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CMOS BULLETIN SCMO

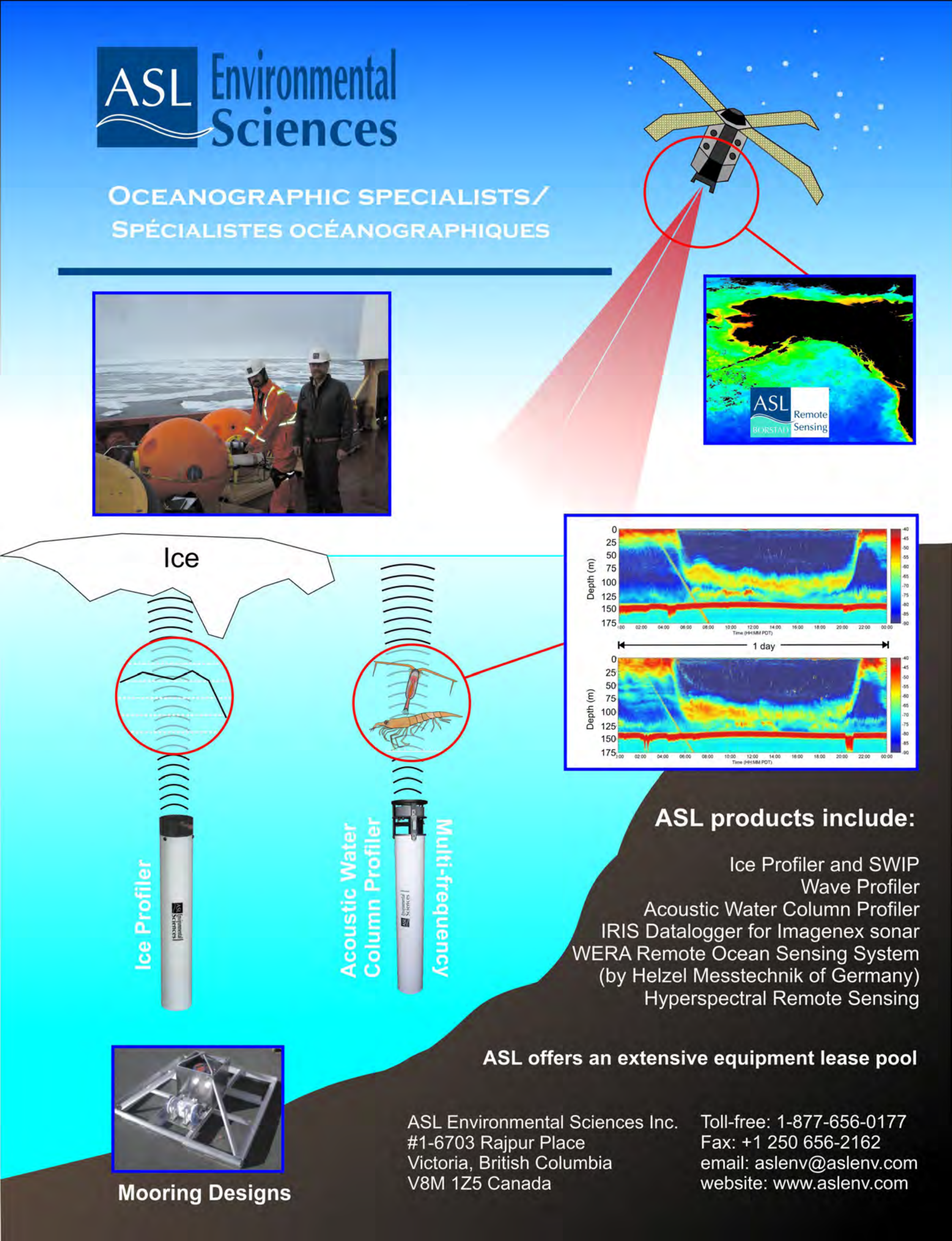
Canadian Meteorological and Oceanographic Society

La Société canadienne de météorologie et d'océanographie

February / février 2012 Vol.40 No.1

Top Canadian Weather Stories for 2011

Événements météorologiques canadiens marquants de 2011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Oceanographic specialists/
Spécialistes océanographiques
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1 day
Ice Profiler
Acoustic Water Column Profiler
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....from the President’s Desk

Friends and colleagues:

Norman McFarlane
President CMOS
Président de la SCMO

I am writing this in the early days of January. I take this opportunity to wish all CMOS members a happy and healthy new year, and to remind you to renew your membership if you have not already done so. To those readers who are not members I encourage you to consider becoming a member of CMOS. New and continuing members alike, please consider making a donation. CMOS is a registered charity and able to issue receipts for donations made to the Society. The donations page on the CMOS web site (www.cmos.ca) provides information on ways to make charitable donations to CMOS. The coming year will be an eventful one for CMOS. The 46th CMOS Congress will take place from May 29th to June 1st 2012 in Montréal, jointly with the 21st AMS Conference on Numerical Weather Prediction and the 25th AMS Conference on Weather Analysis and Forecasting. This promises to be another outstanding Congress where exciting and important leading Canadian work in meteorology and oceanography and related topics will be presented. Please visit the Congress Web site (www.cmos.ca/congress2012/index.htm) to see important dates and get information about the Congress. Some of these critical dates, such as the deadline for submission of abstracts, are rapidly approaching. Please plan to attend and encourage the participation of your colleagues and students. Also, encourage your students to apply for a scholarship and consider nominating a colleague and a student for a CMOS prize or award. CMOS members will have received information sheets for prizes and awards with the December issue of the Bulletin and for scholarships with the current issue. This information can also be found posted on the CMOS web site.

Some of the readers of this column may have followed the Canadian and international media coverage of the recent United Nations Climate Change Conference in Durban (COP 17) and the subsequent announcement by Peter Kent, Minister of the Environment, of Canada’s withdrawal from the Kyoto Protocol. These events motivated me to review the public statements and communications on the topic of climate change that CMOS has made over the past

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Articles

Our regular sections / Nos chroniques régulières

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Le but de la SCMO est de stimuler l'intérêt pour la météorologie et l'océanographie au Canada.

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

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Cover page: Each year, Environment Canada publishes the Top 10 Canadian Weather Stories for the year just gone by. 2011 is no exception. With David Phillips as the author, it is always interesting to read those stories that have marked our life during the past year. The *CMOS Bulletin SCMO* is proud to publish these Top 10 once more. You can read them in sequence starting on **page 12.**

Page couverture: Chaque année, Environnement Canada publie les 10 événements météorologiques les plus marquants pour l'année qui vient de s'écouler. 2011 ne fait pas exception. Il est toujours intéressant de lire les histoires qui ont façonné notre vie durant la dernière année et qui nous sont racontées par David Phillips. Le *CMOS Bulletin SCMO* est fier de présenter ces 10 histoires marquantes une nouvelle fois. Vous pouvez les lire dans l'ordre en **page 22.**

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

decade, and, in partnership with other societies, the letter to Members of Parliament in November, 2009 on the eve of the Copenhagen Conference of the Parties to the UN Framework Convention on Climate Change (UNFCC). These statements and letter are posted on the CMOS web site and are publicly accessible from the home page. I encourage readers of this column to read them if they have not already done so. They assert the reality and increasing rapidity of climate change resulting from human activities. They stress the importance of understanding the science of climate change and variability to develop effective programs and policies on climate change, including addressing the commitments laid out in the Kyoto Protocol. They affirm the validity of the assessments undertaken by the Intergovernmental Panel on Climate Change (IPCC). The statements in 2003 and 2006 note that the Kyoto Protocol would, if fully implemented, slow the increase in the atmospheric concentration of Carbon dioxide but not halt it, and point to the need for further stronger actions later on to achieve that goal.

All of these statements and communications have relied on the understanding provided by the best available climate science. Advances in the scientific understanding of anthropogenic climate change over the past decade have reinforced the earlier conclusions and led to an improved understanding of how the times-scales of the climate system interact with those of the forcing agents, notably emissions of greenhouse gases, that are responsible for anthropogenic climate change. Canadian climate scientists have been at the forefront of this research. It has led to the recognition of the differing roles of the greenhouse gases with relatively short life-times in the atmosphere, and those with much longer life-times, notably carbon dioxide, in producing the warming associated with anthropogenic climate change. While curtailing the accumulation of the shorter-lived gases may limit the peak anthropogenic warming, the build-up of carbon dioxide in the atmosphere will be responsible for warming effects that may last for centuries, producing effectively irreversible climate change. This understanding has more recently led to the development of new metrics involving cumulative carbon emissions to evaluate the long-term impact of greenhouse gas emissions and modeling methodologies for determining how net global emissions must evolve to effectively limit the atmospheric concentration of carbon dioxide.

The Copenhagen Accord sought to control greenhouse gas emissions sufficiently to limit global mean temperature increases to 2°C to prevent dangerous effects of climate change from occurring. However, recent climate science results suggest that this threshold warming will likely be exceeded in the 21st century. Maintaining the 2°C limit will require a rapid reduction and eventual cessation of net global carbon dioxide emissions over the next few decades followed by a net reduction of atmospheric carbon dioxide through the later decades of the 21st century. Such a reduction could not be achieved via the natural slow mechanisms by which atmospheric carbon dioxide is taken up over land surfaces and by the oceans. However, greenhouse gas emissions, including carbon dioxide, have continued at an increasing rate in the past decade with the result that the atmospheric carbon dioxide concentration is now higher than it has been over the past eight hundred thousand years of Earth history. The recently released IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation concludes, among others things, that there is observational evidence that there have been changes in some extreme weather events since 1950 due to anthropogenic influences including increases in atmospheric concentrations of greenhouse gases. For example, it is likely that anthropogenic influences have led to warming of extreme daily minimum and maximum temperatures on the global scale.

The Durban Conference produced an agreement of the participants (including Canada) to enter into a treaty to address global warming, the terms of which are to be produced by 2015 with the treaty to become effective in 2020. The Kyoto Protocol is to continue in effect in the interim but without the commitment of some of the countries, including Canada, that are responsible for a large part of the accumulated emissions that have produced the rapid increase in carbon dioxide over the last century.

In light of the current understanding of anthropogenic climate change, the Canadian decision to withdraw from the Kyoto Protocol is a very sobering development. Although acceptance of the reality of anthropogenic climate change by the Canadian public has increased over the past decade, improved public understanding and awareness of its potentially harmful effects on human society and life on Earth is fundamental to implementing effective actions to address the human causes and long-term impacts of climate change. Consistent with its mandate to advance meteorology and oceanography in Canada, CMOS must continue to play a leading role in bringing about an improved public understanding of climate change. Our public communications are but one aspect of this role. Our tour speakers, supporting and encouraging educational outreach activities, and volunteer activities by CMOS members in Local Centres, are all very important contributions to public education. For their efforts and leadership, I thank the CMOS members who volunteer their time and energy to engage in these activities.

Norman McFarlane
CMOS President
Président de la SCMO

Correspondence / Correspondance

From The Honourable Peter Kent
Minister of the Environment
Les Terrasses de la Chaudière
10 Wellington Street, 28th floor Gatineau
Quebec K1A 0H3 Canada

To: 1) Professor Theodore Shepherd
Co-Chair SPARC SSG
Department of Physics
University of Toronto
Toronto M5S 1A7 Canada

And to 2) Professor Thomas Peter
Co-Chair SPARC SSG
Swiss Federal Institute of Technology ETH
CH-8092 Zurich Switzerland

Date: December 20, 2011

Subject: Closure of Canadian ozone network

Dear Drs. Shepherd and Peter:

Thank You for your letters of September 15 and 22, regarding the continuation of Environment Canada's program for monitoring changes in atmospheric ozone.

Environment Canada, like all other federal departments, has been required to implement a business plan to deliver on its priorities in the context of Government-wide fiscal restraint.

My officials will continue to be directly involved in stratospheric ozone measurements. The Department recognizes the importance of ozone in the atmosphere, which protects the earth from harmful ultraviolet (UV) radiation We are maintaining sites critical for long-term ozone trends information, including the world's oldest ozonesonde site at Resolute Bay in Canada's far north, as well as research capacity for data interpretation and trend analysis We will continue to fulfil our obligations under international agreements, and to host the World Ozone and Ultraviolet Radiation Data Centre.

Departmental officials are working to define the optimal and integrated ozone monitoring network needed to facilitate the delivery of sound science and to address our international commitments within our budgetary means.

As Minister, I am committed to ensuring that my department is in a position to focus on the environmental challenges facing our country.

I appreciate your interest in this matter, and extend my best wishes.

From: 1) Professor Theodore Shepherd
Co-Chair SPARC SSG
Department of Physics
University of Toronto
Toronto M5S 1A7 Canada

And from 2) Professor Thomas Peter
Co-Chair SPARC SSG
Swiss Federal Institute of Technology ETH
CH-8092 Zurich Switzerland

Date: December 21, 2011

To: The Honourable Peter Kent
Minister of the Environment
Les Terrasses de la Chaudière
10 Wellington Street, 28th floor Gatineau
Quebec K1A 0H3 Canada

Subject: Closure of Canadian ozone network

Dear Minister Kent:

We would like to thank you for your letter to us dated December 20, 2011, in response to our original letters of September 15 and 22, 2011 [Ref.: *CMOS Bulletin SCMO*, Vol.39, No.6, pages 197-198], which had expressed our concern with regards to the possible closure of the Canadian ozone network. We are immediately distributing your letter to the additional signatories of our September 22 letter and to the wider SPARC community.

We are pleased to hear from you that Environment Canada recognizes the fundamental importance of atmospheric ozone for environmental sustainability, and is committed to a science-based evaluation of its ozone measurement needs to support sound science for decision-making and Canada's fulfilment of its international obligations for environmental monitoring. Ozone plays several distinct roles within the climate system — as a pollutant, as a greenhouse gas, and as a blocker of harmful ultraviolet (UV) radiation — which is why different, complementary measurement techniques are required, and we recognize that this can lead to some confusion. Thus we welcome a comprehensive, integrated analysis of Canada's ozone measurement needs.

In particular, we are pleased to hear that the long-running Arctic ozonesonde stations will continue, as these represent especially unique measurements. The first-ever Arctic ozone "hole", which was observed last spring (and for which the Canadian ozonesondes provided essential information), has underscored the fact that the atmosphere is always capable of surprising us — which is why we need continuing measurements of essential climate variables such as ozone. We are also very pleased to hear that you will maintain EC's research capacity for data interpretation and trends analysis; this is very important, as measurements are of no value unless there is good quality control and they are interpreted correctly. Finally, we are very pleased to hear that EC will continue to host the World Ozone and Ultraviolet Data Centre.

From		Dr. Andy Bush Professor, Department of Earth and Atmospheric Sciences University of Alberta Past President, CMOS (2008-2009)
To:	1)	Dr. Norm McFarlane University of Victoria (CCCma) President CMOS
And to	2)	Dr. Ian Rutherford Executive Director CMOS
And to	3)	CMOS Executive
Date:		January 6, 2012
Subject:		IFMS Meeting in Xiamen, China

Dear Norm, Ian and others on the CMOS Executive,

I attended the Second Global Meeting of the International Forum of Meteorological Societies (IFMS) on behalf of CMOS. The meeting was held Nov. 3-4 in Xiamen, China. I do think that it's important that Canada be represented in this burgeoning effort, given the number of countries involved and what I believe Canada can contribute.

The meeting was held in conjunction with the Chinese Meteorological Society's annual meeting. There were 15 countries represented at the IFMS meeting (both presenting and some consulting). Representatives from the WMO, the European Met. Soc. (and ECMWF is included in this), and the AMS were all present. I presented an overview of CMOS and our Society (thanks for the slides, Ian).

There is a strong initiative to help East Africa (the hope is to combine the Societies, and Services, of Burundi, Kenya, Uganda, Rwanda, and Tanzania). This region is subject to drought/flood cycles that have become worse recently and they are seeking aid in terms of meteorological knowledge and training from other members of the IFMS while at the same time building their own Societies and enhancing their Meteorological Services. They wish to emphasize mitigation strategies, capacity building, education (public and training), and the transfer of knowledge from research and technology.

The IFMS is working towards facilitating training people from underdeveloped or developing nations. This would be done by both freedom of information exchange (Bulletins, etc.) as well as the possibility of training people from a different country.

The representative from Argentina had an interesting story: their Meteorological Service was controlled by the Air Force for 40 years (up until 4 years ago) and during that time all research activity was stopped. Academics are now back in the saddle, and there's a meeting in Mendoza, May 28-June 1, 2012, for them.

Walter Dabberdt, the AMS representative (and initiator of this project) talked about an interesting site for developing countries (OARE: Online Access to Research in the Environment; www.oaresciences.org). Access would be free if they are deemed to be 'developing'. Walter also described the financial state of AMS publications (rated at $5 million a year to publish everything!) and discussed open access issues.

The president of the Chinese Met. Soc. suggested that, with developing countries trying to get their Societies up and running (usually with bare minimum funding/equipment) a 'successful' Society should have at least one peer-reviewed journal (China has now about 45 journals, all arising after the Cultural Revolution).

Walter Dabberdt had 6 key points for us all, which I'll outline below.

1) Keep ties with the WMO; this will be handled by Rob Masters, most likely, but is not in our realm of responsibility.

2) The IFMS is setting up a website, maintained and supported by the AMS, and requests updated web material from each member society. Web material should be sent to Lan Yi at (and this is the only email address I have for her right now: ifms-gm2@cms1924.org

3) We should actively try to increase the number of member societies (from my best estimate it's about 30 countries right now).

4) Lan Yi and Walter Dabberdt will work on the website to update the benefits of being in IFMS.

5) Consistent representation of each member Society (in terms of web format and information provided).

6) Developing some form of online conferencing for outreach/streaming lectures. This will be explored by the AMS.

An important last point is that each Society needs a contact person. This would normally be the President or the Executive Director. This would involve updating information for IFMS on their website. I note that this would not be an onerous task. I would be willing to do this, though as CMOS evolves if there are other takers that's fine.

The next meeting of the IFMS was proposed to be in East Africa: Ethiopia, Tanzania, or Kenya.

That's it for my report. Hope this helps you all get a feeling for what's developing on the international front.

SMCC and the New Year

The Science Media Centre of Canada (SMCC) is an independent, not-for-profit organization that exists to raise the level of public discourse on science in Canada by helping journalists access the experts and evidence-based research they need in order to cover science in the news.

Lately, SMCC has distributed a list of the top five science stories for 2011 and the top five stories from 2011 worth watching for 2012. Among these five stories worth watching, the second one is of particular interest to CMOS Members:

2 . Canadian government scientists

Concerns continued to be raised from scientists, journalists and policy makers, this year, that federal government scientists, from fish biologists to nuclear researchers to environmental monitors, are subject to increasingly strict media guidelines and communications management. The restrictions prompted questions about Canadians' right to information gleaned from publicly funded research, the role of government science, and the ability of scientists to talk freely about their research results in a timely manner.

Hopefully, the SMCC concerns will turn out to be wrong!

CCSM et le Nouvel An

Le Centre canadien science et médias (CCSM) est un organisme de bienfaisance indépendant dont le mandat est d'aider les journalistes à trouver les experts et les renseignements dont ils ont besoin lorsque la science fait les manchettes.

Dernièrement, le CCSM a fait parvenir une liste de cinq nouvelles scientifiques qui ont fait les manchettes en 2011 et cinq nouvelles canadiennes de 2011 à surveiller de près en 2012. Parmi ces cinq nouvelles à surveiller, la deuxième est particulièrement intéressante pour les membres de la SCMO:

2. Les chercheurs du gouvernement du Canada

Les chercheurs, les journalistes et les décideurs ont continué cette année à exprimer leur inquiétude parce que les chercheurs à l'emploi du gouvernement fédéral, des ichtyobiologistes aux chercheurs dans le domaine nucléaire en passant par les contrôleurs environnementaux, se trouvent de plus en plus bâillonnés dans leurs relations avec les médias et pour la gestion des communications. Ces restrictions ont amené à se poser des questions sur le droit des Canadiens à être informés des résultats d'études financées par les fonds publics, le rôle de la science gouvernementale et la capacité, pour les chercheurs, de parler librement des résultats de leurs recherches en temps opportun.

Espérons que les craintes du CCSM ne seront pas fondées!

Next Issue *CMOS Bulletin SCMO*

Next issue of the *CMOS Bulletin SCMO* will be published in **April 2012.** Please send your articles, notes, workshop reports or news items before **March 2, 2012** to the address given on page 2. 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 2012.** Prière de nous faire parvenir avant le **2 mars 2012** vos articles, notes, rapports d'atelier ou nouvelles à l'adresse indiquée à la page 2. Nous avons un besoin URGENT de vos contributions écrites.

ARTICLES

2011: World's 10th warmest year, warmest year with La Niña on record, second-lowest Arctic sea ice extent

L'année 2011 est la dixième année la plus chaude à l'échelle du globe, l'année la plus chaude en relation avec un épisode La Niña et l'année de la deuxième plus faible étendue de la banquise arctique

Résumé: En 2011, la température moyenne à la surface du globe est actuellement la dixième la plus élevée jamais relevée et est supérieure à toutes celles enregistrées lors des années précédentes correspondant à des épisodes La Niña, qui se traduisent normalement par un refroidissement relatif. De plus, les 13 années les plus chaudes font toutes partie des 15 dernières années écoulées depuis 1997. Quant à la banquise arctique, elle a présenté en 2011 la deuxième plus faible étendue et le plus faible volume jamais observés. Sont présentés ici quelques-uns des points saillants de la version provisoire de la Déclaration annuelle de l'Organisation météorologique mondiale (OMM) sur l'état du climat mondial, qui donne une évaluation de la température moyenne à la surface du globe ainsi qu'un aperçu des principaux événements météorologiques et climatiques qui se sont produits dans le monde en 2011 et qui a été rendue publique (Communiqué de presse de la OMM # 935) à la conférence climatique internationale qui s'est tenue en décembre 2011 à Durban, en Afrique du Sud.

