: in either printed or electronic format as decided by Council from time to time and to receive credit for a donation for that part of the fee that exceeds the regular member fee.]
c) Corporate membership is open to companies and other organizations. Each Corporate Member will be entitled to receive all publications of the Society [*add*: in either printed or electronic format as decided by Council from time to time]. Each Corporate Member shall nominate one person who shall act on behalf of the organization in all dealings with the Society [*add*: and who shall enjoy all the benefits of an individual member, including discounted congress registration.]
d) Student membership is open to full-time students. [*add*: The publication entitlements of student members may be defined by Council from time to time.]

BY-LAW 3 - Publications

a) The Society shall publish a bi-monthly CMOS Bulletin SCMO and an Annual Review. The former publication shall contain Society and other news in the fields of interest to Society members, as well as appropriate technical articles, particularly on climatological and operational meteorological and oceanographic subjects. These two publications shall be received by all members [*add*: in either printed or electronic format as decided by Council from time to time.]
b) The Society shall also publish [*add*: or cause to be published] the journal ATMOSPHERE-OCEAN on a subscription basis. [*add*: Members may be offered discounted subscriptions.]

[Purpose: to give the Council the flexibility to change the publication entitlements of members without having to amend the By-Laws each time.]

BY-LAW 16 - Finances

b) The Treasurer [*add*: and the Executive Director] shall make arrangements for the preparation of the accounts of the Society for external audit at the end of the fiscal year. The accounts, the budget and the Auditor's Report shall be presented at each Annual General Meeting.

[Purpose: to recognize that the Society's accounts are held at the national office.]

APPENDIX I TO BY-LAWS
PRIZES, AWARDS AND SCHOLARSHIPS

l) The CMOS - The Weather Network/Météomédia Scholarship
This scholarship ($1500) is offered to a 3rd [*delete*: or 4th]year female student at a Canadian university who intends to pursue a career in the fields of Forecast Meteorologist, On-Air Meteorologist or Meteorological Briefer.

[Purpose: to recognize that a student in 4th year cannot be eligible for a scholarship for the following academic year.]

CURRENT CMOS POLICIES AND POSITION STATEMENTS

c) [*add*: **Uri Schwarz**] **Development Fund**

The [*add*: Uri Schwarz] Development Fund

[Purpose: to implement change of name approved at the AGM in 2010]

Proposition de modification de la Constitution et les Règlements de la SCMO

À sa réunion du 8 décembre 2010 et en accord avec l'article 5, le conseil d'administration de la SCMO a accepté de soumettre à tous les membres les modifications suivantes comme propositions du conseil :

RÈGLEMENT 1 - Adhésion

b) Les désignations de membre régulier et membre de soutien sont offertes aux individus. Chaque membre de soutien a droit à toutes les publications de la Société [*ajouter* : en format imprimé ou électronique tel que le conseil peut déterminer de temps en temps et droit à un crédit d'impôt pour la portion des frais qui excède les frais régulier.]
c) Des compagnies ou autres organisations peuvent devenir membres corporatifs. Chaque membre corporatif a droit à toutes les publications de la Société [*ajouter* : en format imprimé ou électronique tel que le conseil peut déterminer de temps en temps]. Chaque membre corporatif doit nommer un individu qui agira au nom de l'organisation au cours de ses affaires avec la Société [*ajouter* : et qui aura tous les droits d'un membre individu, incluant les frais réduits d'enrégistrement au congrès annuel]
d) Les étudiants à plein temps peuvent devenir membres-étudiants. [*ajouter* : Les droits aux publications de la Société seront déterminer par le conseil de temps en temps.]

RÈGLEMENT 3 – Publications

a) La Société entreprendra de publier un CMOS Bulletin SCMO à tous les deux mois et une Revue Annuelle. La première publication doit contenir des nouvelles de la Société et d'autres sujets intéressant les membres de la Société, ainsi que des articles techniques appropriés, particulièrement sur des sujets de météorologie et d'océanographie climatologique et opérationnelle. Ces deux publications devront être distribuées à tous les membres [*ajouter* : en format imprimé ou électronique tel que le conseil peut déterminer de temps en temps.]
b) La Société entreprendra de publier [*ajouter* : ou faire publier] le journal ATMOSPHERE-OCEAN aux personnes qui en auront acquitté les frais d'abonnement.]