"Il nous incombe de diffuser des connaissances scientifiques qui guident l'action des décideurs" a déclaré le Secrétaire général de l'OMM, M. Michel Jarraud. "*Notre science est fiable et démontre sans ambiguïté que le climat mondial se réchauffe et que ce réchauffement est dû aux activités humaines*".

"*Les concentrations de gaz à effet de serre dans l'atmosphère ont atteint de nouveaux pics qui s'approchent très rapidement des niveaux correspondant à une élévation de 2 à 2,4 °C de la température moyenne à la surface du globe, laquelle pourrait entraîner, selon les scientifiques, des changements radicaux et irréversibles de notre planète, de la biosphère et des océans*" a-t-il ajouté.

Selon déclaration provisoire de l'OMM, la température moyenne combinée de l'air à la surface de la mer et des terres émergées pour la période comprise entre janvier et octobre 2011 présente une anomalie positive estimée à 0,41 °C ± 0,11 °C par rapport à la moyenne annuelle de 14,00 °C pour la période 1961-1990. L'année 2011 se classe donc au dixième rang ex-aequo des années les plus chaudes depuis le début des relevés en 1850.

La température moyenne de la décennie 2002-2011, supérieure de 0,46 °C à la moyenne à long terme, est la plus élevée jamais constatée, à égalité avec la décennie 2001-2010.

Global temperatures in 2011 have not been as warm as the record-setting values seen in 2010 but have likely been warmer than any previous strong La Niña year, based on preliminary data from data sources compiled by the World Meteorological Organisation (WMO). The global combined sea surface and land surface air temperature for 2011 (January–October) is currently estimated at 0.41°C ± 0.11°C [Note 1] above the 1961–1990 annual average of 14.00°C. At present, 2011's nominal value ranks as the equal 10th highest on record, and the 13 warmest years have all occurred in the 15 years between 1997 and 2011. Model reanalysis data from the European Centre for Medium-Range Weather Forecasts (ECMWF) are also consistent with this ranking. The 10-year average for the period 2002-11, at 0.46°C above the long-term average, equals 2001-10 as the warmest 10-year period on record. Final annual figures for 2011 will be available once November and December data are available in early 2012.

Global climate in 2011 was heavily influenced by the strong La Niña event which developed in the tropical Pacific in the second half of 2010 and continued until May 2011. This event, which on most measures was one of the strongest of at least the last 60 years, was closely associated with many of the year's notable regional climate events, including drought in east Africa, the central equatorial Pacific and the southern United States, and flooding in southern Africa, eastern Australia and southern Asia. Strong La Niña years[Note 2] are typically 0.10 to 0.15°C cooler than the years preceding and following them. 2011's global temperatures followed this pattern, being lower than those of 2010, but were still warmer than the most recent moderate to strong La Niña years, 2008 (+0.36°C), 2000 (+0.27°C) and 1989 (+0.12°C). La Niña conditions have redeveloped in recent weeks but are not expected to approach the intensity seen in late 2010 and early 2011.

Surface air temperatures were above the long-term average[Note 3] in 2011 over most land areas of the world. The largest departures from average were over Russia, especially in northern Russia where January-October temperatures were about 4°C above average in places. The spring was especially warm in this region with some stations more than 9°C above average for the season, whilst European Russia had another hot summer (the third-hottest on record in Moscow), although not as extreme as that of 2010. The hot summer conditions extended into nearby countries, with Helsinki (Finland) having its hottest summer in nearly 200 years of data, and Armenia setting an all-time national record (43.7°C). January-October 2011 was also 1°C or more above average over large parts of Europe, southwest Asia and northern and central Africa, as well as the southern United States and northern Mexico, most of eastern Canada (especially the northeast), and Greenland. The Central American region is on course to have its hottest year in at least 140 years, while Spain has also had its hottest January-October period on record and several other western European countries approached records. The above-average temperatures in most northern polar regions were associated with the second-lowest Arctic sea ice minimum on record.

The most significant area of below-normal temperatures in 2011 was in northern and central Australia where temperatures were up to 1°C below average in places, largely the result of above-average cloudiness and heavy rain early in the year. Other regions to experience below-normal temperatures in 2011 included the western United States and south-western Canada, and parts of east Asia including the Indochina Peninsula, eastern China and the Korean Peninsula.

Sea ice

Arctic sea ice extent was again well below normal in 2011. After tracking at record or near-record low levels for the time of year through the first half of 2011, the seasonal minimum, reached on 9 September, was 4.33 million square kilometres (35% below the 1979-2000 average). This was the second-lowest seasonal minimum on record, 0.16 million square kilometres above the record low set in 2007. Unlike the 2007 season, both the Northwest and Northeast Passages were ice-free for periods during the 2011 summer. Sea ice volume was even further below average and was estimated at a new record low of 4200 cubic kilometres, surpassing the record of 4580 cubic kilometres set in 2010.

Severe drought, then flood, in east Africa

Severe drought developed in parts of east Africa in late 2010 and continued through most of 2011. The most severely affected area encompassed the semi-arid regions of eastern and northern Kenya, western Somalia and some southern border areas of Ethiopia.

In this region, rainfall was well below normal for two successive rainy seasons, the "short rains" of October-December 2010 and the "long rains" of March-May 2011. Drought in 2010-11 was rated alongside 1983-84 and 1999-2000 as the three most significant of the last 60 years over eastern and northern Kenya; it was the driest 12-month period on record at some locations within the region. (The 2004-05 drought also had a large impact over the wider region but was less intense in Kenya). Rainfall for the 12 months from October 2010 to September 2011 was 50% to 80% below normal over most of the area. The humanitarian impacts of the drought were severe, especially in Somalia and Kenya, with significant famine and large-scale displacement of population. The UN Office for Coordination of Humanitarian Affairs (OCHA) estimated that 13 million people required humanitarian aid.

There was a dramatic change to the pattern in early October, with heavy rains beginning in the second week of the month and continuing into early November. Many parts of north-eastern and coastal Kenya have already received well in excess of their average rainfall for the full October-December season. Wajir, in north-eastern Kenya, only received 73 millimetres of rain in the 12 months from October 2010 to September 2011 (76% below the long-term average of 310 millimetres), its driest 12-month period in the post-1950 period, but has received 402 millimetres between 1 October and 12 November, already more than its annual average. Whilst the recent rains have provided relief in the worst-affected areas, the resultant floods have caused some crop damage and other disruption.

Major floods in south-east Asia

Rainfall was well above average during the 2011 monsoon season (June-September) through large parts of south-east Asia. Over most of Laos and in northern and central Thailand, rainfall for the June-September period was 20-80% above average, and averaged over northern Thailand as a whole, June-September rainfall was 38% above average, with all four months being significantly wetter than average, a highly unusual event.

The largest rainfall anomalies were over the Mekong River basin and the upper part of the Chao Phraya river basin. After earlier lesser flood episodes, the wet season culminated with severe flooding which moved downstream in both rivers from late September onwards. The floods caused major loss of life in Thailand, Cambodia and Myanmar, with at least 930 deaths across the three countries, and produced widespread inundation across all three countries as they moved downstream. Severe and long-lived flooding, exacerbated by high tides, affected many parts of the major city of Bangkok from mid-October onwards and persisted for several weeks. In addition to human casualties, there were major losses throughout the region in agriculture and industrial production, amounting to at least several billion US dollars.

A year of extremes in the United States and southern Canada

It was a year of extremes in the United States, with fourteen separate weather/climate events which caused losses of US$1 billion or more each. Extreme drought affected parts of the southern United States and adjacent parts of northern Mexico. The core of the drought was in Texas, where state-wide averaged rainfall for January-October 2011 was 273 millimetres (56% below normal), well below the previous record of 327 millimetres set in 1956. The drought region also had an exceptionally hot summer, with Texas's summer (June-August) mean temperatures (30.4°C), being 3.0°C above the long-term average, and the highest ever recorded for any American state. In addition to agricultural losses and water shortages, impacts of the drought included severe wildfires and dust storms.

In marked contrast, many northern and central parts of the United States experienced heavy rain and flooding in 2011. The January-October period was the wettest on record for several north-eastern states and for the north-east region as a whole, with precipitation totals widely 30-50% above normal. The most severe floods in this region, reaching record levels in places, were associated with Hurricane Irene in August and Tropical Storm Lee in September. Spring and early summer were extremely wet in many central areas, particularly the Ohio Valley and the upper Midwest of the United States and the Prairie provinces of Canada, which experienced some of the worst flooding on record. There was also substantial spring flooding in the north-eastern United States and the Canadian province of Quebec. The heavy spring rains, combined with the melting of a heavy winter snowpack in northern areas, caused major downstream flooding during May and June. Parts of the Mississippi River experienced the worst floods since 1933, and there was also major flooding in the Missouri River and several Canadian rivers.

It was also one of the most active tornado seasons on record, with numerous major outbreaks, particularly in April and May. A tornado caused 157 deaths in Joplin, Missouri in May, the deadliest single tornado in the United States since 1947. 2011 (to date) has had the third-greatest number of tornadoes since 1950, after 2004 and 2008, and the fourth-greatest number of deaths (537) on record. There were also a number of major snowstorms, including the most significant October snowstorm on record in the north-eastern states.

Flooding in many parts of the world

Flooding affected many parts of the world in 2011, both flash floods and more long-lived events. In terms of loss of life, the most extreme single event occurred in Brazil on 11-12 January, when a flash flood, caused by rainfall which exceeded 200 millimetres in a few hours, in mountainous terrain about 60 kilometres north of Rio de Janeiro, caused at least 900 deaths. This was one of the worst natural disasters in Brazil's history.

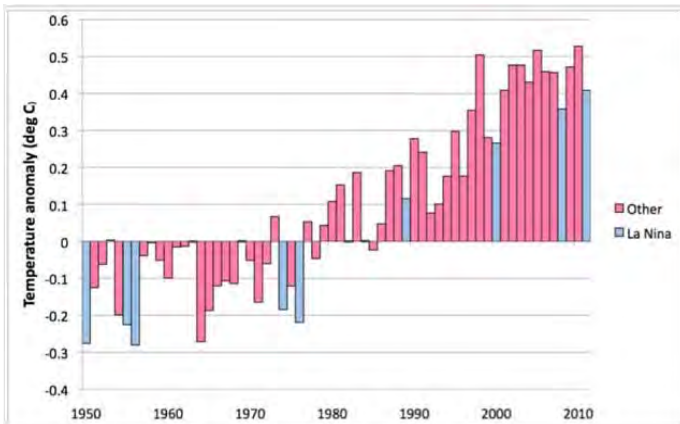
Persistent above-normal rainfall through the summer months caused widespread flooding in both eastern Australia and southern Africa. In southern Africa, rainfall from January-March 2011 was two to four times average over many parts of a region encompassing Zimbabwe, Botswana, Namibia, Angola and northern South Africa, and flooding occurred on several occasions. Rainfall for the 12 months from July 2010 to June 2011 was more than double the average over northwestern parts of South Africa. In Australia, the period from September 2010 to March 2011 was the wettest on record (100% above average), with many southeastern areas having the wettest summer on record. There was widespread flooding in eastern Australia, especially from late December to early February, with the worst-affected areas being southeast Queensland and northern Victoria. The city of Brisbane had its worst floods since 1974 with many riverside properties inundated. The heavy rains of late 2010 and early 2011 ended long-term drought conditions in south-eastern Australia, whilst near-normal winter rainfall also eased severe drought conditions which had persisted into the early months of 2011 in the southwest of Western Australia.

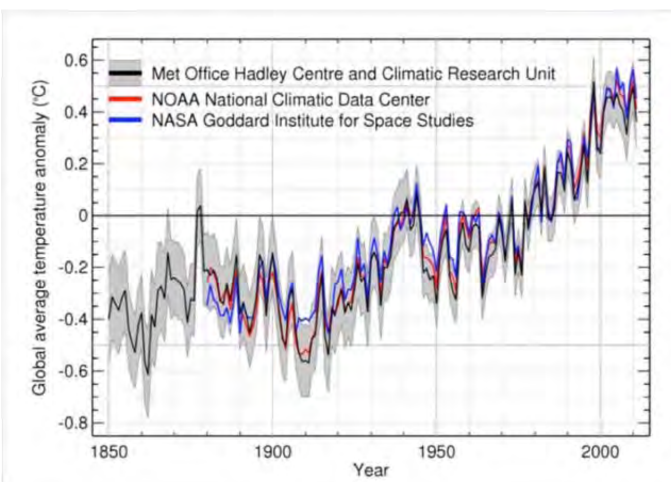
For the second year in succession, Pakistan experienced severe flooding in 2011. The floods were more localised than in 2010, being largely confined to the southern part of the country. It was the wettest monsoon season on record for the province of Sindh (247% above normal). Most of the rain fell in a four-week period from mid-August to early September, with some stations receiving more than 1100 millimetres during this time. Monsoon rainfall was also well above average in western border areas of India, with some flooding, but below average in the north-east; June-September rainfall for India as a whole was 2% above average.

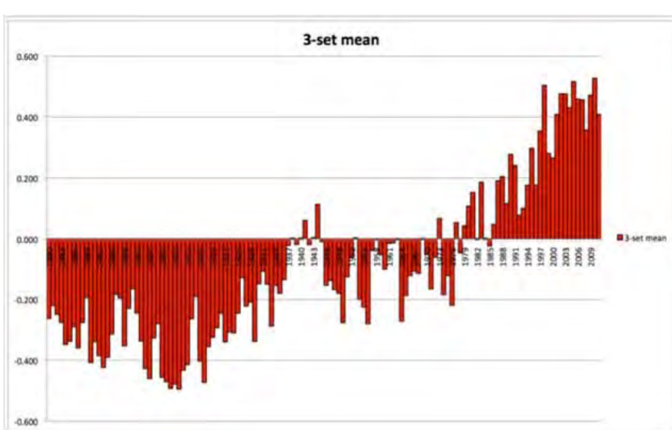
Central America experienced major flooding in October, exacerbated by heavy rains from a tropical depression. 1513 millimetres of rain fell in Huizucar, El Salvador in the 10-day period from 10-20 October. The worst floods were in El Salvador, but Guatemala, Nicaragua, Honduras and Costa Rica were also affected. At least 105 deaths were attributed to the floods. Earlier in the year, consistently above-average rainfall in the first half of the year resulted in floods in northwestern South America, especially Colombia and Venezuela, although conditions were less extreme than they had been at the end of 2010. Bogota received 773 millimetres of rain in the first half of 2011, 67% above average.

In eastern Asia, tropical cyclones caused flooding in several parts of the region, particularly in Japan in September as a result of Talas and Roke. Talas was responsible for a 72-hour rainfall of 1652.5 millimetres at Kamikitayama in Nara Prefecture, a Japanese record. The Korean peninsula had more consistent rainfall through the summer. It was the wettest summer on record for the Republic of Korea with a national average of 1048 millimetres (44% above the 1973-

2011 average). Seoul had 1131 millimetres in July alone (187% above the 1908-2011 average), its second-wettest month on record, and 1702 millimetres for the summer (91% above the 1908-2011 average); there were substantial floods in the city in late July.







Flooding also affected a number of countries, including France, Italy, Spain, Tunisia and Algeria in the western and central Mediterranean during October and November, with loss of life in Italy, Spain and Algeria. Two separate events in north-western Italy in late October and early November each produced rainfalls in excess of 400 millimetres in a few hours, with Spezzino receiving 472 millimetres in six hours on 25 October, while rainfall totals for the period 1-9 November exceeded 900 millimetres at some locations in south-eastern France.

A dry start to the year in Europe and eastern China

Following the exceptionally cold conditions of December 2010, temperatures returned to above normal levels in most of Europe (except the northeast) from January onwards. Dry conditions developed in western Europe early in the year and the drought intensified during the spring. It was the driest spring on record over many parts of western Europe, and set national records in France and the Netherlands,. Some stations in France and the United Kingdom had less than 20 millimetres for the season. It was also a very warm spring. France (2.5°C above average), the United Kingdom (2.1°C above average), Spain (2.3°C above average) and Switzerland (3.5°C above average) all had their warmest spring on record, whilst Germany and Belgium had their second-warmest spring. Parts of the Alps had their earliest spring snowmelt on record. Rainfall returned to near- to above-average levels during the summer, before turning dry again during the autumn. In some areas the summer was very wet; the Netherlands followed its driest spring on record with its wettest summer, Norway also had its wettest summer on record, and record summer rainfalls also occurred in many parts of Denmark and northeast Germany.

Severe drought which affected parts of eastern China in late 2010 continued into the early months of 2011. It was especially dry in the lower Yangtze basin, where the January-May rainfall was 202 millimetres, 53% below average and well below the previous record of 320 millimetres. From June onwards the dry conditions in this region were replaced by above-average rainfall, with some flooding in places, but further south in China rainfall during the summer monsoon season was well below average. The January-October rainfall in Hong Kong was 1388 millimetres, 40% below average.

Drought, associated with the ongoing La Niña event, affected parts of the tropical western and central Pacific. Tuvalu and Tokelau were amongst the worst affected. Tuvalu was especially severely affected; by October, drinking water supplies had to be brought in from outside the country on barges as domestic supplies reached critically low levels.

Another year of below-average tropical cyclone activity

Global tropical cyclone activity was again below average in 2011, although not to the same extent as in 2010, which had the lowest number of tropical cyclones since satellite records began in the late 1960s. As of 22 November there had been 69 tropical cyclones in 2011, compared with the long-term full-year average of 84.

It was an exceptionally quiet season in the Southwest Indian Ocean (west of 90°E), with only 2 cyclones in 2011, and 3 in the full 2010-11 season, the second-lowest number of the last 50 years. Over the full South Indian Ocean there were 7 cyclones, about half the average number.

The only basin to experience significantly above-normal cyclone activity was the North Atlantic, with 19 cyclones (long-term average 11). A disproportionately large number of these cyclones were relatively weak, with the number of hurricanes being close to normal (6 hurricanes, 3 of which reached category 3[Note 4] or higher). In contrast, the Northeast Pacific had a below-average number of cyclones, but most of those which did form reached hurricane intensity, resulting in a near-average number of hurricanes. In the other basins (Northwest Pacific, South Pacific, North Indian), the total number of cyclones was close to average, but all 4 cyclones in the North Indian basin were minimal tropical storms which did not last more than one day. No tropical cyclones have formed in the Bay of Bengal so far in 2011.

By the standards of recent years there were few destructive landfalls by intense tropical cyclones, although cyclones contributed to major flooding in several parts of the world. The year's most intense landfall was that of Yasi in early February: it was a category 4 system when it made landfall at Mission Beach (between Townsville and Cairns), making it the most intense system at landfall on the east coast of Australia since at least 1918. Only one death was attributed to Yasi but property damage exceeded US$1 billion. Other systems of comparable peak intensity, all of which weakened before landfall, were *Songda* (May), *Muifa* (July) and *Nanmadol* (August), all of which peaked east of the Philippines. Another damaging landfall event was that of *Irene*, a category 1 cyclone which struck the northeastern United States in late August and caused in excess of US$7 billion in damage, mostly from flooding.

Background to data used in this statement

This preliminary information for 2011 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 dataset 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). Additional information is drawn from the ERA-Interim reanalysis-based data set maintained by the European Centre for Medium-Range Weather Forecasts (ECMWF). Some information on humanitarian impacts is obtained from the UN Office of Coordination for Humanitarian Affairs (OCHA). 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 2011 will be published in March 2012 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: For this purpose, a 'La Niña' year is one where a La Niña event is in place at the start of the year. In addition to the years listed, other strong La Niña years were 1976 (global temperature anomaly −0.22°C), 1974 (−0.19°C), 1956 (−0.28°C), 1955 (−0.23°C) and 1950 (−0.28°C). This set of years includes four of the five coldest years of the last 75 years.
Note 3: Long-term averages in this document are generally for the 1961-1990 period, but different reference periods are used for some national data sets.
Note 4: In this section the Saffir-Simpson category scale is used.

Source: WMO Website http://www.wmo.int visited on December 01, 2011.

WMO is the United Nations' authoritative voice on weather, climate and water.

International Polar Year 2012 Conference

Palais des Congrès, Montreal, Quebec, Canada

April 23-27, 2012

Conférence 2012 Année Polaire Internationale

Palais des Congrès, Montréal, Québec, Canada

23-27 avril 2012

Top 10 Canadian Weather Stories for 2011

by David Phillips[1]

A Year in Review

From the death and destruction following the Japanese earthquake/tsunami to extreme weather in the United States that killed more than 1,000 people through the course of the year, Mother Nature seemed to be on the warpath. All told, it was the second costliest year on record for weather catastrophes globally, with 2005 still holding the number one slot. But while Canadians had plenty to "weather" in 2011, being either buried under snow, soaked, drowned or frightened at various times through the year, we were still quietly thankful for living in a country that – while not immune to Nature's wrath – remained fairly unscathed compared to the plight of some of our global neighbours.

For those in Canada who were impacted by severe weather events, it was the stuff of biblical scripture or Hollywood catastrophes. And for the third year in a row, the Canadian insurance industry faced billion-dollar losses due to weather-related catastrophes. As was the case globally, Canada also had the second most expensive year for weather losses. Dominating this year's top Canadian weather stories were floods in three provinces – not the flash type, but more the slow-motion and long-lived type that takes its toll mentally as well as physically. Moving from West to East, British Columbia fared best while Prairie residents faced record floods, fires and furies. Eastern Canada also got more than its share of bad weather throughout a wild year of twisters, hurricanes, floods and big blows.

Historic flooding across Saskatchewan and Manitoba logged in as the number one weather story in Canada. Everything about the flooding, including its size, magnitude and duration, was unprecedented. It was also one of Canada's few billion-dollar disasters. Alberta owned two of the year's top weather stories, including story number two: a wildfire that almost destroyed the entire town of Slave Lake – the second-most expensive insurance loss in Canadian history. Flooding along the Richelieu River in Quebec took the number three spot when it spilled its banks for 69 days in spring. While not the worst natural disaster in the province, it was surely the longest.

At the top of the world, Arctic sea ice continued to disappear, reaching its second-lowest seasonal minimum and the least volume on record. While more climate-related in nature, shrinking ice continued to have a profound impact on the environment at home and abroad. The Atlantic Ocean had an active hurricane season in 2011 with 19 named storms. Although a disproportionately large number of the tropical storms were relatively weak, seven were categorized as hurricanes, and all three that were considered "major" were felt in Canada. Irene was the deadliest and most destructive storm of the season. For Canadian farm producers, this year's dichotomic weather was especially challenging. Everywhere, growers faced a very wet spring and a month-long delay to the start of the growing season. Yet their worst enemy turned out to be their best ally when summer weather extended well into the fall, saving what would have been a crop disaster. As always, given the reality of long, often cold and snowy winters in Canada, we think nature owes us a nice summer. For those in the middle of the country, payback was sweet with a "summer of summers," while on the coasts summer didn't show up until vacations were all but over. Also on the list of this year's top Canadian weather events were a Groundhog Day blizzard that hammered North America from New Mexico to Newfoundland, a strong tornado that pummeled parts of the picturesque town of Goderich on the shores of Lake Huron and powerful Chinook winds that ripped through downtown Calgary at hurricane-force speeds causing millions of dollars in property damages.

Among the runner-up stories in 2011 were: a one-two storm punch in March that buried Quebec in 70 cm of snow; a record wet spring in Ontario and Quebec; three fierce storms in Ontario that could have been catastrophic; and a deluge in Gatineau that rivaled the billion-dollar Saguenay flood in 1996. The forest fire season was mostly quiet across Canada except at Slave Lake and in northwestern Ontario, where huge tracks of timber were burned in some of the largest fires on record. The news wasn't all bad, though! Nature tried to make amends for all the weather misery by offering a spectacular Thanksgiving week for millions of Canadians.

Globally, it was the 10th-warmest year on record over the past 160 years, according to the World Meteorological Organization (WMO). This was in spite of the fact that it was also one of the strongest La Niñas in 60 years, featuring a relative cooling effect that lasted almost half the year. According to the WMO, the global average temperature has risen about three times faster since 1976 compared to the rate for the past 100 years. Additionally, the 13 warmest years on record have all occurred in the last 15 years. In Canada, it was another warm year – our 15th year in a row. From January to November, the national

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average temperature was about 1.2°C above normal. Every region except British Columbia was warmer, especially the Arctic tundra, which experienced its fifth-warmest January-to-November period on record.

The following **Top Canadian Weather Stories for 2011** 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.

Top Ten Canadian Weather Stories for 2011

1	**Historic Flood Fights in the West**
2	**Slave Lake Burning**
3	**Richelieu Flooding ... Quebec's Longest Lived Disaster**
4	**Down on the Farm: Doom to Boom**
5	**Tornado Goderich in a Wild Week of Weather**
6	**Good Night, *Irene* ... and, *Katia*, *Maria* and *Ophelia***
7	**Summer: Hummer or Bummer?**
8	**Arctic Sea Ice Near Record Low**
9	**Groundhog Day Storm: Snwomageddon or Snowbidgeal?**
10	**Wicked Wind from the West**

1. Historic Flood Fights in the West

Word came early that there would be some serious flooding in the eastern Prairies in 2011. Westerners are usually ready for a good flood flight because they face high waters every year, but nobody could have prepared for the flood of 2011 that was unprecedented on so many fronts. Epic melts occurred everywhere – from the Qu'Appelle Valley to eastern Manitoba and from The Pas south to the Canadian-American border – resulting in more acreage under water than ever recorded. Flood talk was continuous and exhausting, lasting from October 2010 when a weather bomb soaked the southern Prairies through to late July when the military on flood patrol finally went home. Known as the flood that would never end and the spring flood that became the summer flood, it featured the highest water levels and flows in modern history across parts of Manitoba and Saskatchewan. Statistically, the flooding on the Assiniboine River in 2011 was estimated to be at levels experienced once in 330 years. And on Lake Manitoba, engineers called the flood a one-in-2,000-year event. Governments at all levels spent close to $1 billion on flood fighting and victim compensation.

It was a recipe for disaster that started just before Halloween 2010, when a super-charged weather bomb dumped 50 to 100 mm of rain and big snows across the southern Prairies. Officials warned that conditions were ripe for one of the most destructive and disastrous spring floods in years, given that several Manitoba lakes and rivers were already near their highest levels ever. A normal or above-normal snowpack combined with a quick thaw would only worsen a bad situation.

Southern Manitoba was within a millimetre of having its wettest year on record in 2010. At freeze-up, soil moisture levels were the second highest since 1948; only 2009 had more. Cold temperatures throughout the winter resulted in deep soil-frost penetration, meaning spring meltwater was likely to spread out instead of soaking in. And at the season's midpoint, the snowfall total was at a 15-year high. In January, hydrologists estimated an elevated spring runoff potential above 120 per cent across almost all of Manitoba south of the Nelson River. When spring did arrive, cold temperatures slowed the melt and the inevitable flooding. By mid-April, there was plenty of snow left to melt and nowhere for the water to go. Then came heavy spring precipitation, with rains and snow that added to an already bad flooding situation. Water levels climbed steadily, and not just on the perennial flooder, the Red River; the Assiniboine, Souris, Pembina, Qu'Appelle and several other rivers also swelled, as did a host of Manitoba lakes. In early April, Manitoba declared a high flood risk for six rivers, including two that pass through Winnipeg.

The Red River peaked in Winnipeg on the evening of April 7, when an ice jam drove up water levels. The high stage ranked the third largest in the last 150 years. Fortunately, the Assiniboine River only crested days later. Once again the Floodway saved the day, along with some help from Mother Nature, who brought no major rain or snow event to the area in April, May or June.

On May 9, the Manitoba government declared a province-wide state of emergency, issuing evacuation notices for several municipalities along the Assiniboine River. Brandon was at the epicentre of the months-long flood battle. There, the Assiniboine reached its highest level since 1923 and kept rising. The River was nearly seven metres higher than normal and 20 to 30 times wider in some places. Flooding on the Assiniboine near Brandon lasted 120 days and was the largest on record. The fight against the flood waters along the Assiniboine involved thousands of residents, 1,800 members of the Canadian Forces, emergency measures officials and volunteers, including inmates from a local jail.

In late May, the flood fight opened up a front on the Manitoba lakes, where Lakes Manitoba and Winnipeg and at least four others reached record water levels. Hundreds of residents and cottage owners were ordered to leave due to high winds and waves. Lake-side residents feared any wind from the north because it would send waves crashing onto cottage properties along the south shore. Lake levels were higher than the flooding experienced there in 1955 and were enhanced due to water diverted from the Assiniboine River. A late May storm with strong north winds sent water crashing against dozens of homes at Delta Beach on the south shore of Lake Manitoba. The inundation was so far inland that beach-front cottages were now located 3 km 'out to sea'.

In all, 7,100 Manitobans were displaced from their homes, with 2,700 still evacuated at the end of the year. Flooding swamped three million hectares of farmland, causing ranchers to move thousands of cattle. And local states of emergency were declared in 70 Manitoba communities. In addition, flood waters forced the closure of 850 roads, including parts of the Trans-Canada Highway.

In southern Saskatchewan, the historic flooding was the result of a number of events, including intense June rainfalls at the same time snowmelt waters were arriving from the Rockies and excessive precipitation during the previous summer, fall and winter. Five days of heavy rain between June 16 and 20 drenched already-soggy ground. Between 50 and 120 mm of added rain fell with heavier amounts occurring in thunderstorms. Immediately, lakes and reservoirs filled to their maximum allowable flood level, necessitating increased water release through spillways and adding to the flood risk downstream. The deluge at Estevan led to flash flooding and swelled an already burgeoning Souris River, spilling its banks. In May and June, more than 323 mm of rain fell in the city – 14 per cent more than the previous record for that period. All Souris river channels, nearby sloughs and reservoirs were filled to the brim. Authorities were forced to release surplus waters from upstream dams to ease the pressure. The ensuing flood siege forced 800 people from their homes. The village of Roche Percee was almost swallowed by the overflowing Souris. Downstream, almost 4,000 residents along the river spent the Canada Day weekend displaced from their homes because of flooding, while 400 Canadian Forces reservists came to the rescue. The long duration of the flood season, more than 150 days, was evident when the Souris River crested during the second week of July at a worst-case level of 1,100 cubic metres per second – twice the rate experienced on April 26 when the Souris first peaked.

2. Slave Lake Burning

On Friday the 13th in May, fire weather forecasters in Alberta were shocked at what they saw – perfect breeding conditions for a fire storm with Slave Lake at the epicentre. Forest greening was delayed, aspen trees were at their most flammable point of the season and weeks of warm, dry weather had created a bone-dry forest floor. By early Sunday morning, blustery southeast winds and Sahara-dry air had sucked every bead of water from the matted grass and forest litter. So when a fire did inevitably start, the blaze, aided by 100 km/h winds, spread quickly. As the fire raged, flames circled the town. Crews couldn't get to the scene quickly enough and, when they did, they were forced to retreat for their own safety. Inside the inferno, the flames consumed all the oxygen and the intense heat created the fire storm's own dry lightning and thunder. The fast-spreading blaze was propelled by powerful winds, strong enough to cause power lines to short out and spark more fires. Wind gusts whipsawed glowing red-hot embers, twigs and bark overhead and on to homes and businesses that quickly ignited. Racing through Slave Lake at 70 metres per minute, the wildfire chased away most of the 7,000 residents.

One-third of the homes and businesses in Slave Lake (about 400 structures) were incinerated in the 1000°C heat – reduced to burnt concrete, twisted steel and blackened rubble. The wildfire razed the town hall, provincial government offices, library, radio station and a medical clinic. An entire subdivision in the southeast part of town was fire-stormed with only foundations and driveways remaining, possibly the largest number of private homes lost from a single event in Canadian history. Scores of families were left with nothing. Outside of town, flames consumed 220 square kilometres of timber and killed several animals. A helicopter pilot died when his fire-fighting aircraft crashed into Lesser Slave Lake.

The Insurance Bureau of Canada reported the Slave Lake wildfire was the second costliest natural disaster in Canadian history at more than $700 million, with $400 million in uninsurable losses. The most expensive insured disaster was the ice storm that hit Quebec and Ontario in 1998, which cost more than $1.8 billion. Insurers claim it was the largest wildfire loss in Canadian history. Alberta's Premier called it the province's worst disaster in recent memory. Unfortunately for Slave Lake residents, it didn't end there. Three weeks after the fire storm it began to rain and wouldn't stop. In June, there were 17 consecutive days of rain, yielding a monthly total of 200 mm – the wettest month on record for the area. Torrential rains caused flooding, leaving beleaguered residents to wonder what more could happen. They didn't have to wait long to find out. A second deluge from July 7 to 9 dumped 100 mm of rain, washing out roads and filling basements again.

3. Richelieu Flooding ..... Quebec's Longest Lived Disaster

For several weeks in spring, Quebecers living up and down the Richelieu River filled sandbags, sloshed through hip-deep waters and prayed that the flooding would soon recede. The Richelieu flood was arguably the worst overland flooding in southern Quebec since Confederation and Quebec's worst natural disaster since the Saguenay flood in 1996. Without question, it was the province's slowest natural disaster ever – wearing out residents physically and mentally.

Flood conditions started months before in the mountains of northern Vermont and New York. Storm after storm swept over the Adirondacks and Green Mountains around Lake Champlain, leaving a record snow pack. In spring – much later and swifter than normal – the snow started melting, swelling countless rivers and streams that empty into Lake Champlain. Additionally, days of intense rains saturated the ground of headwaters around the Lake, raising water levels to record highs for 37 days in a row. The overflow spilled into Mississquoi Bay, flooding shoreline homes and rushed down the Richelieu River, washing over its river banks and flooding hundreds of farms. In at least 20 municipalities, sloshing waters inundated rows of streets up to a kilometre from the river's banks. But water didn't just drain into the Richelieu; southerly winds also pushed metre-high waves into the river from Lake Champlain. With overpowering force, water surged north at volumes as much as five times greater than the Richelieu's average year-round flow.

Just when the threat seemed to be easing, flooding worsened in the last week of May. Following several wet days from an almost immobile weather system, more rain and strong winds caused water levels on the Richelieu River to rise yet again to an all-time high of 30.7 metres. Hundreds of roads and bridges were heavily damaged, parts of the shoreline were swept away and thousands of hectares of farmland were submerged. Fish swam where grain should have been growing. Canadian Forces personnel -- about 800 strong -- and patrols from the Sûreté du Québec were mobilized to help weary townsfolk and local emergency officials. Relentless spring rains and the incredible slowness of the declining water levels prolonged the agony for 2,000 stressed and demoralized residents, who were kept from returning home for weeks.

Spring rains were unprecedented all around the Richelieu. Montreal had its wettest March to May on record in 2011 – 182 per cent of normal. Southeast of Montreal, the rainfall numbers were even more dramatic. At Lennoxville, there were nine days in May with rain amounts exceeding 10 mm (normal is 3.4). When homeowners around the Richelieu did return, it was to ruined belongings, thick mould, building rot, cracked foundations and overflowing septic tanks. Flooded farmland became non-cultivable and schools closed for lengthy periods, forcing students to transfer. In July, an army of volunteers 10,000 strong moved into the area to clean up what the receding waters left behind. SOS Richelieu was the largest volunteer-led cleanup operation in the province's history. After weeks backbreaking labour and heartbreaking losses (in excess of $78 million), water-logged residents of the Richelieu Valley were finally able to move on with their lives but the psychological toll and memories will last forever.

4. Down on the Farm: Doom to Boom

In the West…

Some farmers unable to seed their fields in 2010 were in the same predicament again this year due to excessively wet weather. Others managed to seed only to watch their fields submerge under water not once but twice. By the first day of summer, several growers had given up and those who persevered knew only too well that late-seeded crops typically yield less and are at greater risk from fall frosts. The Canadian Wheat Board estimated that 2.75 million hectares of farmland went unseeded in the West, mostly in Manitoba and Saskatchewan, which amounted to the second largest incidence of abandoned cropland since the early 1970s; 2010 was the worst. The prolonged flooding and saturation threatened to cost the western economy several billion dollars. Farmers needed abundant sunshine and drying winds but got neither, with the area between Regina and Portage la Prairie awash in water. On into June, some diehard producers were still seeding a month later than normal. In contrast, central and northern Alberta and Saskatchewan had favourable May weather allowing farmers to make excellent progress during the late spring.

Even more extraordinary was the reversal of weather come summer. Veteran farmers couldn't remember a growing season more challenging as the land changed from saturated to scorched. For some, a growing season that began as a washout ended in a spectacular harvest with three months of great ripening and drying weather. A hot, dry, sunny July and August helped boost crop development and enabled farmers to play catch-up while northern growing areas saw much-needed rains. In Winnipeg, July was the driest month since record-keeping began in 1872. Even the most rain-soaked areas dried out by August. The town of Souris, Manitoba, which needed the military to bag and bail in June, was desperate for rain in July. While one reporter described it as a case of weather whiplash, it was best summed up by a seasoned grower who stated: "I could be receiving flood and drought insurance payments at the same time."

Across the Prairies summer came in September. As urbanites headed to parks and pools (opened past Labour Day), farmers worked around the clock to bring in the harvest. On September 25, four days after the start of fall, Edmonton hit its warmest temperature of the year at 31.4°C. August and September were the city's driest on record, coming out of one of the wettest June-July periods on record. In Calgary, the September rainfall of 10.6 mm was about one-quarter of its monthly average and in a six-week period from mid-August to September 25, the city had only 6 days with rain. Amazingly, there were two five-day spells with temperatures above 25°C in September, after a June, July and August with no more than two-day spells of similar temperatures. When a severe frost hit in the middle of September, damage was minimal as most crops had matured. By the end of that month the harvest was 85 per cent complete and all wrapped up by Thanksgiving. With the reversal of weather came a reversal of fortunes, with yields of average to above average in quantity and quality. Instead of losing billions, western farm producers pocketed their fourth-highest net return ever. As an added bonus, prices were strong.

In the East…

Farmers in the East also faced a challenging growing season. It started with cold weather and heavy rains that stalled planting, followed by a lengthy dry spell at a critical stage of crop reproduction. Heavy and relentless rains followed between August and October, which delayed the harvest and reduced crop quality. The seeds of a difficult growing season were sown early with a wet spring that washed away or drowned what was planted. Farmers lost a whole month to weather. In Ontario and Quebec, less than 5 per cent of the corn crop was sown by the end of April compared to 90 per cent in 2010. And when it wasn't raining, it unfortunately wasn't drying as sunshine totals averaged over 2.5 hours less per day in May. Even bees were behind in pollinating. Veteran growers quickly declared it the worst year for planting anyone could ever remember. The lingering cool and wet weather also kept farmers in Atlantic Canada off their sodden fields, delaying planting of potatoes and grain, and raising fears about moisture-related crop diseases.

On the first day of summer, the weather abruptly changed across central Canada. By mid-July, Ontario farmers were desperate for water. Bouts of dry, hot weather were especially hard on wheat, corn and soybeans. Niagara's fruit producing region was particularly parched. In a 28-day period between the last week of June and the first three weeks of July a paltry 0.2 mm of rain fell in Hamilton. Some late July rains came just in the nick of time to prevent a crop disaster. August was record wet in southern Quebec, which delayed the harvest, while in Ontario excessive rains in September and October were enough to significantly delay the harvest. Some growers reported a majority of crop still standing by mid-October. In Essex County, only 10 per cent of soybean crops had been harvested by Halloween while practically no corn had been taken from the fields – not surprising since the nearby City of Windsor experienced rain on more than half the days in September and October. The two-month total rainfall was 330 mm or more than twice the normal average. Many farmers couldn't reach their crops without getting stuck in the mud and the soggy conditions also prevented the seeding of winter wheat. On the plus side, farmers benefited from a late first frost and snow. In London, for example, the first frost was two to three weeks late while in Ottawa no snow fell before Remembrance Day for the first time since records began in 1937. For growers in the East, a warmer-than-normal period from August to November was their saving grace. In the end, the wavering weather created a multitude of outcomes for farmers ranging from doom to boom depending on the crop and location.

5. Tornado Goderich in a Wild Week of Weather

Approaching the end of August, the severe weather season in Ontario had been fairly quiet and tame all summer. With 10 mostly weak tornadoes, incessant lightning and wild wind events in the Ottawa Valley, and a strong tornado in late July in Lambton County, most considered summer's severe weather to have been pretty much uneventful. Then on August 21, warm, humid air and an unstable atmosphere over the lower Great Lakes created ripe conditions for some active weather. And when a triggering Great Lakes breeze was thrown into the mix, there were the makings for some turbulent summer weather: funnel clouds, blustery winds, hail and tornadoes.

What followed was a wild week of weather that began with a killer twister ravaging the historic town of Goderich on the shores of Lake Huron. During the afternoon of August 21, Doppler radar revealed classic rotating clouds over the lake. Environment Canada had already issued a severe thunderstorm watch that had mentioned the possible formation of severe thunderstorms capable of producing heavy rain, hail, damaging winds and a tornado. Then, at around 3:45 p.m., the weather watch became a tornado warning. Ten minutes later, a severe tornado crossed the shoreline and struck Goderich. The twister's violent winds blew off roofs, knocked down brick walls, tossed cars, hurled lumber through the air and pulled down large trees. In less than two minutes, the tornado ripped through the heart of the charming, picturesque community with unbelievable damage, killing one person and injuring 40 others. During the subsequent damage survey, meteorologists determined the force of the twister as a Fujita Scale 3 (F3), with winds between 250 and 320 km/h. The length of the tornado track was approximately 20 km, with a width that varied from up to 1,500 m in Goderich to less than 200 m further southeast. The last confirmed F3 tornado in Ontario occurred 16 years ago, on April 20, 1996.

Stunned residents wandered in shock through streets buried in rubble and mangled trees. Trees lay inside houses, while rocks, chunks of cement, thousands of bricks, branches and glass littered the ground everywhere. Once-majestic buildings built 150 years ago lost roofs and upper floors, and structures that weren't flattened or scattered were shifted off their foundation. Officials placed the town under a state of emergency, blocked access to the downtown and cut off natural gas to damaged areas. Hundreds of citizens had to move in with friends and family, or leave town. The Insurance Bureau of Canada's estimate for insured damage exceeded $100 million. Ten days later residents could finally turn on lights, take warm showers and talk on their phones. After hitting Goderich, the tornado blew out east of town towards the St. Lawrence River, with wind gusts of 100 km/h, golf ball-sized hail and heavy downpours. In Toronto, torrential rains and gusty winds toppled sailboats, tore limbs from trees and disrupted power. An F1 tornado (peak winds 120 to 170 km/h) occurred in the western part of Gananoque, with tree and minor property damage.

Only three days later, severe weather hit the province again. As August 24 dawned, it became evident that a number of factors were going to coalesce late in the day to trigger severe thunderstorms with the possibility of tornadoes. So electric was the atmosphere that Environment Canada posted a tornado watch at 11:00 a.m. and constantly updated its tornado warnings and watches during the day. The sky darkened prematurely as black storm clouds rolled in, and then lit up with multiple sheet and fork lightning. After 5:00 p.m., thunderstorms came to life east of Lake Huron. For the next six hours, dozens of powerful storm cells rolled non-stop through the province. In the following days, Environment Canada confirmed that three tornadoes occurred on August 24. Two of them – one in the Nairn area to the northwest of London and another in an area between Cambridge and Burlington – were F1 events, while a third in the community of Neustadt in the southwest portion of Grey County was rated F0.

Hydro One reported that 25,000 customers lost power throughout southwestern Ontario and into cottage country. With bursts of lightning crackling at an intensity rate of 1,000 strikes every two minutes, officials in Toronto wisely emptied the stands at BMO Field during a Toronto FC soccer game. At the nearby Canadian National Exhibition grounds, midway rides were shut down as a precaution. In and around Goderich, the threat of a repeat tornado only three days after the last one had hit stoked anxiety levels in the area for much of the evening. Understandably, many of the town's residents took shelter in their basements waiting for the all clear as thunderstorms lashed the area and skies turned midnight black.