[Objet : donner au conseil la fléxibilité de changer les droits des membres aux publications sans la nécessité de changer les règlements à chaque fois.]

RÈGLEMENT 16 - Finances

b) Le trésorier [*ajouter* : et le directeur exécutif] doit faire des arrangements pour la préparation des comptes de la Société pour un examen par un vérificateur externe à la fin de l'année fiscale. La comptabilité, le budget et le rapport du (des) vérificateur(s) sont déposés devant chaque assemblée générale annuelle.

[Objet : reconnaître le fait que les comptes de la Société sont tenus au bureau national.]

APPENDICE I AUX RÈGLEMENTS
PRIX, HONNEURS ET BOURSES

l) **La bourse SCMO - The Weather Network/Météomédia**
Cette bourse (\$1500) est offerte à une étudiante dans la 3e [*effacer* : ou 4e] année d'un programme de Sciences atmosphériques dans une université canadienne, avec aspirations de carrière en tant que Météorologue prévisionniste, Météorologue ''en- ondes'' ou Météorologue ''briefer''.

[Objet : reconnaître qu'une étudiante dans la 4e année ne peut pas être éligible pour une bourse dans l'année suivante.]

POLITIQUES ET ÉNONCÉS DE POSITION COURANTS DE LA SCMO

c) **Fonds de développement** [*ajouter* : **Uri Schwarz**.]

Le fonds de développement [*ajouter* : Uri Schwarz] est . . .

[Objet : changement approuvé à la réunion annuelle de 2010]

SHORT NEWS / NOUVELLES BRÈVES

DFO Pacific Science Program Wins International Award

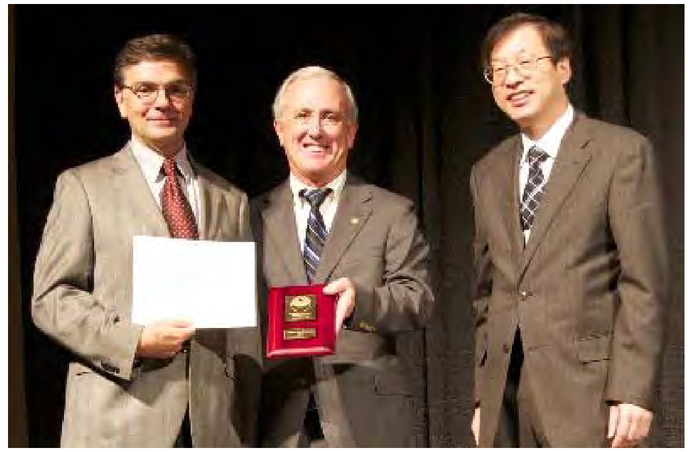
The North Pacific Marine Science Organization (PICES) awarded its PICES Ocean Monitoring Service Award (POMA) to the **Line P / Station P Monitoring Program** of DFO - Pacific Region. The award was presented at the PICES Annual General Meeting in Portland, Oregon on October 25.

This award is given for "*significant contributions to the progress of marine science in the North Pacific through long-term monitoring operations, management of data associated with ocean conditions and marine bio-resources in the region, or both categories*".

The Line P / Station P Monitoring Program (Line P) samples ocean properties three times per year along a line of 27 ocean stations running 1,500 km west of Vancouver Island into deep-sea waters of the North Pacific Ocean. DFO observations on Line P in the past decade have proven that its surface waters are starved for iron, that a massive Northeast Pacific biological bloom in late summer 2008 was fuelled by iron from a recently erupted volcano, and that oxygen concentrations at mid-depths have been declining for the past 50 years. Ongoing programs, in partnership with Canadian and American academics and agencies, are looking into climate change in these waters, ocean acidification, and changes in fisheries and in deep-sea bacteria populations.

With more than 50 years of observations, the Line P program is the world's premiere open-ocean time series. The first scientific observations of this program began in 1956 with simple measurements of temperature from ocean surface to mid-depths. Until 1981 all measurements were taken from weatherships heading to and returning from Ocean Station Papa at 50°N, 145°W in the northeast Pacific Ocean. Daily measurements were taken at Ocean Station Papa itself. DFO took on almost all costs in 1981 with the ending of the Weathership Program, and now sends three cruises per year to Station P, with about half of the scientific crew from non-DFO agencies.