6. Good Night, *Irene* ... and, *Katia*, *Maria* and *Ophelia*

Hurricane experts predicted an active Atlantic hurricane season in 2011 and they were right. From *Arlene* to *Sean* (plus one unnamed storm), 19 tropical storms formed in the Atlantic basin – well above the long-term average of 11. Only seven became full-blown hurricanes, with three logged as major at Category 3 or higher: *Irene*, *Katia* and *Ophelia*. The busy storm season reflected a continuation of above-normal activity that began in 1995. Since then, all but two Atlantic hurricane seasons (1997 and 2002) have been stormier than normal. Among the factors contributing to the active hurricane season were a continuation of heated ocean waters across the tropical Atlantic, higher ocean heat content, favourable winds, and an upper-air circulation that encouraged easterly winds with lower wind shearing. Additionally, La Niña conditions re-emerged over the tropical Pacific in August after a brief interlude of neutral conditions from May to July.

Irene

Irene was the season's first hurricane and, as it turned out, its deadliest and most devastating. On August 27, *Irene* made landfall on the Outer Banks of North Carolina. In the following days, the storm moved slowly northeast, making a second landfall in New Jersey and a third in Brooklyn, New York. Up and down the eastern seaboard torrential rains turned streams into gushing torrents, destroying roads and bridges. Storm surges of more than a metre caused significant river flooding across eight states. *Irene* claimed at least 47 lives and caused an estimated $7 to $10 billion dollars in damage in the United States, making it among the top 10 costliest disasters in that country's history.

By the time *Irene* hit Canada on August 28 in the St. Lawrence region of Quebec and northwestern New Brunswick, it had been downgraded to a post-tropical cyclone. The storm centre followed the Appalachian mountain range, crossed the St. Lawrence River near Matane and reached Labrador late on August 29. Although less intense at that point, *Irene* covered a broader area than a typical hurricane, with strong winds and heavy rains spread well away from the storm's centre in an expansive 800-km diameter. It was also slow-moving, traveling at a top speed of 32 km/h compared to speeds of 48 to 64 km/h for similarly-sized storms. At one point, its massive rain shield extended from Kingston to Halifax and from New Jersey to Newfoundland-Labrador. And at its worst in Canada, *Irene*'s winds topped 113 km/h east of Québec City on Île d'Orléans and rainfall amounts approached 150 mm in just a few hours around Montmagny – L'Islet. The north shore of the St. Lawrence River received 40 to 70 mm with the exception of Québec City and Charlevoix, which, because of their proximity to the storm track, received between 100 and 150 mm. Pounding rains falling at the rate of 10 to 15 mm an hour inundated several communities, particularly in the Eastern Townships, the Montérégie and Lac-St-Jean. Fast-moving waters flooded basements, collapsed roads, washed out culverts and triggered landslides and soil slumps. Storm winds also uprooted trees and downed power lines. Nearly one-quarter of a million Quebecers were left in the dark and some 50,000 customers in New Brunswick and 8,000 in Nova Scotia were without power during the peak of the storm. Northeast of Montreal, a motorist drowned after a landslide sent a chunk of roadway tumbling into the Yamaska River, swallowing two cars. *Irene*'s impact was made worse in southern and western Quebec, where they had already experienced the wettest August on record.

Katia

On September 9, Hurricane *Katia* moved northward between the United States and Bermuda as a Category 1 storm. On the morning of September 10, as it passed south of Newfoundland, *Katia* became a strong extratropical cyclone. Its effects on Canada were confined to heavy surf and rip currents. Sea swells of two to three metres came ashore along Nova Scotia's Atlantic coastline, while waves as much as 13 metres were recorded well offshore over the southern Grand Banks off Newfoundland.

Maria

Maria made landfall over the southwestern Avalon Peninsula as a Category 1 storm on September 16, but with little impact. St. John's residents weren't taking any chances. With memories of Hurricane *Igor* still fresh almost a year later, they had prepared well for *Maria*, which helped to cushion the storm's blow. Preparations began a week ahead of the storm's arrival. Ditches and drainage areas were cleaned out, tenuous tree limbs were removed, construction sites were checked for proper drainage and schools were closed ahead of the storm's arrival. *Maria* brought heavy rain ahead of its centre and strong winds with its passage. Rainfall in excess of 60 mm fell in Burgeo and St. Lawrence and on the Burin Peninsula. While only 13 mm fell at St. John's, wind gusts reached nearly 80 km/h. At a few exposed locations around the Avalon Peninsula they hit 100 km/h, including a peak wind of 103 km/h at Cape Pine near St. Shotts. The storm surge was not significant, registering around one-half metre at Argentia at low tide early on September 16. According to the National Hurricane Centre in Miami, *Maria* was the 13th hurricane to make landfall in Newfoundland since 1851. Also of note, 2011 is the second consecutive year a landfalling hurricane has occurred within the province – a first for the record books.

Ophelia

While *Ophelia* was the strongest storm of the Atlantic hurricane season, its fury was largely played out over the open Atlantic, where it intensified as a Category 4 storm northeast of Bermuda on October 1. The next day it weakened to a Category 1, and on October 3 entered Newfoundland waters. *Ophelia* ultimately made landfall over the Avalon Peninsula, where it morphed into a post-tropical storm north of Cape Race with heavy rain (up to 65 mm) and a brief period of strong winds (close to 100 km/h). Although it came and went in short order, *Ophelia*'s presence was definitely felt – particularly on the Burin and Bonavista peninsulas, where rains in excess of 20 mm per hour led to some basement flooding, road washouts and a few home evacuations.

Tropical Storm *Sean* had no direct effect on Canada; however, a weather front that dumped huge amounts of rain on the Maritimes on Remembrance Day tapped into moisture from *Sean*.

7. Summer: Hummer or Bummer?

On the first day of astronomical summer, June 21, temperatures were on the rise from Saskatchewan to Quebec, blanketing millions of Canadians in warmth and sunshine. In the midst of summer's dog days, the mercury often bubbled into the 30s, with the humidity making it feel like the 40s. Extreme as it was, many Canadians seemed to enjoy the sun and the sweat, possibly because of a winter that had been long and tough at times, and a cool, wet spring.

July was especially hot from Brandon to Beaconsfield and from Windsor to Wabush. The heat was unrelenting under a continental-sized dome of high pressure that covered 40 states and four provinces. Dozens of sites broke temperature records for both night and day. Windsor, arguably Canada's hottest city, recorded its warmest July ever. The mean daily temperature was three degrees above normal at 25.9°C. No major city in Canada has ever recorded a higher mean temperature. Windsor also reached another weather milestone with its hottest day ever. On July 21, the average daily temperature in Windsor was 32.1°C. Amidst the heat and humidity was some welcome relief – little smog or haze to be found. Additionally, humidex values peaked in the upper 40s across Ontario and Quebec, with one observing site in Toronto recording a humidex of nearly 51. In Quebec, new sweltering temperature records were set in Montreal, Sherbrooke and l'Assomption. The hottest temperature occurred at St-Hubert at 36.0ºC. Farther west, Winnipeg's seemingly endless summer registered 24 days when the daytime high rose above 30°C, exceeding the total for the past three years combined. Its hottest day was the warmest in 16 years: 37.2°C on August 23. To the delight of residents, it rained only four Saturdays and Sundays out of 27, resulting in perfect weekend weather for almost the entire summer.

Across central Canada, health officials issued dozens of heat alerts. For one hour on July 21, electricity demand in Ontario skyrocketed to about 25,300 megawatts – the highest it had been in four years. In Toronto, worry about the health and safety of sports fans and players resulted in the Blue Jays ball club keeping the retractable roof at Rogers Centre closed for a matinee game. In Montreal, health experts attributed the death of 10 people to the prolonged extreme heat. Hospital admissions in the city spiked during the heat wave, and police officers and firefighters went door-to-door to check on residents.

For those on the west and east coasts, it was a different story altogether as they endured cool temperatures, endless rain and overcast or foggy skies. In Atlantic Canada, summer temperatures were near normal, but there was no denying how wet it was – some 20 per cent wetter than normal. Fredericton had its wettest July and August ever. In Moncton, May, June, July and August were the rainiest on record. The monotony of the damp weather made it even more unbearable. The longest stretch of rain-free days in May and June was just two days; in July it was three days. During one foul spell, Halifax featured a string of 35 wet days out of 40. In venerably wet St. John's, residents cursed the relentless rains. During one miserable stretch of weather between July 12 and August 14, it rained on 32 of 33 days. On the flip side, Atlantic Canada did get some great summer weather – it just didn't show up until September when people had returned to school and/or work. And as is often the case on the East Coast, the fall was spectacular; this year even more so with record warm temperatures.

In the West, residents of coastal British Columbia often have to endure a couple of weeks of cool, cloudy and wet weather (called the June gloom or *Junuary*) before summer inevitably takes hold. Sometimes it occurs earlier, sometimes later, but rarely does it persist from April to July as it did in 2011. Meteorologists blamed the inclement weather on the hangover effects of La Niña and cooler sea surface temperatures. Unfortunately for residents and visitors in the B.C. Interior and Alberta, the cool, cloudy, coastal weather extended farther east than normal and persisted through June and July. Edmonton recorded 280 mm of rain during those two months, making it the wettest beginning to summer on record. The long spate of dark, damp and dank weather was tough on everyone – especially gardeners, farmers and vintners. The lack of sunshine slowed the ripening process and meant fruit was less sweet. August finally brought long-awaited summer heat and sunny skies to southern B.C. Vancouver had just one day of rain in August, well below the monthly average of seven, and featured 53 more hours of sunshine than normal for the month. Fortunately for all, the warmth and sunshine continued into early September.

8. Arctic Sea Ice Near Record Low

According to Environment Canada and the National Snow and Ice Data Centre in Colorado, sea ice covering the Arctic Ocean declined to its second-lowest extent on record in September 2011. The near-record ice melt was surprising owing to the absence of the unusual warm weather and oceanic conditions that contributed to the super melt in 2007. Thin, year-old ice less than a metre thick that now dominates the Arctic ice pack is much more prone to melting than durable, multi-year ice. Since 1979, September Arctic sea ice extent has declined by 12 per cent per decade. Additionally, the five greatest ice retreats of the satellite era have occurred in the past five years.

Arctic sea ice cover fell below 4.33 million square km on September 9, 2011, with only 310,000 square km more than the previous record of minimal ice extent in 2007 – the lowest seasonal ice minimum extent since record-keeping began more than 50 years ago. This year's minimum level was 35 per cent below the 1979 to 2000 average minimum of 7 million square km.

Although it's much more difficult to measure, it's estimated that sea ice volume shrank to a new record low of 4,200 cubic km – some 8 per cent less than the record set in 2010.

The melt season started with more first-year ice and less of the thicker multi-year ice. The oldest and hardest multi-year ice, which ranges in thickness from 2 to 5 metres, now accounts for only 20 per cent of all sea ice compared to 90 per cent 30 years ago. Arctic sea ice is now estimated to be 40 to 50 per cent thinner than it used to be. Continued loss of the oldest, thickest ice has reduced the summer minimum extent.

Ice cleared again from both the Northwest Passage and the Russian Northern Sea Route, along with much of the Beaufort Sea north of the Yukon-Alaska border. According to the Canadian Ice Service, sea ice extent in the wider and deeper northern route through Parry Channel was the lowest in September 2011 since record-keeping began in 1968. The Northern Sea Route opened in mid-August and was still open at the end of September. The southern route of the Northwest Passage, through the straits of the Canadian Arctic Archipelago, opened for the sixth year in a row. The area around the magnetic North Pole would have 75 per cent ice coverage in a typical year. However, in August 2011, ice covered just 40 per cent of the area.

By late January, waters in the Miramichi Bay and much of the Gulf of St. Lawrence and Northumberland Strait are usually frozen solid, with ice as thick as 30 cm. In 2011, the ice was half that thick as a result of unseasonably mild temperatures, strong winds and a high storm surge. And it marked the second year in a row that these water bodies encountered abnormally low ice concentrations. Last year, ice cover was the lowest since the 1969 season. For some veteran fishers, the last two winters were the worst in more than four decades – just too thin and "slushy" to hold an ice-fishing shack.

At the start of the East Coast seal hunt in late March, only a couple of boats could get into the Gulf of St. Lawrence to hunt on small patches of ice. The ice also broke up faster than normal, causing hundreds of seal pups to drown. In the end, only a fraction of the seal hunt quota was taken. In August 2010, a huge tabular sheet of ice fractured off the Petermann Glacier near Greenland. It was initially thought to be 251 square km – the biggest ice island bobbing around the North Atlantic in nearly 50 years. Once the size of Manhattan, it came down the Labrador coast through May and June 2011 and became visible off Newfoundland's Northern Peninsula in mid-July, much to the thrill of locals and iceberg tourists. The ice behemoth was one-fifth its original size, weighing between 3.5 and 4 billion tonnes, and featured its own geography of hills, waterfalls and ponds, but was weathering quickly from wave action and warmer sea water.

9. Groundhog Day Storm: Snwomageddon or Snowbidgeal?

During the last week of January, meteorologists across North America warned of pending doom – a storm of the century that could potentially affect 100 million people from New Mexico to Newfoundland. What became known as the Groundhog Day Storm shut down two countries with high winds, dangerous wind chill, ice, blizzards and flash freezes. The powerful and historic winter storm with life-threatening weather severely impacted ground travel and led to thousands of cancelled flights across North America and countless school closings.

The storm had an enormous impact on the United States and set the scene for the most devastating weather year in American history. The storm featured 2.5 cm of ice accretion in some areas, tornadoes in the South and more than a half metre of snow in Chicago from a blinding blizzard featuring 100 km/h winds. Cancellations and closures were everywhere and ranged from days to weeks. In the end, the storm was responsible for 36 lives and caused damages exceeding $4 billion US.

Conditions were ripe for a mammoth and powerful storm. A fierce Alberta Clipper led the charge, followed by a huge dome of Arctic air with a central pressure of 105.2 kPa that could re-supply the cold air for days. And it took direct aim at an equally impressive low pressure area coming ashore in northern California. That system crossed the Rockies and garnered support from a Texas low that was dragging moisture from the Gulf of Mexico. The meteorological concoction intensified and lumbered northeastward along a powerful mid-latitude jet stream.

The sprawling storm headed for the Great Lakes and southern Ontario, with forecasts calling for a blanket of snow from Windsor to as far north as Sudbury. Fear of heavy snowfalls, lifted and drifted by powerful winds, along with freezing rain and frigid temperatures scared many into taking precautions ahead of the storm. Windsor declared a snow emergency before the storm's arrival. In an unusual move, the Toronto District School Board closed its nearly 600 elementary and secondary schools – the first city-wide snow day for students since 1999. Via Rail added extra capacity to accommodate the increased demand for travel in the Ontario-Quebec corridor, and many workers stayed home or holed up in hotels. Even before the first snowflakes fell, flights were cancelled and provincial police urged drivers to stay home. In southern Ontario, there was a widespread blizzard warning – the first since March 1993's 'storm of the century'. Of note, the criteria for a blizzard changed in Ontario (omitting wind chill) in the months leading up to the Groundhog Day storm, making the possibility of blizzards in Ontario more likely.

For portions of southern Ontario, the storm had more bark than bite. For example, at a critical moment in the early morning, the storm took on a shot of dry air which largely defused the weather bomb aimed at Toronto. Instead of the expected 30 cm of snow, the city received just 13 to 17 cm – a far smaller dump than many in recent years. Twitter users started calling the storm (previously dubbed Snowmageddon) Snowtorious, Snowbigdeal and Snowhysteria. But while the storm didn't live up to its hype in Toronto, elsewhere in Ontario it was the real deal. Ontario Provincial Police reported dangerous conditions throughout southern Ontario, with blowing snow causing zero visibility in some areas. The Niagara region received 29 cm of snow, with even more to the lee of Lake Huron, while winds at Long Point approached 120 km/h. Across the south, vehicles slid off the snow-packed and icy roads, and many secondary roads were buried under deep snow drifts. Under the new criteria, blizzard conditions did take hold from Lake Huron to Niagara.

The storm had an even greater impact on Quebec and Atlantic Canada. In Quebec, several communities were bombarded with heavy snowfall, high winds and blowing snow. The hardest hit areas included: the Eastern Townships (between 15 and 50 cm of snow); Parc du Mont-Orford (50 cm); Owl's Head (45 cm); Parc national du Mont-Mégantic (35 cm); Sutton (34 cm); and Bromont (30 cm). Three days later, a second system brought another 25 to 40 cm of snow to the same region. Traffic pile-ups were numerous, including one 3-km smash-up involving a school bus near Montreal that injured 29 people, and schools in the Eastern Townships and Sherbrooke were closed for days. Over the Maritimes, the Groundhog Day storm lasted two days, depositing between 20 and 40 cm of snow. It was the sixth time that winter that southeastern New Brunswick was hit by a significant snowfall and, as a result, building roofs were weakened and a few collapsed. In Halifax, schools were closed and events had to be rescheduled including the general meeting of the Whiskey Tasting Society, church youth groups and arts classes. Winds howled at 60 km/h and visibility was down to half a kilometre in whiteouts, shutting down air travel, disrupting traffic and forcing cancellations everywhere. The storm's final blast in North America was felt in Clarenville and Bonavista in Newfoundland-Labrador. St. John's got 20 to 30 cm of snow over four days and winds buffeted Bonavista with gusts at 76 km/h.

10. Wicked Wind from the West

Southern Alberta is one of the windiest regions in Canada. Second only to St. John's, Lethbridge gets more days with strong winds than any city in Canada, while Calgary – famous for its Chinook blows – is the windiest large city in Canada. During the last week of November, some of the most powerful winds ever recorded in the area ripped across southern Alberta, inflicting many millions of dollars in property damages. It was a classic meteorological set-up, featuring a deep low-pressure system from the northern Pacific Ocean that moved inland across the northern section of British Columbia and Alberta. At the same time, a dominant ridge of high pressure was anchored over the western United States. With the high circulating clockwise and the low moving the other way, the air between was pinched into a jet of fast-moving winds that rushed down the Rocky Mountains and hit the Prairies as a warm, dry and fierce wind. The super-charged Chinook broke records for high temperatures, but even more pronounced were the near hurricane-strength winds. Surface-based wind gusts measured 144 km/h at Claresholm, 131 km/h at Stavely and 117 km/h in Lethbridge. And at a home weather station in Pincher Creek, winds were clocked at 204 km/h. On November 22, wind gusts were so strong near Nanton that eight vehicles were blown off the highway and the roof of a high school gymnasium was peeled away, forcing students and staff to evacuate the premises. The strong winds also contributed to the rapid spread of a fire at a feedlot near Cayley.

Five days later, on November 27, more destructive winds blew into Calgary, smashing windows and ripping away at building facades in the downtown. On the 58th floor of one office tower, maximum winds were clocked at 149 km/h. Flying debris became a hazard for both motorists and pedestrians on roads and walkways. Traffic in the downtown core was shut down and officials warned residents to stay indoors and away from windows as glass and pieces of roofing membrane rained down on city streets. Several parked cars were damaged beyond repair – some crushed by falling century-old trees – and the power was knocked out briefly to a number of homes. Outside the city, the RCMP advised large vehicles to stay off highways and slow down. In Lethbridge, a raging grass fire forced at least 125 people from their homes.

It was fortunate the windstorm hit on a Sunday during Grey Cup, with many residents off the streets and glued to their televisions. Miraculously, no one was seriously hurt, although one firefighter hit by falling glass suffered minor injuries. At the height of the storm, Calgary's 311 and 911 call centres handled four days' worth of calls in just five hours.

Source: "Top 10 Canadian Weather Stories for 2011", Meteorological Service of Canada - Environment Canada - Government of Canada. http://www.ec.gc.ca/meteo-weather visited 22 December 2011 at 12:00 a.m. (EST).

Les dix événements météorologiques canadiens les plus marquants de 2011

par David Phillips[2]

Bilan de l'année

Des morts et de la destruction, engendrés par le tremblement de terre et le tsunami au Japon, aux conditions météorologiques exceptionnelles aux États-Unis, qui ont fait plus de 1000 morts au cours de l'année, Dame nature semble avoir déterré la hache de guerre. De fait, il s'agit de la deuxième année la plus coûteuse enregistrée à l'échelle mondiale en ce qui a trait aux catastrophes météorologiques. L'année 2005 détient toujours la première place. À divers moments de l'année en 2011, les Canadiens ont été ensevelis sous la neige, trempés, inondés ou terrifiés. Bien que le temps ait été dur, nous sommes toujours reconnaissants de vivre dans un pays qui, même s'il n'échappe pas totalement à la colère de Dame nature, est passablement épargné, comparativement à la situation de certains de ses voisins.

Pour les Canadiens qui ont été touchés par des phénomènes météorologiques violents, cela ressemblait aux récits des Saintes Écritures ou aux catastrophes hollywoodiennes. Et, pour la troisième année consécutive, l'industrie canadienne des assurances rapporte des pertes qui s'élèvent à des milliards de dollars en raison des catastrophes météorologiques; tout comme à l'échelle mondiale, il s'agit de la deuxième année la plus coûteuse à ce chapitre pour le Canada. Les événements météorologiques les plus marquants au Canada en 2011 ont été les inondations survenues dans trois provinces; ce n'était pas le genre de catastrophe qui prend fin lorsque le beau temps revient, mais plutôt le genre qui affecte les

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gens durant une longue période, et ce, mentalement et physiquement. En allant de l'ouest vers l'est, la Colombie-Britannique se portait mieux pendant que les habitants des Prairies étaient confrontés à des inondations, à des incendies et à des intempéries. L'est du Canada a également eu plus que sa part de mauvais temps tout au long de cette année de météo déchaînée, remplie de tornades, d'ouragans, d'inondations et de vents destructeurs.

L'inondation historique qui a frappé la Saskatchewan et le Manitoba est l'événement météorologique le plus marquant au Canada. Tout ce qui se rapportait à cette inondation, notamment la taille, l'ampleur et la durée, était sans précédent. Il s'agit également de l'une des catastrophes qui a coûté quelques milliards de dollars au Canada. L'Alberta a connu deux des événements les plus marquants de l'année, dont l'incendie de forêt qui a presque tout détruit la ville de Slave Lake qui arrive en deuxième position. Il s'agit également de la deuxième plus importante perte liée aux assurances de l'histoire du Canada. Les inondations survenues au Québec le long de la rivière Richelieu sont le troisième événement le plus marquant; au printemps, la rivière a envahi les rives durant 69 jours. Bien qu'il ne s'agisse pas de la pire catastrophe naturelle survenue dans la province, elle est sans aucun doute celle qui a duré le plus longtemps.

Tout au nord, les glaces de mer de l'Arctique continuent de fondre à un rythme alarmant, atteignant leur deuxième moins grande superficie saisonnière et le volume le plus faible enregistré. Bien qu'il y ait de plus en plus de problèmes liés au climat, la fonte des glaces continue à avoir une incidence marquée sur l'environnement au Canada et à l'étranger. En 2011, la saison des ouragans dans l'océan Atlantique a été très active, avec ses 19 tempêtes nommées. Bien qu'un nombre disproportionnellement élevé de tempêtes tropicales aient été relativement de faible intensité, sept d'entre elles ont été classées dans la catégorie des ouragans; les trois tempêtes considérées comme «majeures» ont été ressenties au Canada. La tempête la plus destructrice et meurtrière de la saison a été Irène. Pour les producteurs agricoles canadiens, les conditions météorologiques dichotomiques de cette année ont représenté un véritable défi. Partout, les cultivateurs ont été confrontés à un printemps très humide, et la saison de croissance a eu un mois de retard. Pourtant, leur pire ennemi s'est révélé leur meilleur allié quand les conditions météorologiques estivales se sont prolongées jusqu'à l'automne, permettant ainsi de sauver ce qui aurait pu s'avérer une récolte désastreuse. Comme toujours, compte tenu de la réalité de nos longs hivers, souvent froids et enneigés, nous estimons que la nature nous doit un bel été. Au centre du pays, le retour s'est fait en douceur avec «l'été des étés», alors que sur les côtes, l'été ne s'est pointé le nez qu'à la toute fin des vacances. Parmi les événements météorologiques les plus marquants au Canada en 2011, figurent le blizzard du jour de la marmotte qui a touché l'Amérique du Nord, du Nouveau-Mexique à Terre-Neuve-et-Labrador, une forte tornade qui a détruit certaines parties de la pittoresque ville de Goderich sur les rives du lac Huron et un puissant chinook qui a traversé le centre-ville de Calgary à des vitesses de la force d'un ouragan, causant des dommages matériels de quelques millions de dollars.

Parmi les finalistes des événements marquants de 2011, on compte la brève tempête du mois de mars qui a enfoui le Québec sous 70 cm de neige, un printemps exceptionnellement humide en Ontario et au Québec, trois orages violents en Ontario, qui auraient pu être catastrophiques, et un déluge à Gatineau qui a rivalisé avec les inondations qui ont coûté des milliards de dollars au Saguenay en 1996. La saison des incendies de forêt a été plutôt calme à travers le Canada, sauf à Slave Lake et dans les régions du nord-ouest de l'Ontario où de vastes territoires de bois d'œuvre ont été brûlés, représentant les feux les plus importants des annales. Mais on compte quelques bonnes nouvelles! Dame nature a tenté de se racheter auprès de millions de Canadiens en leur offrant une température spectaculaire durant la semaine de l'Action de grâce.

Selon l'Organisation météorologique mondiale (OMM), il s'agit de la dixième année la plus chaude enregistrée au cours des 160 dernières années à l'échelle mondiale, malgré le fait que nous avons connu l'une des plus fortes La Niña en 60 ans, entraînant un effet de refroidissement qui a duré presque la moitié de l'année. Selon l'OMM, la température planétaire moyenne a augmenté environ trois fois plus rapidement depuis 1976 qu'au cours des 100 dernières années. De plus, les 13 années les plus chaudes enregistrées sont toutes survenues au cours des 15 dernières années. Au Canada, il s'agit encore d'une année chaude, notre quinzième année consécutive. De janvier à novembre, la température moyenne à l'échelle nationale a été d'environ 1,2 °C au-dessus de la normale. Toutes les régions, sauf la Colombie-Britannique, ont eu du temps plus chaud, tout particulièrement la toundra arctique qui a eu droit à sa cinquième période la plus chaude enregistrée pour les mois de janvier à novembre.

Les dix événements météorologiques canadiens les plus marquants en 2011 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 2011

1	**Luttes historiques contre les inondations dans l'Ouest**
2	**Slave Lake en feu**
3	**Inondations du Richelieu: la plus longue catastrophe au Québec**
4	**Agriculture: du mauvais sort à l'essor**
5	**Tornade à Goderich lors d'une semaine de météo déchainée**
6	**Au revoir Irene, Katia, Maria et Ophelia**
7	**Un été décevant ou sans fin?**
8	**Les glaces de mer de l'Arctique près de leur plus bas niveau**
9	**Blizzard du jour de la marmotte: tempête historique ou dans un verre d'eau**
10	**Vents violents de l'Ouest**

N^o 1 Luttes historiques contre les inondations dans l'Ouest: Surnommée l'inondation sans fin ou l'inondation printanière devenue estivale, l'inondation dans les Prairies en 2011 est caractérisée par les niveaux et les débits d'eau les plus élevés de l'histoire moderne dans certaines régions du Manitoba et de la Saskatchewan.

N^o 2 Slave Lake en feu: Les conditions de feu étaient idéales au mois de mai dernier. Ainsi, lorsqu'un incendie s'est déclaré, le brasier, aidé par des vents de 100 km/h, s'est propagé rapidement. Le tiers des maisons et des entreprises de Slave Lake (soit environ 400 bâtiments) ont été incinérées par une chaleur de 1 000 ^{o}C et réduites en un amas de béton brûlé, d'acier tordu et de gravats noircis.

N^o 3 Inondations du Richelieu -- la plus longue catastrophe au Québec: La crue de la rivière Richelieu est sans doute la pire inondation terrestre que le sud du Québec ait connue au cours de ce siècle. Des centaines de routes ont subi des dégâts importants, des parties du rivage ont été emportées et des milliers d'hectares de terres agricoles ont été submergés. Des poissons nageaient là où des céréales étaient censées pousser.

N^o 4 Agriculture -- du mauvais sort à l'essor: Des agriculteurs dans l'ensemble du pays ont dû composer avec des inondations prolongées, mais ils ont vécu un retournement de situation plus tard dans la saison pour ce qui est des conditions météorologiques. En fin de compte, les conditions météorologiques changeantes ont créé une multitude de conséquences, allant du mauvais sort à l'essor, selon les cultures et leur emplacement.

N^o 5 Tornade à Goderich lors d'une semaine de météo déchainée: Après un été relativement calme, une semaine de conditions météorologiques exceptionnelles s'est abattue sur l'Ontario, en commençant par Goderich, le 21 août. En moins de deux minutes, la tornade a balayé cette collectivité pittoresque en provoquant des dégâts incroyables, tuant une personne et en blessant quarante autres. Seulement trois jours plus tard, des nuages sombres et de la foudre se sont amenés et trois autres tornades ont eu lieu en Ontario.

N^o 6 Au revoir *Irene*, *Katia*, *Maria* et *Ophelia*: D'*Arlene* à *Sean*, 19 tempêtes tropicales se sont formées dans le bassin de l'Atlantique, un chiffre bien supérieur à la moyenne de 11. Seulement six de ces tempêtes se sont muées en ouragans dont trois ont été classés comme majeurs, soit de catégorie 3 ou plus : *Irene*, *Katia* et *Ophelia*. Cette saison de tempêtes active faisait suite à une activité supérieure à la normale ayant commencé en 1995.

N^o 7 Un été décevant ou sans fin?: Le premier jour de l'été, les températures étaient à la hausse de la Saskatchewan au Québec, recouvrant des millions de Canadiens de chaleur et de soleil. Toutefois, pour les habitants des côtes est et ouest, l'histoire a été bien différente, car ils ont eu droit à des températures fraîches, à des pluies continues et à un temps couvert ou brumeux.

N^o 8 Les glaces de mer de l'Arctique près de leur plus bas niveau: D'après Environnement Canada et le National Snow and Ice Data Center, qui se trouve au Colorado, la couverture de glace de mer de l'océan Arctique a diminué à son deuxième niveau le plus bas en septembre 2011. Cette fonte des glaces presque record a surpris en raison de l'absence des conditions météorologiques et océaniques inhabituellement chaudes qui avaient entraîné une fonte très importante en 2007.

N^o 9 Blizzard du jour de la marmotte: tempête historique ou dans un verre d'eau: Au cours de la dernière semaine du mois de janvier, les météorologues ont émis un avertissement d'orage pouvant toucher 100 millions de personnes, du Nouveau-Mexique à Terre-Neuve-et-Labrador. Pour certaines parties du sud de l'Ontario, la tempête a été moins méchante qu'elle n'y paraissait. Toutefois, des conditions de blizzard sont survenues, s'étendant du lac Huron jusqu'à Niagara et du Québec jusqu'aux Maritimes. La tempête a duré deux jours et a laissé tomber entre 20 et 50 cm de neige.

N^o 10 Vents violents de l'Ouest: Le sud de l'Alberta est l'une des régions les plus venteuses du Canada. Au cours de la dernière semaine de novembre, certains des vents les plus puissants jamais enregistrés dans la région ont balayé le sud de l'Alberta, y compris Calgary, causant des dommages matériels s'élevant à quelques millions de dollars.

Source: "Les dix événements météorologiques les plus marquants de 2011", Service Météorologique du Canada - Environnement Canada - Gouvernement du Canada http://www.ec.gc.ca/meteo-weather visité le 22 décembre 2011 à 12 h (HNE).

Summer 2011 on the Canadian Prairies: Paradox of flood loss and record grain yields!

by Ray Garnett[1], Madhav Khandekar[2] and Emdad Haque[3]

Summary: L'été 2011 dans les Prairies canadiennes a été caractérisé par une distribution uniforme des précipitations de mai à juillet. Une humidité adéquate des sols durant la saison de croissance, accompagnée de températures modérées, ont entraîné des rendements records de 2,90 t/ha (tonnes par hectare) pour le blé de printemps et de 1,90 t/ha pour le canola, les deux plus importantes cultures des Prairies. Cette courte note montre de quelle manière de bonnes pluies et des températures estivales modérées ont contribué à ces récoltes exceptionnelles.

1. Introduction

The Canadian Prairies currently produces 50 million tonnes of grain, over half of which is spring wheat. Canada is traditionally the second largest exporter of wheat behind the US, in international markets. The most critical months in establishing yields are May through July (Garnett 2002) with adequate moisture and moderate sunshine. The yields fail to attain full potential due to extreme weather conditions. The weather related hazards that most often affect North American crops are: Drought 55%, Excess moisture 16%, Frost 11%, Hail 8%, Wind 3%, Disease 3% and Flooding 2% (Schwanz 1997).

Flooding has been the main hazard to crops and other assets and properties over the Prairies in recent years. In 2010, farmers were adversely impacted by extreme precipitation and saturated soil moisture, resulting in water-logging. The cost of assisting waterlogged farmers in 2010 was $450 million (Garnett and Khandekar, 2010). In 2011, eastern Prairies received 181% of normal in the March to May period (58 mm/month, the sixth wettest for the period 1900-2007). The 2011 Flood damage has been estimated at $815 million (Winnipeg Sun, December 16, 2011). Environment Canada rated the *2011 historic Prairie flood fight* as first amongst its top ten stories in that it was unprecedented on so many fronts. At one point there were three million hectares of farmland under water as the Assinaboine River struck 'record-breaking heights' only seen once every 300 years! (Winnipeg Free Press, December 23, 2011). A comparison of 2011 monthly temperature and precipitation data (Tables 1a and 1b) with their normal patterns (based on 44 years of data) reveals that precipitation in 2011 was much higher in May and June, while the temperature was below normal during the two growing season months.

Month	Actual	Normal	% of Normal
May	60	47	128
June	98	74	132
July	68	67	101

Table 1a: Precipitation in mm

Month	Actual	Normal	% of Normal
May	10.6	10.8	-0.2
June	15.2	15.4	-0.2
July	18.5	18.0	+0.5

Table 1b: Temperature in ^{o}C

Note:
1) Actual precipitation and temperature data are based on 30 stations;
2) Normal values are for the period 1950-1994 based on over 100 stations.

2. Early indicators once again pointed to wetter than normal May-July

Garnett and Khandekar (2010) described the summer of 2010 as the wettest on the Canadian Prairies in 60 years. Subsequent data analysis reveals that May-July of 2010 was the fourth wettest in 111 years after 1902, 1991 and 1901. The summer of 2005 was the 10th wettest summer on the Canadian Prairies. Drivers for the excessive rains were factors like the SSTs (Sea Surface Temperatures) in the equatorial Pacific, diminished sunspot numbers and lower-than-normal North American snow cover in the April-May period, all combining favourably.

In order to assess the drivers of weather extremes, a research project has been initiaated at the Natural Resources Institute (NRI) of the University of Manitoba, sponsored by the Manitoba Rural Adaptation Council. A data matrix was created consisting of 19 types of predictors each having 12 monthly values from the previous September through August, providing 170 potential predictors. Predictors and response variable datasets were set up consisting of monthly precipitation and temperatures for the prairie region for the period 1900-2010, Palmer Drought Severity Index Data (PDSI) for 17 stations averaged over the prairie region from 1971-2010, spring wheat yields 1909-2010, canola yields 1943-2010 and protein content of spring wheat 1950-2010. Similar datasets of predictors were then created for four agricultural ecological (Ag Eco) zones namely, the Peace River, Palliser North, Palliser Brown Soil and the Eastern Prairies. Ag Eco Zone delineation was based on the study carried out by Bullock *et al*(2010) and Padbury *et al* (2002). By applying correlation and regression techniques, a comprehensive data analysis was made for the five areas noted above.

Based on a provisional regression model, developed at the University of Manitoba, a forecast of "*more than 70mm of rains (above normal) for June-July 2011"* was issued on the 27th of April 2011. Among the independent variables in the regression equation: Niño 3.4 SSTs in May, the Western Pacific (WP) Teleconnection Index during previous October-November and an index of equatorial stratospheric biennial wind oscillation, often identified as the QBO (Quasi-Biennial Oscillation) at the 50hp level. The QBO is an enigmatic wind oscillation in the equatorial stratosphere with an approximate cycle of about 26 months (between easterly and westerly winds).

It is of interest to note here that the above model provided a very good forecast of 2011 spring flood over Manitoba. This model is being examined further with inclusion of additional predictors like the MJO (Madden-Julian Oscillation at 120^0 W in the equatorial western Pacific), the North American Snow Cover in April-May, the QBO at 100 and 50hp levels, the well-known PNA (Pacific North American) Index and an index of earth's geomagnetic activity, called the *AP Index* which is calculated twice daily at an observatory in Niemegh Germany. Preliminary results suggest that the MJO together with SSTs in the Nino-3 region of the equatorial Pacific during the antecedent months, provide a strong correlation with spring and/or summer rains over the eastern Prairies in particular. Also, inclusion of an appropriate index of solar activity (geomagnetic activity) during previous months seems to strengthen this correlation with spring-summer rainfall. In some of our earlier studies (e.g., Khandekar 2004: Garnett et al 2006), solar activity as represented by 'monthly sunspot numbers' appears to provide a definite linkage to drought/wet cycles on the Canadian Prairies.

3. Weather and grain evolution during the summer of 2011.

Garnett's (2002) recent study has attempted to explain how climatic factors affect the wheat plant. The first critical stage is tiller initiation and development, which occurs during May. Excess precipitation in May 2011 (128% of normal) promoted a high tiller count. Also, excess precipitation in June (132% of normal) immensely favoured stem extension and vegetative growth. Normal climate in July, especially the moderate temperatures, meant crops passed through heading-flowering or reproductive phase with a minimum of moisture stress. May and July are probably the two most critical months affecting spring wheat yield in that May determines the number of tillers and therefore stems and heads, and July determines the number of kernels in each head.

The following excerpts taken from the *Ray Garnett Climate and Crop Letter* published by Agro-Climatic Consulting *(ACC)* provides additional details of 2011 growing season rainfall and its favourable impact on subsequent grain yields:

-*May 9th* "Based on 30 stations, April brought 104% of normal precipitation (144% in Manitoba, 62% in Saskatchewan and 80% in Alberta). Planting normally occurs during May and flooding is leading to serious planting delays. Planting has barely commenced in Saskatchewan. In summary, soil moisture conditions are good".

-*May 26th* " At mid-May, planting was 20% complete with biggest delays occurring in eastern Saskatchewan and south western Manitoba".

-*June 9th* "May 30-June 5th brought rains in excess of 200% of normal to the Palliser Brown Soil and Eastern Prairies regions causing delays in planting. May brought 128% of normal rainfall to the prairies, 219% of normal precipitation to the eastern prairies and 89% of normal precipitation to the western prairies. Reports indicate that only 25% of the crop has been planted in southwest Manitoba and eastern Saskatchewan and many producers have given up hope of planting before the June 25th Insurance deadline".

-*June 24th* "June 11-20 brought 200% of normal rainfall to the Canadian prairies (100-200mm to central Alberta) amidst slightly cooler-than-normal temperatures. April 22 to June 20 brought in excess of 150% of normal rainfall to the southern and eastern areas such that crops are reportedly three weeks late between Regina and Winnipeg. An estimated 4% of cropland or six million acres of crops have gone unplanted given excessive rain this spring".

-*July 28th* "July 18 to July 24th brought rains in excess of 200% of normal to central Alberta, northern Saskatchewan and northern Manitoba. Except for dryness in the southeast corner of Manitoba, there are no signs of agricultural drought anywhere. Rainfall the past two months has generally been 115-150% of normal favouring yields. Weather the past month has been slightly warmer than normal serving to advance a late crop. In summary, very good yields are anticipated on a reduced area with a high risk of frost damage on the eastern prairies".

4. Record spring wheat yields in five of the past nine years.

The pattern in spring wheat yields for the years 1980-2011 are illustrated in Figure 1. Only in 1988, 2001 and 2002, which were drought years, did yield departures exceed one standard deviation (0.39 t/ha). Since the 2002 drought, record spring wheat yields have been set in 2004, 2005, 2008, 2009 and 2011 indicative of ideal growing conditions.

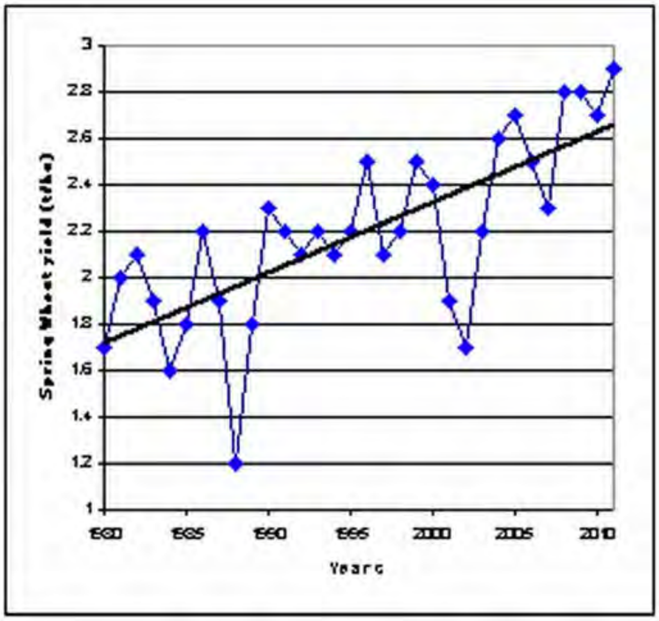

Figure 1. Spring wheat yields in tonnes per hectare 1980-2011

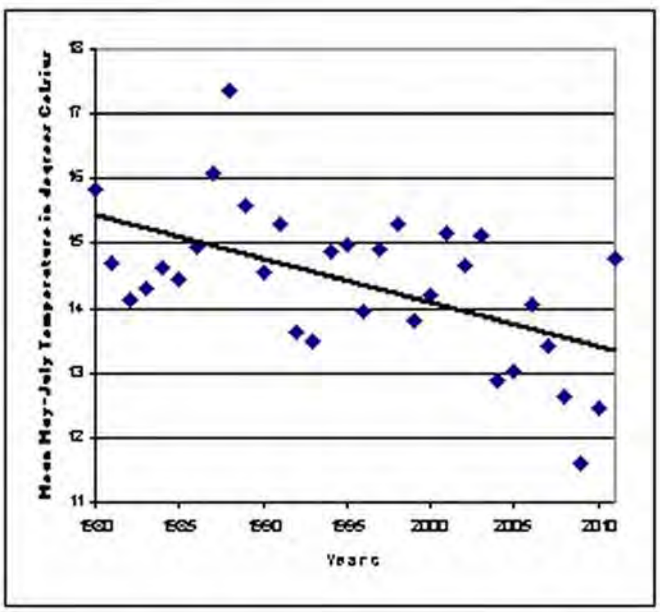

Figure 2. May-July temperatures in ^{o}C1980-2011

In the nine years since the drought cycle of 1999-2002, summer rainfall (May through July) has been above normal (more than 1 standard deviation of normal) in five of the nine years, those years being 2004, 2005, 2008, 2010 and 2011.

It is useful to assess the May-July temperatures for the period 1980-2011, as illustrated in Figure 2. Mean summer temperatures exceeded one standard deviation (~1.2C) in 1988, 2003, 2009 and 2011. The relatively cool summers of 2004, 2005, 2008, 2009 favoured record spring wheat yields.

5. Concluding Remarks

Near ideal rainfall spurred tiller initiation and development during May 2011. Heavy rains in June prompted good stem extension and luxuriant vegetation. Moderate temperatures and precipitation in July allowed near ideal conditions for heading and flowering of spring wheat and canola crops. Also, a lack of 'damaging frost' in late summer 2011 helped produce a record-breaking grain yield. It is worth noting that the flood disaster of 2011 caused close to a billion dollars of damage to Manitoba's economy, exceeding the damage caused by the 1997 '*Flood of the Century*'.