The program is coordinated by scientist Marie Robert of the Institute of Ocean Sciences in Sidney, B.C.; Marie Robert was not at the meeting to accept this award. It was presented to Bill Crawford of IOS at the PICES Annual Meeting, with a later award ceremony at IOS in early November to Marie Robert. Also at this second ceremony were DFO emeritus scientist Frank Whitney, and former DFO scientist Susumu Tabata, two of the three "godfathers" of Line P. The founder of this program and first "godfather," John P. Tully, passed away several years ago. Appropriately, the research vessel that now carries scientists to Ocean Station Papa is named the *Canadian Coast Guard Ship John P. Tully*.



Left to right: Dr. Bill Crawford, accepting the POMA Award on behalf of DFO Science, Dr. John Stein, Chair of the PICES Science Board, Dr. Tokio Wada, Chairman of PICES Governing Council

Bill Crawford's acceptance speech

I was honoured when asked to accept this award on behalf of Marie Robert and the Line P/Station P Program. My role is mainly administrative, as many of the Line P scientists are in my section of Fisheries and Oceans Canada. This morning I compiled a list of 36 scientists who stand out among the thousands of persons who contributed to this program over the past years. I admit it is biased to recent years because my knowledge of the start of the program is limited. In mostly chronological order:

John Tully	Sus Tabata	Tim Parsons
Robin Lebrasseur	John Strickland	Cary McAllister
John Garrett	Bob Stewart	Cedric Mann
John Davis	C.S. Wong	Paul Harrison
Ken Denman	Peter Niiler	John Love
Reg Bigham	Bernard Minkley	Laura Richards
Frank Whitney	Tim Soutar	Howard Freeland
Robin Brown	Wendy Richardson	Mike Arychuk
Marie Robert	Ron Bellegay	Janet Barwell-Clarke
Lisa Miller	Keith Johnson	Sophie Johannessen
Angelica Peña	Jim Christian	Hugh Maclean

Doug Anderson	David Mackas	And our data quality queen: Germaine Gatien

On behalf of Fisheries and Oceans Canada, Marie Robert, the three godfathers, the list of 36, and the cast of thousands, thank-you PICES for this great honour.

Canada's Green Economy Past, Present and Future

December 2010 - ECO Canada's latest report "Defining the Green Economy" is the result of a year-long study to bring clarity to a highly-dynamic sector. The project involved extensive research including input from 13 national sector councils, an extensive review of 54 green economy related publications, and a survey conducted with 431 decision makers representing green organizations across Canada.

"This was done in an effort to provide the first critical step in solidifying the Canadian definition of the term 'Green Economy," says Grant Trump, President and CEO of ECO Canada.

In addition to communicating consensus-driven definitions, the report begins to uncover the top areas of economic opportunity in Canada and the impact it will have on employment.

The report outlines how a growing sense of environmental responsibility in conjunction with new government policies, and financial incentives is encouraging organizations in almost every sector of the economy to adopt greener practices. "By building upon the existing skill-sets of the environmental workforce and promoting cross-sectoral collaboration, green organizations within Canada will be better positioned to embrace the opportunities that lie ahead," says Trump.

This study lays a critical foundation for additional research that will explore the economic opportunities to uncover their implications for industry as well as narrow in on the actual occupations playing the most critical roles in the green economy. The report is available for free public download at www.eco.ca/greeneconomy.

Background:
ECO Canada is a not-for-profit organization that was first established in 1992 under the federal government's Sector Council initiative. Over the past 17 years, ECO Canada has grown into its own as an organization focussed on supporting Canada's environment industry by communicating with industry stakeholders, conducting research and creating the necessary resources required to address human resource needs in order to ensure the success of this dynamic sector.

The objective of ECO Canada's Labour Market Information reports is to provide Canada's environmental stakeholders including employers, the academic community, potential employees, and governments at all levels with current and accurate information to help guide initiatives and foster growth within the sector.

Concours photographique 2011 de la SCMO

Tous les membres qui ont une passion pour la photographie sont invités à participer au concours de photographie 2011 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 2011.** Pour toutes questions, prière de contacter Bob Jones à webmaistre@scmo.ca.

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Race Rocks Lighthouse: Photo courtesy of SpringTideCharters


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