Acknowledgements:

This note is part of a two-year research project being carried out at the Natural Resources Institute (NRI) of the University of Manitoba, which was sponsored by the Manitoba Rural Adaptation Council (MRAC). We would like to thank the MRAC, the Friends of Science (FOS) in Calgary Alberta, the University of Manitoba and Beyond Agronomy Inc. for their funding assistance. We thank Mr. Jeff Babb, Department of Mathematics and Statistics, the University of Winnipeg and Besong Taiwo, Department of Computer Science, the University of Manitoba, for their kind contributions, particularly in data processing efforts in compiling a 110-year prairie climate database. The support from Dr. Hill of the Prairie Agro-Climate Unit (PAU) in Regina, Saskatchewan is also gratefully acknowledged.

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Inondation à Gatineau «de la taille de celle de la rivière Saguenay»

par David Phillips

Des orages puissants et incessants se sont abattus sur la région d'Ottawa-Gatineau le jour de la Saint-Jean, moins de 24 heures après que la zone ait été touchée par une tornade et une tempête de grêle. Pendant deux jours, il est tombé entre 150 et 180 mm de pluie dans la région, bien que les quantités aient été hautement variables d'une zone à l'autre. Le front météorologique, associé à une perturbation sur l'est de l'Ontario et l'ouest du Québec, a commencé à déverser d'énormes quantités de pluie dans l'après-midi du 22 juin, se déplaçant lentement sur la région au cours des deux jours suivants. L'atmosphère était très instable, entraînant de fortes précipitations, mais cette région montagneuse, jusqu'à l'escarpement d'Eardley, a contribué à ces pluies abondantes. Des vagues d'humidité venues du sud étaient soulevées rapidement et abruptement par l'escarpement, intensifiant ainsi les orages. L'accumulation de pluie (intensité égale à 60 mm en 60 minutes, 135 mm en 6 heures et 250 mm en moins de deux jours) était sans précédent depuis 100 ans. Sur les collines de la Gatineau, une quantité invraisemblable de pluie (250 mm) a représenté plus de deux fois la quantité normale pour un mois de juin, et l'un des épisodes les plus humides de l'histoire de l'est du Canada. Le déluge de Gatineau était comparable aux inondations de la rivière Saguenay survenues du 18 au 21 juillet 1996, tant dans la durée des précipitations que dans leur intensité. Seule l'étendue spatiale était différente; elle était en effet 50 fois plus importante lors de la tempête de la rivière Saguenay.

Le long de la rivière des Outaouais, les habitants ont signalé des voies d'accès submergées, des sous-sols inondés et des arbres abattus. Les pannes de courant étaient éparses mais fréquentes, touchant 75 000 foyers. Les agents responsables de l'aéroport international Macdonald-Cartier d'Ottawa ont annulé ou retardé plus

Route "Chemin des Érables" emportée par la crue soudaine du ruisseau. Photo de Dominic Gagné, Gatineau, QC, juin 2011.

d'une dizaine de vols, et le centre hospitalier pour enfants de l'est de l'Ontario a annulé son pique-nique Teddy Bears' Picnic pour la première fois en 27 ans. De l'autre côté de la rivière des Outaouais, au Québec, des inondations et des glissements de terrain ont incité la Commission de la capitale nationale à fermer plusieurs zones du parc de la Gatineau. Les inondations étaient importantes, provoquant la fermeture de dizaines de routes; les égouts n'étaient plus en mesure de gérer le trop-plein, forçant ainsi l'évacuation de 200 maisons mobiles à la suite d'une accumulation d'eau d'un mètre. Quatre cents autres résidences ont été inondées par des débordements d'égouts et des glissements de terrain, principalement à Chelsea et Cantley.

Note de l'Éditeur: Gatineau est la ville de ma résidence. Cette inondation était dans la liste des finalistes des événements météorologiques marquants d'Environnement Canada pour l'année 2011 préparée et rapportée par David Phillips. Source: **http://www.ec.gc.ca/meteo-weather**

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Summer Meteorology Workshop Project Atmosphere 2012

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 **15 to 27 July 2012** 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 be 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 19, 2012**. 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

Summer Oceanography Workshop Maury Project 2012

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 **9-20 July 2012** 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 (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.

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 **March 17, 2012)** 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.

Please note that the English versions precede.

Atelier d'été en météorologie Projet Atmosphère 2012

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 **15 au 27 juillet 2012** 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 **19 mars 2012.** 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

Atelier d'été en océanographie Projet Maury 2012

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 **9 au 20 juillet 2012** 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.

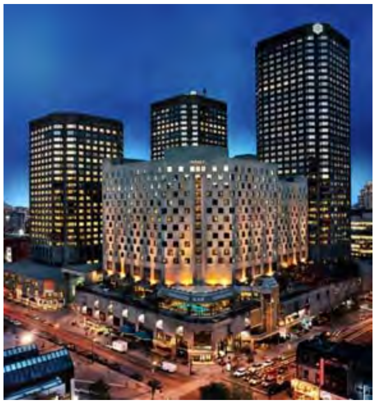
Le lauréat devra écrire un court rapport pour la SCMO de son expérience estivale qui pourra être publié dans le Bulletin de la SCMO.

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 **17 mars 2012.** 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.

Congrès conjoint de la SCMO 2012 avec les conférences de l'AMS sur la Prévision numérique du temps et sur la Prévision et l'analyse météorologique


Complexe hôtelier la nuit

Le 46e congrès annuel de la Société canadienne de météorologie et d'océanographie (SCMO) se tiendra du 29 mai au 1er juin 2012 à l'hôtel Hyatt-Regency de Montréal (Québec) au Complexe Desjardins. Ce congrès est organisé conjointement avec la 21e Conférence de l'"American Meteorological Society" (AMS) sur la Prévision Numérique du Temps (21st Conference on Numerical Weather Prediction) et la 25e Conférence de l'AMS sur la Prévision et l'analyse météorologique (25th Conference on Weather Analysis and Forecasting). Ces deux conférences se tiennent une fois sur deux à l'extérieur de la réunion annuelle de l'AMS et en 2012, elles se tiendront à Montréal et seront organisées en collaboration avec la SCMO. Un Comité conjoint du programme scientifique a déjà été formé pour organiser les sessions portant sur la prévision numérique du temps et la météorologie opérationnelle, des thèmes communs aux deux partenaires. Un effort particulier sera fait pour encourager une participation internationale sur ces thèmes.

Dates importantes à retenir en 2012:

Début des soumissions des résumés: janvier 2012;
Date limite des soumissions de résumés:
17 février 2012;
Date limite des demandes de bourses d'étudiants:
3 mars 2012;
Date limite des rabais pour exposants: 14 mars 2012;
Date limite pour l'inscription anticipée: 13 avril 2012;
Date limite pour les réservations d'hôtel: 27 avril 2012;
Début du congrès: 29 mai 2012.

Pour plus de renseignements, communiquez avec le Comité conjoint du programme scientifique (Courriel: spc@cmos.ca) ou le Comité organisateur (Courriel: lac@cmos.ca).

Joint 2012 CMOS congress with the AMS Numerical Weather Prediction and Weather Analysis and Forecasting conferences


Typical scenery of Montreal

The 46th congress of the Canadian Meteorological and Oceanographic Society (CMOS) will take place from May 29 to June 1st 2012 at the Montréal Hyatt-Regency hotel in Complexe Desjardins in Montréal (Québec). This congress is organized jointly with the 21st American Meteorological Society (AMS) Conference on Numerical Weather Prediction (NWP) and the 25th AMS Conference on Weather Analysis and Forecasting (WAF). These two conferences are organized one out of two outside the annual AMS meeting and in 2012, they will be held in Montréal and organized in collaboration with CMOS. A joint scientific committee has already been formed to organize the sessions on NWP and WAF, themes that are common to the two groups. A special effort will be made to seek an international participation on those topics.

Important Dates to Remember in 2012:

Abstract submissions open: January 2012;
Abstracts submission deadline: February 17, 2012;
Student bursary application deadline: March 3, 2012;
Early Bird Exhibits: March 14, 2012;
Early Bird Congress registration: April 13, 2012;
Early Hotel booking deadline: April 27, 2012;
Congress starts: May 29, 2012.

For more information, please contact the Joint Scientific Program Committee (Email: spc@cmos.ca) or the Local Arrangements Committee (Email: lac@cmos.ca).

Atmosphere-Ocean 50-1 Paper Order

Applied Research / Recherche appliquée

A Method for Estimating Monthly Freshwater Discharge Affecting British Columbia Coastal Waters by J. Morrison, M. G. G. Foreman and D. Masson

Lapse Rate Adjustments of Gridded Surface Temperature Normals in an Area of Complex Terrain: Atmospheric Reanalysis versus Statistical Up-Sampling by Alex J. Cannon, Denise Neilsen and Bill Taylor

Exploratory Observations of Winter Oceanographic Conditions in the Saguenay Fjord by Daniel Bourgault, Peter S. Galbraith and Gesche Winkler

Neural Network Based Seasonal Predictions of Lake-Effect Snowfall by Heike Hartmann

Fundamental Research / Recherche fondamentale

Impact of Climate Change on Ozone Pollution in the Lower Fraser Valley, Canada,by by Christian Reuten, Bruce Ainslie, Douw G. Steyn, Peter L. Jackson and Ian McKendry

Characterization of Cloud and Precipitation Features over and near Southern Baffin Island during STAR by Alex Laplante, Ronald Stewart and William Henson

Climate Change in Western North America due to CO_2 Rise: A Coupled Atmosphere-Ocean Model Simulation [Part 1] by Edward W. Pollock and Andrew B.G. Bush

Contribution of Tibetan Plateau Snow Cover To the Extreme Winter Conditions of 2009/10 by Hai Lin and Zhiwei Wu

Interaction of an Intense Pacific Low Pressure System with a Strong Arctic Outbreak over British Columbia: Forecast Challenges of the Early December 2007 Storm by Quanzhen Geng, Ruping Mo, Mindy Brugman, Brad Snyder, Jim Goosen and Greg Pearce

Intraseasonal Canadian Winter Temperature Responses to Interannual and Interdecadal Pacific SST Modulations by Amir Shabbar and Bin Yu

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A-O Abstracts Preview

Avant Première des résumés de A-O

The following abstracts will soon be published in your next *Atmosphere-Ocean* publication **(50-1)**.

Les résumés qui suivent paraîtront sous peu dans votre prochaine revue *Atmosphere-Ocean* **(50-1).**

Applied Research / Recherche appliquée

A Method for Estimating Monthly Freshwater Discharge Affecting British Columbia Coastal Waters

by J. Morrison, M. G. G. Foreman and D. Masson

Abstract: River runoff is an important influence for many coastal oceanographic processes, but in many places of the world much of the flow is in ungauged rivers. The model developed here uses the historical relationship between precipitation and runoff and applies it to the ungauged areas to produce an estimate of ungauged flow. The combination of gauged and ungauged flow is then used to estimate the total freshwater discharge affecting the coastal waters of British Columbia. A distinction is made between pluvial and nival-glacial watersheds to accommodate their widely different precipitation regimes within the study area. Calendar year and water year variants of the model are tested with the water year version proving to be superior for short time-span evaluations. Hindcasts are computed for the period 1970 to 2009, and the average annual runoff for the study area is found to be 998 km^3. No statistically significant trend is found for the forty-year time series. Runoff estimates from a subset of the study area are shown to match an earlier study that used area scaling, rather than precipitation scaling. The freshwater flux estimated by this method is twice the flux predicted for this region by a global runoff model but that global model reported a suspected under-representation of precipitation.

Résumé: L'écoulement fluvial est un facteur important pour plusieurs processus océanographiques côtiers, mais à de nombreux endroits dans le monde la majeure partie du débit est dans des rivières non jaugées. Le modèle mis au point ici utilise la relation historique entre les précipitations et l'écoulement et l'applique aux régions non jaugées pour produire une estimation de l'écoulement non jaugé. La combinaison de l'écoulement jaugé et non jaugé sert ensuite à estimer le débit total d'eau douce aboutissant dans les eaux côtières de la Colombie-Britannique. Nous faisons une distinction entre les bassins hydrologiques pluvial et nival-glacial pour tenir compte de leurs régimes de précipitations qui diffèrent grandement à l'intérieur de la région à l'étude. Nous testons les variables de l'année civile et celles de l'année hydrologique du modèle et nous trouvons que la version avec l'année hydrologique est supérieure pour les évaluations sur de courtes périodes. Des prévisions a posteriori sont produites pour la période de 1970 à 2009, et il ressort que l'écoulement annuel moyen pour la région à l'étude est de 998 km^3. Nous n'avons trouvé aucune tendance statistiquement significative au cours de la série chronologique de 40 ans. Les estimations d'écoulement pour une portion de la région à l'étude montrent une correspondance avec une étude précédente ayant utilisé une mise à l'échelle spatiale plutôt qu'une mise à l'échelle des précipitations. Le flux d'eau douce estimé avec cette méthode est le double du flux prévu pour cette région par un modèle global d'écoulement, mais ce modèle global a utilisé des précipitations suspectement sous-représentées.

Lapse Rate Adjustments of Gridded Surface Temperature Normals in an Area of Complex Terrain: Atmospheric Reanalysis versus Statistical Up-Sampling

by Alex J. Cannon, Denise Neilsen and Bill Taylor

Abstract: The applicability of elevation-regression based interpolation methods for long-term temperature normals, for example the Parameter-elevation Regressions on Independent Slopes Model (PRISM), becomes increasingly limited in data sparse, complex terrain such as that found in mountainous British Columbia (BC), Canada. Recent methods to improve both the resolution and accuracy of interpolation models have focused on the development of "up-sampling" algorithms based on local lapse rate adjustments to the original interpolated surfaces. Lapse rates can be derived from statistical models (e.g., elevation-based polynomial regression equations) or dynamical models (e.g., vertical temperature profiles from numerical weather prediction (NWP) models). This study compares a widely used statistical up-sampling algorithm, ClimateBC, to two NWP reanalysis products, the National Centers for Environmental Prediction/National Corporation for Atmospheric Research, Reanalysis 1 (NCEP1) and the more modern European Centre for Medium-range Weather Forecasts (ECMWF) Reanalysis Interim (ERA-Interim). Thirtyyear climate normals for maximum and minimum temperatures were calculated using statistical up-sampling and NWP lapse rate adjustments to existing PRISM-based climate normals at a subset of stations in BC. Specifically, up-sampling model evaluation was performed using 1951–80 climate normals from an independent set of 54 surface stations (1 m to 2347 m) which were not included in the PRISM interpolation or assimilated into the NWP reanalysis products. All models performed similarly for minimum temperature, which showed only a slight improvement over PRISM. For maximum temperature, ClimateBC, NCEP1 and ERA-Interim all performed significantly better than PRISM, in particular during spring and summer. The ERA-Interim reanalysis outperformed NCEP1 in almost all months. The results suggest that lapse rate adjustment algorithms based on reanalysis products will have greater potential as progress continues on developing NWP components.

Résumé [Traduit par la rédaction]: L'application des techniques d'interpolation par régression en fonction de l'altitude pour les normales de température à long terme, comme le *Parameter-elevation Regressions on Independent Slopes Model* (PRISM), devient très difficile dans les régions accidentées pour lesquelles on dispose de données insuffisantes, par exemple les secteurs montagneux de la Colombie-Britannique (C.-B.) au Canada. Les toutes dernières méthodes destinées à augmenter le degré de résolution des modèles d'interpolation et leur précision reposent sur la conception d'algorithmes d'échantillonnage vertical fondés sur l'ajustement des surfaces interpolées originales au moyen du gradient vertical local. Nous pouvons établir les gradients verticaux à partir de modèles statistiques (p. ex., des équations de régression polynomiales en fonction de l'altitude) ou de modèles dynamiques (p. ex., des profils verticaux de température à partir de modèles de prévision numérique du temps (PNT)). Dans la présente étude, nous comparons un algorithme d'échantillonnage vertical statistique communément utilisé, le programme ClimateBC, à deux produits de réanalyse de PNT, celle des National Centres for Environmental Prediction/National Corporation for Atmospheric Research Reanalysis 1 (NCEP1), et la réanalyse provisoire (ERA-Interim) du Centre européen pour les prévisions météorologiques à moyen terme (ECMWF). Les normales climatiques de trente ans pour les températures maximums et minimums ont été calculées en appliquant la méthode d'échantillonnage vertical statistique et l'ajustement du gradient obtenu par PNT aux normales climatiques établies à partir du PRISM pour un sous-ensemble de stations en Colombie-Britannique. Plus particulièrement, nous avons procédé à l'évaluation du modèle d'échantillonnage vertical en nous servant des normales climatiques (1951–1980), pour un ensemble de 54 stations d'observation en surface indépendantes (1 m à 2347 m), exclues du modèle d'interpolation PRISM et des produits de réanalyse de PNT. Pour tous les modèles, nous avons obtenu des résultats comparables pour la température minimum, soit une légère amélioration seulement par rapport au PRISM. Pour la température maximum, nous avons obtenu avec ClimateBC, NCEP1 et ERA-Interim, des résultats nettement plus probants qu'avec PRISM, notamment au printemps et en été. Les réanalyses ERA-Interim ont donné de meilleurs résultats que NCEP1 pour pratiquement tous les mois. D'après ces résultats, le potentiel des algorithmes d'ajustements des gradients verticaux de température, établis à partir de produits de réanalyse se renforcera à mesure que les composantes de PNT se développeront.

Exploratory Observations of Winter Oceanographic Conditions in the Saguenay Fjord

by Daniel Bourgault, Peter S. Galbraith and Gesche Winkler

Abstract: A literature review and a search through public databases revealed that little attention had been paid to the winter oceanographic conditions of the Saguenay Fjord. This observation led to an exploratory survey carried out in the Saguenay Fjord during winter 2010, providing the first historical winter measurements throughout the entire water column. Contrary to hypotheses raised about 40 years earlier, the winter water column was well stratified both in temperature and salinity with a dynamically stable pycnocline. The water column was, in fact, more stratified than during the previous summer with a thinner and fresher surface layer lying above a sharper halocline. This stronger winter stratification is attributed to the shielding effect of sea ice to wind-induced mixing. An intermediate water mass lying between 20 and 60 m, called here the Saguenay Intermediate Water (SIW), is identified and documented. This water mass appeared clearly as a warm intermediate layer during winter 2010. It is hypothesized that SIW was formed during the previous summer as a mixture of St. Lawrence Estuary Cold Intermediate Layer (CIL), found at flood tide near the mouth of the fjord, and surface water from the Saguenay Fjord. It is further hypothesized that during winter the SIW is eroded and mixed with cold and salty water from the St. Lawrence Estuary found near the mouth of the fjord. This new mixture creates the T -S characteristics of the Saguenay Deep Water (i.e., the water mass that fills the bottom of the Saguenay Fjord). A wintertime water-column echogram is also presented. The echogram reveals a series of biological strata with small fish near the top of the water column (5–20 m), showing little movement, and active larger fish at mid-depth (below 80 m). The echogram also shows vertical migration of zooplankton, possibly euphausiids, mysids or hyperiid amphipod occurring at sunset. Turbulence measured through the migration does not show evidence of enhanced turbulent diffusivity.

Résumé [Traduit par la rédaction]: L'analyse documentaire et la recherche dans des bases de données publiques que nous avons effectuées ont permis d'établir que peu d'études portent sur les conditions océanographiques en hiver dans le fjord du Saguenay. Voilà pourquoi nous avons procédé à une étude de reconnaissance dans le fjord pendant l'hiver 2010 afin de recueillir les premières mesures hivernales historiques dans l'ensemble de la colonne d'eau. Contrairement aux hypothèses avancées il y a une quarantaine d'années, la colonne d'eau en période hivernale était bien stratifiée du point de vue de la température et de la salinité et elle présentait une pycnocline stable sur le plan dynamique. En réalité, la colonne d'eau était plus stratifiée qu'au cours de la période estivale précédente : une mince couche d'eau douce en surface au contact d'une halocline prononcée. La stratification plus forte en hiver est attribuable à l'effet de protection de la glace marine par rapport au brassage induit par le vent. Nous avons établi l'existence d'une masse d'eau intermédiaire située à une profondeur variant de 20 à 60 m, appelée ici couche intermédiaire du Saguenay (SIW), et nous l'avons décrite. Pendant l'hiver 2010, cette masse d'eau était de toute évidence une couche d'eau chaude intermédiaire. Nous formons l'hypothèse que la SIW s'est formée l'été précédent, par le mélange de la couche intermédiaire froide (CIL) de l'estuaire du Saint-Laurent, observée à la marée montante à l'embouchure du fjord, et de la couche d'eau en surface du fjord du Saguenay. Nous postulons également que l'hiver, la SIW subit de l'érosion et que son eau se mélange à l'eau froide et salée de l'estuaire du Saint-Laurent qui se trouve à proximité de l'embouchure du Saguenay. Ce mélange confère sa température et salinité aux eaux profondes du Saguenay (c'est-à-dire la masse d'eau au fond du fjord

du Saguenay). Nous présentons également un échogramme de la colonne d'eau en période hivernale. L'échogramme révèle une série de strates contenant de petits poissons dans le haut de la colonne d'eau (5 à 20 m), pratiquement immobiles, et de gros poissons actifs en zone intermédiaire (sous les 80 m). L'échogramme révèle également que le zooplancton, possiblement composé d'euphausiacés, de mysididés ou d'amphipodes hypéridés apparaissant à la brunante, se déplace verticalement. Nous avons mesuré la turbulence pendant la migration, mais nous n'avons pas relevé d'indices d'augmentation de la diffusivité turbulente.

Neural Network Based Seasonal Predictions of Lake-Effect Snowfall

by Heike Hartmann

Abstract: In the case of the city of Buffalo (New York, United States), located on the eastern shore of Lake Erie and, therefore, strongly influenced by the lake-effect, total monthly snowfall was predicted one to six months in advance. For this, neural network (NN) techniques, specifically a multi-layer perceptron, as well as a multiple linear regression (LR) model were applied. The period of analysis comprised 28 years from January 1982 to December 2009. Input data included surface air temperature; the temperature difference between the lake surface water temperature (LSWT) and the 850 hPa air temperature; the u-component of the wind (u-wind) and the v-component of the wind (v-wind), geopotential height (GPH) over Lake Erie and the surrounding regions at the 1000, 925, 850 and 700 hPa levels as well as the surface pressure; the 500 hPa GPH over James Bay, Canada; the surface pressure over the Great Plains; and the mean water temperature and LSWT of Lake Erie, as well as the amount of ice cover. Moreover, several teleconnection indices were implemented: the North Atlantic Oscillation (NAO), the Arctic Oscillation (AO), the Pacific/North American (PNA) pattern, the Southern Oscillation Index (SOI) and the Pacific Decadal Oscillation (PDO).

Different lead times for the input variables were tested for their suitability. The most accurate result was obtained using the NN with an optimized one-month lead time approach (lead times varied between one and six months for the different input variables).

Résumé [Traduit par la rédaction]: Dans le cas de la ville de Buffalo (New York, États-Unis), située sur la rive est du lac Érié et donc fortement influencée par l'effet de lac, nous avons prévu la chute de neige mensuelle totale de un à six mois à l'avance. À cette fin, nous avons appliqué des techniques de réseau neuronal, plus précisément un perceptron multicouche, ainsi qu'un modèle de régression linéaire multiple. La période d'analyse s'étendait sur 28 années, de janvier 1982 à décembre 2009. Les données d'entrée consistaient en : la température de l'air à la surface; la différence entre la température de l'eau à la surface du lac et celle de l'air à 850 hPa; la composante u du vent (vent-u) et la composante v du vent (vent-v), la hauteur géopotentielle au-dessus du lac Érié et de la région environnante aux niveaux 1000, 925, 850 et 700 hPa ainsi que la pression à la surface; la hauteur géopotentielle à 500 hPa au-dessus de la baie James au Canada; la pression à la surface dans les Grandes Plaines; et la température moyenne de l'eau ainsi que la température de l'eau à la surface du lac Érié de même que l'étendue de la couverture de glace. De plus, nous nous sommes servis de plusieurs indices de téléconnexion : l'oscillation de l'Atlantique Nord, l'oscillation de l'Arctique, la téléconnexion Pacifique-Amérique du Nord, l'indice d'oscillation australe et l'oscillation décennale du Pacifique.

Nous avons testé la convenance de différents délais de démarrage pour les variables d'entrée. Le résultat le plus précis a été obtenu en utilisant le réseau neuronal avec une approche de délais de démarrage optimisé d'un mois (les délais de démarrage variaient entre un et six mois pour les différentes variables d'entrée).

Fundamental Research / Recherche fondamentale

Impact of Climate Change on Ozone Pollution in the Lower Fraser Valley, Canada

by Christian Reuten, Bruce Ainslie, Douw G. Steyn, Peter L. Jackson and Ian McKendry

Abstract: Assuming current emissions and background concentrations, we investigate how changes in synoptic meteorology alone affect ozone episodes in the Lower Fraser Valley, Canada, in future climates. We perform synoptic typing of combined sea level pressure and 500 hPa geopotential heights for June to September 1961–2000 using the National Centers for Environmental Prediction (NCEP) reanalysis data. Five clusters provide a qualitatively good representation of typical synoptic conditions and stratify exceedance days into one cluster with more than half of all exceedances. Independent cluster analyses for climate model output from the Third Generation Coupled Global Climate Model (CGCM3.1 T63) 1961–2000 control runs and 2046–65 Special Report on Emissions Scenarios (SRES) A1B scenario runs give clusters qualitatively similar to those using NCEP data. When CGCM output is mapped to the NCEP clusters, the CGCM control run cluster frequencies are almost identical to NCEP frequencies, while CGCM 2046–65 output shows only small frequency changes. This indicates that, in future climates, the frequency of occurrence of synoptic types conducive to ozone exceedances will not be appreciably different than they are in the present climate. However, the CGCM predicts substantial increases in daily maximum temperatures in the Lower Fraser Valley across all five clusters. An analysis of exceedance probabilities suggests that the predicted temperature increase will more than double the number of exceedance days per year.

Résumé [Traduit par la rédaction]: Sur la base des niveaux d'émission et des concentrations de fond actuels, nous étudions comment les seuls changements dans la météorologie synoptique influencent les épisodes d'ozone dans la vallée du bas Fraser, au Canada, dans les climats futurs. Nous effectuons un typage synoptique de la pression au niveau de la mer combinée aux hauteurs géopotentielles de 500 hPa pour juin à septembre 1961–2000 en utilisant les données de réanalyse des NCEP (National Centers for Environmental Prediction). Cinq grappes fournissent une représentation qualitativement bonne des conditions synoptiques typiques et stratifient les jours de dépassement dans une grappe avec plus de la moitié de tous les dépassements. Des analyses de grappes indépendantes pour la sortie du modèle climatique faites à partir des passes de vérification du CGCM3.1 T63 (Third Generation Coupled Global Climate Model) pour la période 1961–2000 et des passes de scénario du SRES (Special Report on Emissions Scenarios) A1B pour 2046–2065 donnent des grappes qualitativement semblables à celles obtenues avec les données des NCEP. Quand la sortie du CGCM est mise en correspondance avec les grappes des NCEP, les fréquences des grappes des passes de vérification sont presque identiques aux fréquences des NCEP, et en même temps la sortie du CGCM 2046–2065 ne montre que de petits changements de fréquence. Cela indique que, dans les climats futurs, la fréquence d'apparition des types synoptiques menant à des dépassements d'ozone ne diffèrera pas notablement de ce qu'elle est dans le climat présent. Cependant, le CGCM prévoit des augmentations appréciables dans les températures maximales

journalières dans la vallée du bas Fraser dans les cinq grappes. Une analyse des probabilités de dépassement suggère que l'augmentation de température prévue fera plus que doubler le nombre de jours de dépassement par année.

Characterization of Cloud and Precipitation Features over and near Southern Baffin Island during STAR

by Alex Laplante, Ronald Stewart and William Henson

Abstract: This study focuses on cloud and precipitation features over southern Baffin Island and the adjacent oceanic regions for the period 1 October to 30 November 2007. This period corresponds with the Storm Studies in the Arctic (STAR) field research project based in Iqaluit, Nunavut, Canada. Satellite data from CloudSat and Aqua were obtained from which a number of parameters were used to examine clouds and precipitation. A total of 91 orbital segments were examined comprising 82,388 vertical profiles.

During the observation period, clouds were observed 86% of the time, but precipitation was only observed 13% of the time when clouds were present, and there was a preference for the precipitation to occur over regions of higher terrain. The mean cloud top height and temperature were 2.3 km above sea level (ASL) and –20°C, respectively, but 18% of tops were higher than 7 km. The majority (76%) of clouds were characterized by single-layer clouds although multi-layer clouds were also common with up to four cloud layers sometimes present.

Four significant storm events, including the remnants of Hurricane Noel, were studied in greater detail. These were deep cloud systems (more than 5 km thick) with high and cold cloud tops (higher than 7 km ASL and as low as –65°C, respectively) and layering (up to four layers). Strong vertical and horizontal variations in reflectivity indicated, for example, regions of sublimation and/or evaporation aloft as well as orographic precipitation. Frequency diagrams of radar reflectivity profiles illustrated varying precipitation production features including layers of precipitation growth and reduction.

Résumé [Traduit par la rédaction]: Dans la présente étude, nous nous penchons sur les caractéristiques des nuages et des précipitations dans la partie méridionale de l'île de Baffin ainsi que dans les zones océaniques adjacentes entre le 1er octobre et le 30 novembre 2007. C'est entre ces deux dates que s'est déroulée la campagne météorologique du projet de recherche Storm Studies in the Arctic (STAR) dans la localité d'Iqaluit au Nunavut, Canada. Nous avons utilisé les données des satellites CloudSat et Aqua pour établir un certain nombre de paramètres en vue d'étudier les nuages et les précipitations. En tout, nous avons examiné 91 portions d'arc d'orbite, comprenant 82 388 profils verticaux.

Au cours de la période visée, nous avons observé des nuages 86 % du temps, mais des précipitations, 13 % du temps seulement lorsqu'il y avait des nuages. Les précipitations se sont produites surtout dans les régions en plus haute altitude. En moyenne, le sommet des nuages atteignait 2,3 km de haut par rapport au niveau de la mer (ASL), et la température, -20 °C, mais 18 % des sommets dépassaient 7 km d'altitude. Dans la majorité des cas, il s'agissait de nuages monocouches (76 %). Toutefois, nous avons aussi souvent observé des nuages multicouches, le nombre de couches superposées pouvant aller jusqu'à quatre.

Nous avons étudié de façon plus exhaustive quatre tempêtes majeures, notamment les restes de l'ouragan Noël. Il s'agissait de systèmes de nuages épais (plus de 5 km) caractérisés par des sommets froids de nuages élevés (plus de 7 km ASL et des températures inférieures à -65 °C) et des couches superposées (jusqu'à quatre couches). Les fortes variations verticales et horizontales de réflexivité indiquaient notamment les secteurs de sublimation et d'évaporation dans le ciel, de même que les précipitations orographiques. Nous avons illustré, au moyen de diagrammes de fréquence de la réflexivité radar, la variation des caractéristiques de la production de précipitations, notamment la progression et la diminution des quantités de précipitations.

Climate Change in Western North America due to CO_2 Rise: A Coupled Atmosphere-Ocean Model Simulation [Part 1]

by Edward W. Pollock and Andrew B.G. Bush

Abstract: This study investigates the interactions between carbon dioxide, global atmospheric circulation and the climate of the cordillera of western North America in the twenty-first century under a relatively conservative Intergovernmental Panel on Climate Change (IPCC) emission scenario through the use of a global coupled atmosphere-ocean model. Increasing global carbon dioxide concentrations result in rising temperatures and increasing atmospheric water vapour, particularly at higher latitudes where precipitation increases are most pronounced. The greater warming in polar regions induces a poleward shift in the position of the mid-latitude jets and reduces their strength throughout most of the mid-latitudes, reducing the formation of baroclinic eddies. Nevertheless, a simple model of orographic precipitation indicates that if relative humidity changes little in a warmer climate, western North America will experience substantially larger precipitation increases than the global average, despite weakening mean orographic forcing.

Résumé [Traduit par la rédaction]: Dans un scénario relativement prudent sur les émissions élaboré par le Groupe d'experts intergouvernemental sur l'évolution du climat (IPCC), nous nous penchons, dans la présente étude, sur les interactions entre le dioxyde de carbone, la circulation atmosphérique mondiale et le climat de la Cordillère de la partie ouest de l'Amérique du Nord au XXIe siècle en recourant à un système de modélisation avec couplage océan-atmosphère. L'augmentation des concentrations de dioxyde de carbone à l'échelle planétaire entraîne une hausse des températures et des quantités de vapeur d'eau dans l'atmosphère, notamment dans les latitudes plus élevées, où les précipitations augmentent le plus. Le réchauffement accru dans les régions polaires se traduit par un déplacement marqué vers les pôles de la position des courants-jets des latitudes moyennes et elle réduit leur force dans la majeure partie des latitudes moyennes, ce qui diminue la formation de tourbillons baroclinіques. Cependant, d'après un modèle simple de précipitations orographiques, si l'humidité relative varie peu dans un climat plus chaud, les quantités de précipitations dépasseront largement la moyenne mondiale dans la partie ouest de l'Amérique du Nord, malgré la diminution du forçage orographique moyen.

Contribution of Tibetan Plateau Snow Cover To the Extreme Winter Conditions of 2009/10

by Hai Lin and Zhiwei Wu

Abstract: Most of the northern hemisphere experienced extreme climate conditions during the winter of 2009/10. This winter in Canada was characterized by the warmest and driest conditions in the past 60 years. Across much of the United States, Europe and northern Asia, persistent below-normal temperatures caused a significant adverse economic and societal impact. Dynamical seasonal forecasting systems failed to predict this winter's extreme conditions. Here we show that the snow cover anomaly over the Tibetan Plateau and adjacent areas is significantly correlated with the atmospheric circulation pattern that contributes to these anomalous winter conditions. A statistical model using this snow-cover information and the El Niño signal in autumn 2009 was able to predict the general distribution of the anomalous conditions for this winter. This implies that an improved understanding of the Tibetan Plateau snow-cover effect and its representation in general circulation models are important for seasonal predictions, particularly of high-impact climate events.

Résumé [Traduit par la rédaction]: Pendant l'hiver 2009-2010, les conditions climatiques ont été extrêmes dans la majeure partie de l'hémisphère Nord. Cette année-là, les mois d'hiver au Canada ont été les plus chauds et les plus secs jamais enregistrés au cours des 60 dernières années. Un peu partout aux États-Unis, en Europe et dans le nord de l'Asie, les températures inférieures à la normale persistantes ont eu des conséquences catastrophiques sur le plan socio-économique. Or les systèmes dynamiques de prévisions saisonnières ne sont pas parvenus à prévoir les conditions extrèmes de cet hiver. Dans la présente étude, nous démontrons la corrélation étroite entre l'épaisseur anormalement faible de la couverture de neige sur le plateau Tibétain et dans les régions limitrophes, d'une part, et la configuration de la circulation atmosphérique, responsable de ces conditions hivernales anormales. Grâce au traitement des données sur la couverture de neige et du signal El Niño au moyen d'un modèle statistique, nous avons réussi à prédire la répartition générale des conditions anormales pour l'hiver. Nous en déduisons qu'il est important de mieux comprendre les effets de la couverture de neige du plateau Tibétain et sa représentation dans les modèles de circulation générale pour les prévisions saisonnières, notamment les phénomènes météorologiques lourds de conséquences.

Interaction of an Intense Pacific Low Pressure System with a Strong Arctic Outbreak over British Columbia: Forecast Challenges of the Early December 2007 Storm

by Quanzhen Geng, Ruping Mo, Mindy Brugman, Brad Snyder, Jim Goosen and Greg Pearce

Abstract: The interaction of a warm moist air mass from an intense Pacific low pressure system with a cold air mass from a strong Arctic outbreak during 1–5 December 2007 produced a record number of high-impact weather events across British Columbia, including heavy snow, freezing rain, heavy rain, strong winds and extreme wind chill. The unusual concurrence of these two strong weather systems caused many forecast challenges for both the Canadian numerical weather prediction (NWP) models and meteorologists at the Pacific Storm Prediction Centre (PSPC) of Environment Canada. In this study, the evolution of the weather systems and the observed severe weather events during the 1–5 December 2007 storm are analyzed. Weather forecasts by the NWP models and PSPC meteorologists are compared with the observed high-impact weather events. It is shown that the Canadian NWP models forecast the storm reasonably well Meteorologists at PSPC further improved the model forecasts by considering various local effects of the complex terrain over British Columbia that the model has difficulty resolving and model biases caused by inadequacies in its boundary layer parameterizations.

Résumé: L'interaction d'une masse d'air chaud et humide issue d'une forte dépression dans le Pacifique avec une masse d'air froid générée par une forte coulée polaire entre le 1^{er} et le 5 décembre 2007 a engendré un nombre record d'événements météorologiques à fort impact en Colombie-Britannique : neige abondante, pluie verglaçante, pluie forte, vents forts et indice extrêmement élevé de refroidissement éolien. Pour les modèles canadiens de prévision numérique du temps (NWP) et les météorologues du Centre de prévision des tempêtes du Pacifique (PSPC) d'Environnement Canada, la coïncidence inhabituelle de ces deux systèmes météorologiques forts a posé de nombreux défis. Dans la présente étude, nous analysons l'évolution des systèmes météorologiques et les intenses événements météorologiques observés au cours de la tempête survenue entre le 1^{er} et le 5 décembre 2007. Nous comparons les prévisions de la météo établies à partir des résultats des modèles NWP et par les météorologues du PSPC avec les événements météorologiques à fort impact qui ont été observés. Nous démontrons que les modèles canadiens de NWP ont prédit raisonnablement bien l'évolution de la tempête. Les météorologues au PSPC ont rajusté à leur tour les prévisions établies par ces modèles en intégrant les divers effets locaux des terrains accidentés en Colombie-Britannique, qui sont difficiles à résoudre par ces modèles, et leurs biais attribuables au manque de précision des paramétrages de la couche limite.

Intraseasonal Canadian Winter Temperature Responses to Interannual and Interdecadal Pacific SST Modulations

by Amir Shabbar and Bin Yu

Abstract: The influence of the modal structures of the El Niño-Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO) on the wintertime intraseasonal temperatures and temperature extremes over Canada has been analyzed for the 1900–2008 period. Results demonstrate that intraseasonal temperature variability (longer than 11 days) dominates with a high degree of persistence in western Canada, whereas synoptic-scale variability (shorter than 11 days) prevails in eastern Canada. The PDO has been found to exert a significant modulating effect on ENSO-related intraseasonal temperature impacts in western Canada. In eastern Canada, temperature anomalies are generally weaker often with ENSO and the PDO producing opposite effects. Spectral analysis shows reddening of the temperature spectra with significant peaks near the 20-day period in western Canada. In contrast, the power of the spectra is weaker with significant peaks occurring near the 13-day period in eastern Canada.

Analyses of extremes demonstrate that ENSO and the PDO are also important drivers of changes in Canadian temperature extremes with distinct regional responses. Significant differences in the frequency of occurrence of extreme intraseasonal temperatures above the 95^{th} and below the 5^{th} percentile for the base years exist between the in-phase and out-of-phase combinations of ENSO and the PDO across Canada. In general, the in-phase extreme temperature response is stronger and well organized compared with the out-of-phase response. Application of the generalized extreme value analysis shows that the positive (negative) in-phase combination of ENSO and the PDO enhances the positive (negative) shift in the winter absolute minimum temperatures in western Canada. Also, there are fewer cold days, cold nights and cold waves during the positive in-phase combinations of ENSO and the PDO and conversely more warm nights, warm days and heat waves in western Canada. Opposite responses are evident during the negative in-phase combinations of ENSO and the PDO. To the extent that these modes of climate variability can be reliably predicted, our results for extreme temperatures appear strong enough to be useful in extended regional prediction.

Résumé [Traduit par la rédaction]: Nous avons analysé l'influence des structures modales de l'oscillation El Niño australe (ENSO) et de l'Oscillation décennale du Pacifique (PDO) sur les températures

hivernales intrasaisonnières et les extrêmes de températures au Canada durant la période 1900-2008. Les résultats montrent qu'une variabilité intrasaisonnière de la température (plus longue que 11 jours) domine avec un degré de persistance élevé dans l'ouest du Canada alors qu'une variabilité d'échelle synoptique (plus courte que 11 jours) prévaut dans l'est du Canada. Nous avons trouvé que la PDO exerce un effet modulateur important sur l'impact qu'a l'ENSO sur les températures intrasaisonnières dans l'ouest du Canada. Dans l'est du Canada, les anomalies de température sont généralement plus faibles, souvent avec l'ENSO et la PDO produisant des effets opposés. L'analyse spectrale montre un rougissement des spectres de température avec des pics prononcés près de la période de 20 jours dans l'ouest du Canada. En revanche, la puissance des spectres est plus faible avec des pics prononcés se produisant près de la période de 13 jours dans l'est du Canada.

Les analyses d'extrêmes montrent que l'ENSO et la PDO sont aussi d'importants facteurs de changements dans les extrêmes de température au Canada, avec des réponses régionales distinctes. Il existe des différences importantes dans la fréquence des températures intrasaisonnières extrêmes au-dessus du centile 95 et au-dessous du centile 5 pour les années de référence entre les combinaisons en phase et en opposition de phase de l'ENSO et de la PDO à travers le Canada. En général, la réponse des températures extrêmes en phase est plus forte et bien organisée comparativement à la réponse en opposition de phase. L'application de l'analyse généralisée des valeurs extrêmes montre que la combinaison positive (négative) en phase de l'ENSO et de la PDO accentue le décalage positif (négatif) des températures minimales absolues en hiver dans l'ouest du Canada. De plus, il y a moins de jours froids, de nuits froides et de vagues de froid durant les combinaisons en phase de l'ENSO et de la PDO et, réciproquement, plus de nuits chaudes, de jours chauds et de vagues de chaleur dans l'ouest du Canada. Des réponses opposées s'observent durant les combinaisons négatives en phase de l'ENSO et de la PDO. Dans la mesure où ces modes de variabilité climatique peuvent être prévus de façon fiable, nos résultats pour les températures extrêmes semblent assez robustes pour être utiles dans la prévision régionale à long terme.

Invitation for comments!

Readers may have noticed that our practice of republishing the abstracts of all papers in *Atmosphere-Ocean* is starting to have an impact on the size of the *CMOS Bulletin SCMO*. As *Atmosphere-Ocean* progresses toward its goal of 100 articles per year, the impact on your Bulletin may become overwhelming. In order to continue to promote the work of our scientists, we would like to publish instead a précis of some of the articles, explaining their significance in common language. The précis could be written by the author of the article, an interested volunteer or a paid communications specialist. Please tell us what you think!

The editor

Donnez-nous votre avis!

Nos lecteurs ont sans doute noté que notre habitude de republier les résumés de tous les articles de *Atmosphere-Ocean* commence à avoir un impact sur l'épaisseur du *CMOS Bulletin SCMO*. À mesure que *Atmosphere-Ocean* avance vers son objectif de 100 articles par année, l'impact sur votre revue deviendra dominant. Afin de continuer à promouvoir le travail de nos scientifiques, nous aimerions plutôt publier des abrégés faisant ressortir l'importance de certains des articles et rédigés en langage commun. Les abrégés pourraient être préparés par l'auteur de l'article, un bénévole intéressé ou même un spécialiste en communications. Qu'en pensez-vous?

La rédaction

Invitation to Reviewers

As has recently been reported, *Atmosphere-Ocean* is experiencing a strong growth spur and is planning to increase its publication rate to 100 articles per year by 2014 or so. All of the editorial staff are highly committed to reaching this goal and to maintain the high quality for which *A-O* is known. The introduction of the online manuscript submission and review system ScholarOne, provided by our partner Taylor & Francis, has already contributed to a significant increase in publication speed by virtue of its system of automated messages that considerably decreases the time demand on editors. Another source of publication delay is the review process. Members of the editorial board lose time searching and inviting potential reviewers, which could be reduced if our database of reviewers were more extensive and covered our topics better.

Reviewers make an essential contribution to a scientific journal by identifying quality papers, advising the editor and frequently assisting authors. With an acceptance rate of about 60%, three to four reviewers are required for each published paper. Conversely, each publishing scientist should expect to review 3 to 4 times as many papers as he or she publishes: reviewing is a duty. Reviewing is also a skill that must be practiced, and good reviewers may eventually find a role on the editorial board of a journal, leading to editor-in-chief positions.

If you would like to develop your reviewing skills and offer your services to *Atmosphere-Ocean*, please contact a member of the editorial board (http://www.tandfonline.com/action/aboutThisJournal?show=editorialBoard&journalCode=tato20) or one of the co-editors below, indicating the fields that interest you. You will be entered in our database and your name will come up readily when needed. Your reward will be the increasing renown of your journal.

Gouqi Han (hang@dfo-mpo.gc.ca) Co-Editor (Oceanograpphy)

William Hsieh (whsieh@eos.ubc.ca) Co-Editor (Meteorology)

Invitation aux relecteurs et relectrices

Tel que rapporté récemment, *Atmosphere-Ocean* est en pleine croissance et planifie d'accroître son rythme de publication à 100 articles par année vers 2014. Toute l'équipe éditoriale est engagée vers cet objectif ainsi qu'au maintien de haute qualité pour laquelle *A-O* est renommée. L'arrivée du système en ligne pour la soumission et la revue des manuscrits ScholarOne, fourni par notre partenaire Taylor & Francis, a déjà contribué à accroître de manière significative la rapidité de publication, grâce aux messages automatisés qui requièrent beaucoup moins de temps de la part des éditeurs. Le processus de relecture est une autre cause du retard de publication. Les éditeurs perdent du temps à rechercher et à inviter des relecteurs potentiels, ce qui serait facilité si notre banque de relecteurs était plus étendue et couvrait mieux nos sujets.

Les relecteurs font une contribution essentielle à une revue scientifique en identifiant les articles de qualité, conseillant les éditeurs et fréquemment, en aidant les auteurs. Étant donné un taux d'acceptation d'environ 60%, il faut environ 3 à 4 relecteurs pour chaque article publié. Inversement, chaque scientifique qui publie doit s'attendre à devoir relire de 3 à 4 fois plus d'articles qu'il ou elle publie : la relecture est un devoir. La relecture est aussi une habilité qui doit être développée, et les bons relecteurs seront probablement ceux qui trouveront place au sein des comités éditoriaux, menant aux postes d'éditeur en chef.

Si vous désirez développer vos habiletés de relecture et offrir vos services à *Atmosphere-Ocean*, veuillez contacter un des membres du comité éditorial (http://www.tandfonline.com/action/aboutThisJournal?show=editorialBoard&journalCode=tato20) ou un des co-éditeurs ci-bas, en précisant les domaines qui vous intéressent. Votre nom sera inscrit dans notre banque de données et sera porté à l'attention des éditeurs au besoin. Vous trouverez votre récompense dans la renommée grandissante de votre revue.

William Hsieh (whsieh@eos.ubc.ca) Co-directeur scientifique (météorologie)

Gouqi Han (hang@dfo-mpo.gc.ca) Co-directeur scientifique (océanographie)

Proposed Amendments to the CMOS Constitution and By-Laws

At its meeting on 15 December 2011, the Council agreed to put forward to all members the following Council-proposed amendments, in accordance with Art. 5.

BY-LAW 9 - Election of Council
Replace paragraph a) by:
a) The elected officers to Council are the members of the Executive as defined in Article 4. Only members in good standing are eligible to hold office in the Society.
[Purpose: to eliminate duplicate and potentially conflicting lists.]

APPENDIX I TO BY-LAWS
PRIZES, AWARDS AND SCHOLARSHIPS

Insert new paragraph m):
m) **The Daniel G. Wright Undergraduate Scholarship**
This scholarship ($1000) may be awarded to a Canadian undergraduate student entering the final year of a B.Sc. Honours program in Mathematics and/or Physics, or a related discipline, at a Canadian university. The successful candidate will be selected on the basis of: their academic standing; a written commitment to pursue graduate studies in physical oceanography or a related field; and the ability and interest to communicate and share their knowledge with others, as indicated in their resume and letters of reference.
[Purpose: to implement the decision approved at AGM 2011]

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

Le conseil d'administration de la SCMO à sa réunion du 15 décembre 2011, a accepté de soumettre à tous les membres les modifications suivantes comme propositions du conseil :

RÈGLEMENT 9 - Élection du conseil d'administration
Remplacer paragraphe a) par :
a) Les membres élus du conseil d'administration sont les membres de l'Exécutif suivant la définition de l'Article 4. Seuls les membres en bonne et due forme sont éligibles aux postes de la Société.
[Objet : pour éliminer le potentiel d'un conflit entre des listes dupliqués]

APPENDICE I AUX RÈGLEMENTS
PRIX, HONNEURS ET BOURSES
Ajouter un nouveau paragraphe m) :
m) **La bourse d'études du premier cycle Daniel G. Wright**
Cette bourse (1000$) peut être décerné à un étudiant ou étudiante qui commence la dernière année d'un programme du premier cycle avec concentration en physique ou en mathématique, ou en une discipline reliée à une université canadienne. Le candidat gagnant sera sélectionné(e) selon : sa performance académique; son engagement écrite de suivre des études du deuxième ou troisième cycle en océanographie physique ou en une discipline reliée; sa capacité et son intérêt à communiquer et a partager sa connaissance avec d'autres, tel que c'est témoigné par sa résumé et par ses lettres de référence.
[Objet : implémenter la décision approuvée à la réunion générale annuelle de 2011]

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, David Fissel, President Norman McFarlane, Vice-President Peter Bartello and Louis Lefaivre, Chairperson, CMOS Montreal Centre and Chair of the Local Arrangements Committee for the 2012 CMOS Congress in Montreal recommends the candidates named in the following table for the CMOS Council for 2012-13, all of whom have agreed to stand for office.

The Nominating Committee had several rounds of correspondence since the September 22, 2011 CMOS Council Meeting. We endeavoured to identify nominees for the CMOS Executive which will be transerring our activities from Victoria (2009-2012) to Montreal (2012-2015). In association with this move, the terms of our present BC-based Treasurer (Rich Pawlowicz), Corresponding Secretary (Jane Eert) and Recording Secretary (Sophia Johannessen) expire at the time of the Montreal CMOS Congress in May 2012.

Le Comité de mise en candidature composé du Président sortant et Président du Comité David Fissel, du Président de la Société Norman McFarlane, du Vice-président Peter Bartello and Louis Lefaivre, Président du centre de Montréal de la SCMO et Président du comité local organisateur pour le congrès 2012 de Montréal recommande les candidats suivants identifiés dans le tableau qui suit pour le conseil de la SCMO pour l'année 2012-2013. Tous ont accepté d'être nominés.

Le comité des nominations a entretenu plusieurs séries de correspondances depuis la réunion du Conseil de la SCMO, le 22 septembre 2011. Nous nous sommes efforcés de trouver des candidats pour l'exécutif de la SCMO, qui transfèrera nos activités de Victoria (2009-2012) à Montréal (2012-2015). Parallèlement à ce déménagement, les mandats de notre trésorier actuel (Rich Pawlowicz), de notre secrétaire-correspondant (Jane Eert) et de notre secrétaire d'assemblée (Sophia Johannessen), tous en Colombie-Britannique, se termineront au moment du Congrès de la SCMO de Montréal, en mai 2012.

2012-2013 Candidates / Candidats pour 2012-2013

President Président	**Peter Bartello**, Associate Professor, Department of Atmospheric & Oceanic Sciences and Department of Mathematics & Statistics, McGill University
Vice-President Vice-président	***Pierre Gauthier** UQAM, professeur, Département des Sciences de la Terre et de l'Atmosphère
Treasurer Trésorier	***Nacéra Chergui**, Environnement Canada, météorologiste, Centre météorologique aérautique du Canada - Est (CMAC-E)
Corresponding Secretary Secrétaire correspondant	***André Giguère**, Environnement Canada, Centre météorologique canadien (CMC)
Recording Secretary Secrétaire d'assemblée	***David Huard**, Ouranos Inc., Spécialiste en hydrologie
Past President Président d'office	**Norman McFarlane**, Term Professor, University of Victoria, Emeritus Scientist, Canadian Centre for Climate Modelling and Analysis (CCCma)
Councillors-at-Large (3) Conseillers (3)	**Denis Gilbert,** chercheur scientifique, Institut Maurice-Lamontagne, Ministère des Pêches et Océans, (term ends June 2013) **Kimberley Strong**, Professor, University of Toronto, (terms ends June 2014) *** Tetjana Ross** Associate Professor, Deparment of Oceanography, Dalhousie University (terms ends June 2015).

* New nominations; * nouveaux nominés.

The Committee endeavoured to strike a balance in the National Executive between scientific sectors (Government, University and Private Sector), of gender, regions and the two official languages. In addition, the Nominating Committee has identified a Montreal-based nominee potential for Vice-President in 2013-2014: Harinder Ahluwalia, President and CEO, Info-Electronics.

David Fissel
Chair, Nominating Committee

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.

Le comité a cherché à créer un exécutif national représentatif des différents secteurs scientifiques (gouvernemental, universitaire, privé), en plus de tenir compte de la région, de la langue officielle et du sexe des candidats. De plus, le comité des nominations a pressenti un éventuel candidat situé à Montréal pour le poste de vice-président, en 2013-2014 : Harinder Ahluwalia, d'Info-Electronics.

David Fissel
Président, Comité de mise en candidature

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 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.

Note: Le masculin englobe le féminin.

BRIEF NEWS / NOUVELLES BRÈVES

2010 Patterson Medal

The 2010 Patterson distinguished medal has been awarded to Dr. Gilbert Brunet, Director of Meteorological Research with Environment Canada’s Science and Technology Branch, Environment Canada, for distinguished service to meteorology in Canada. His contributions to meteorology in Canada over the past 21 years in the field of meteorological research are recognized both nationally and internationally. His contributions to science and science management at Environment Canada are truly remarkable. Gilbert’s innovative spirit and scientific leadership are exemplary and have a strong impact on the main directions taken by our Department.

David Grimes, ADM, MSC and Dr. Gilbert Brunet

The Patterson Distinguished Service Medal, presented since 1954, is considered the most pre-eminent award recognizing outstanding work in meteorology by residents of Canada. This prestigious award is named in honor of Dr. John Patterson, a distinguished meteorologist who was Director and Controller of the Meteorological Service of Canada from 1929 to 1946, a crucial period in the development of Canada’s weather service.

This prestigious award was presented to Dr. Brunet on Friday, November 25th during a formal luncheon held at the Environment Canada building at Downsview, Ontario.

Congratulations to Dr. Brunet from the CMOS Community.

Médaille Patterson 2010

La médaille Patterson 2010 a été attribuée à M. Gilbert Brunet, Ph.D., directeur de la recherche météorologique à la Direction générale des sciences et de la technologie d’Environnement Canada pour son service distingué en météorologie au Canada. Ses contributions à la météorologie au Canada au cours des 21 dernières années dans le secteur de la recherche météorologique sont reconnues tant à l’échelle nationale qu’internationale. Ses contributions à la science et à la gestion des sciences à Environnement Canada sont vraiment remarquables. L’esprit innovateur et le leadership scientifique de M. Brunet sont exemplaires et exercent un puissant impact sur les principales orientations adoptées par notre ministère.

La médaille de service distingué de Patterson, qui a été décernée depuis 1954, est considérée comme le prix le plus important pour la reconnaissance du travail exceptionnel réalisé en météorologie par des Canadiens. Ce prix prestigieux a été créé en l’honneur de M. John Patterson, Ph.D., un météorologue distingué qui a été directeur et contrôleur du Service météorologique du Canada de 1929 à 1946, une période importante dans le développement du service météorologique du Canada.

Ce prestigieux prix a été remis à M. Brunet le vendredi 25 novembre au cours d’un déjeuner officiel organisé à l’immeuble d’Environnement Canada de Downsview, en Ontario.

Félicitations au Dr. Brunet de la part de tous les membres de la SCMO.

Nouvelle Chaire de recherche à l’UQR

L’Université du Québec à Rimouski vient d’obtenir une Chaire de recherche du Canada en géologie marine. Son titulaire est le professeur Guillaume St-Onge, de l’UQR-ISMER.

Les travaux de la Chaire nouvelle porteront sur les fonds marins et leurs sédiments. Les recherches effectuées par M. St-Onge aideront à comprendre les risques naturels, la variabilité naturelle du climat et l’histoire géologique dans le fjord du Saguenay, l’estuaire et le golfe du St-Laurent de même que l’!rctique. Un budget de 500 000 $ sur cinq ans est attribué à l’UQR-ISMER pour cette chaire.

“*Un des objectifs de la chaire est d’identifier, de caractériser, de dater et de déterminer les mécanismes responsables du dépôt des glissements sous-marins afin de connaître la fréquence et la magnitude de ces événements pour des régions particulièrement à risque*”, explique le nouveau titulaire Guillaume St-Onge. “*Des travaux seront aussi menés afin de déterminer comment se sont accumulés les sédiments que l’on retrouve dans l’estuaire et le golfe du St-Laurent et dans l’Arctique*”.

Professeur St-Onge

Les changements climatiques arctiques seront également étudiés par M. St-Onge et son équipe. "*Il y a deux phénomènes qui jouent actuellement, les gaz à effet de serre qui réchauffent la planète et la variabilité naturelle du climat qui varie à toutes sortes d'échelles de temps. On veut comprendre comment varie le climat aux échelles de temps décennal à millénaire*".

L'estuaire du Saint-Laurent tourne au vinaigre!

Vous pouvez lire dans le dernier numéro (janvier 2012) du magazine Québec Science la liste des dix découvertes de l'année 2011. Comme pour les années passées, on demande au public de voter pour la meilleure découverte. Parmi celles-ci, la huitième en liste est particulièrement intéressante pour les membres de la SCMO. Il s'agit d'un article paru l'été dernier dans *Atmosphere-Ocean* (MUCCI A., STARR M., GILBERT D. and SUNDBY B. (2011) Acidification of Lower St. Lawrence Estuary bottom waters. *Atmosphere-Ocean* **49:** 206-213. doi:10.1080/07055900.2011.599265) qui met en évidence l'acidification plus rapide de l'estuaire du Saint-Laurent lorsque les données obtenues sont comparées aux données océaniques. Sous ce titre provocant, le magazine publie sous la plume de Dominique Forget un article fort intéressant relatant l'expérience des chercheurs à bord du navire de recherche *Coriolis II*. L'article paru dans *Atmosphere-Ocean* avance trois hypothèses pour l'accélération de l'acidification des eaux de l'estuaire soit: 1) le rejet de CO_2 dans l'atmosphère, 2) la production de matière organique dans les eaux de surface du fleuve et, finalement, 3) le réchauffement des eaux. Histoire à suivre!

Si vous désirez voter pour cette découverte en particulier (# 8 dans la liste), prière de consulter le site de Québec-Science à:
http://www.quebecscience.qc.ca/decouverte2011

2012: Année internationale de l'énergie durable pour tous

Reconnaissant l'importance de l'énergie pour le développement durable, l'Assemblée générale des Nations Unies a proclamé en 2010 dans sa résolution 65/151, l'année 2012, **Année internationale de l'énergie durable pour tous**.

L'ÉNERGIE DURABLE
POUR TOUS

Cette Année internationale de l'énergie durable pour tous est l'occasion de sensibiliser à l'importance d'améliorer l'accès durable à l'énergie, l'efficience énergétique, et l'énergie renouvelable au niveau local, régional et international.

Les services énergétiques ont un effet profond sur la productivité, la santé, l'enseignement, les changements climatiques, la sécurité alimentaire et la sécurité de l'approvisionnement en eau ainsi que les services de communications.

C'est pourquoi l'absence d'accès à une énergie propre, abordable et fiable entrave le développement humain, social et économique et constitue un obstacle majeur à la réalisation des objectifs du Millénaire pour le développement.

Pourtant, 1,4 milliard de personnes n'ont pas accès à une énergie moderne, tandis que trois milliards de personnes dépendent de la « biomasse traditionnelle » et du charbon comme source principale de combustible.

Saviez-vous qu'au niveau mondial, le système énergétique est le contributeur principal au changement climatique, représentant environ 60 % des gaz à effet de serre actuels totaux (GES). Donc l'énergie durable peut contribuer à protéger l'environnement.

Les effets nocifs de l'énergie non durable
Les modes actuels de production et de consommation d'énergie non durable menacent l'environnement à l'échelle locale et mondiale.

Les émissions de la combustion fossile sont la cause principale du changement climatique, de la pollution de l'air urbain et de l'acidification des sols et de l'eau. La réduction des émissions de carbone liées à la consommation d'énergie est une priorité.

Étant donné que l'économie mondiale devrait doubler de taille au cours des vingt prochaines années, la consommation mondiale de l'énergie augmentera également de manière significative si l'approvisionnement énergétique, la conversion et l'utilisation continuent d'être inefficaces.

C'est pourquoi il est essentiel:

- de recourir aux sources d'énergie nouvelles et renouvelables;
- d'utiliser des technologies faiblement émettrices de carbone, y compris des techniques moins polluantes d'exploitation des combustibles fossiles;
- et d'exploiter de manière rationnelle des sources traditionnelles d'énergie.

Sous l'égide du Secrétaire général Ban Ki-moon, ONU-Énergie a mis en place une nouvelle initiative "Énergie durable pour tous" qui s'est fixée trois objectifs principaux à l'horizon 2030:

1) l'accès universel à des services énergétiques modernes;
2) une réduction de 40 % de l'intensité énergétique mondiale; et
3) une augmentation de 30 % de l'utilisation des énergies renouvelables dans le monde.

Source: http://www.un.org/fr/events/sustainableenergyforall/

2012 INTERNATIONAL YEAR OF SUSTAINABLE ENERGY FOR ALL

Recognizing the importance of energy for sustainable development, the United Nations General Assembly has designated in 2010, by its resolution 65/151, the year 2012 as the **International Year of Sustainable Energy for All**.

The International Year of Sustainable Energy for All presents a valuable opportunity to raise awareness about the importance of increasing sustainable access to energy, energy efficiency, and renewable energy at the local, national, regional and international levels.

Energy services have a profound effect on productivity, health, education, climate change, food and water security, and communication services.

Lack of access to clean, affordable and reliable energy hinders human, social and economic development and is a major impediment to achieving the Millennium Development Goals.

Today, 1.4 billion people still do not have access to modern energy, while 3 billion rely on "traditional biomass" and coal as their main fuel sources.

Access to modern affordable energy services in developing countries is essential for the achievement of the internationally agreed development goals, including the Millennium Development Goals, and for achieving sustainable development, which would help to reduce poverty and to improve the conditions and standard of living for the majority of the world's population.

Therefore, the General Assembly of the UN emphasized the importance of investing in access to cleaner energy technology options to achieve a climate-resilient future for all and also pointed out the need to improve access to reliable, affordable, economically viable, socially acceptable and environmentally sound energy services and resources for sustainable development.

It also stressed that the wider use and exploration of available and additional cleaner, new and renewable sources of energy require technology transfer and dispersal on a global scale, including through North-South, South-South and triangular cooperation. It also emphasized the need to take further action to mobilize the provision of adequate financial resources, of sufficient quality and arriving in a timely manner, as well as the transfer of advanced technology to developing countries and countries with economies in transition for providing efficient and wider use of energy sources, in particular new and renewable sources of energy.

Further, it reaffirmed the importance of national policies and strategies to combine, as appropriate, the increased use of new and renewable energy sources and low carbon emission technologies, including cleaner fossil fuel technologies, and the sustainable use of traditional energy services, and enhancing national capacities to meet the growing energy demand, as appropriate, supported by international cooperation in this field and by the promotion of the development and dissemination of appropriate, affordable and sustainable energy technologies, as well as the transfer of such technologies on mutually agreed terms.

With leadership from UN Secretary-General Ban Ki-moon, UN-Energy – a coordinating group of 20 UN agencies – is undertaking a new global initiative, Sustainable Energy for All.

This initiative will engage governments, the private sector, and civil society partners globally to achieve three major goals by 2030:

1) Ensure universal access to modern energy services;
2) Reduce global energy intensity by 40 per cent; and
3) Increase renewable energy use globally to 30 per cent.

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

In Memoriam

Dr. Maurice Danard

1934 - 2011

DANARD, Maurice November 21, 1934 October 13, 2011 Maurice's love of the natural world was the inspiration for his profession and a passion he shared with Audrey, his beloved wife of 52 years. At a young age, Maurice pursued amateur astronomy and he spent the rest of his life looking towards the heavens.

Dr. Maurice Danard

Born in Flin Flon, Manitoba, Maurice's career in meteorology took him to Winnipeg, Montreal, Chicago, Toronto, Monterey, Kitchener, Waterloo and finally Victoria. He graduated from Burnaby South High School in 1951. He earned a BASc in engineering physics from University of British Columbia in 1957, an MA in meteorology from the University of Toronto in 1959, and a PhD in meteorology from the University of Chicago in 1963, completing his doctorate in an astounding two years.

A research scientist and professor, Maurice worked for the federal meteorological services in Winnipeg, Montreal and Toronto; Meteorology International Inc. and the Naval Postgraduate School in Monterey, California; the University of Waterloo, and lastly the University of Victoria. He was also the president of Atmospheric Dynamics Corp., a consulting firm that provided long-range weather predictions for BC Hydro and the Calgary Winter Olympic Games among other clients. Maurice's ground-breaking research, involving long-range weather forecasting using computer modeling, was published in 68 scientific papers in international, refereed journals, and he supervised 35 Master's and PhD theses. He was a great mentor to his graduate students, who remember him with affection because he not only assisted them with their studies, he also helped find them good positions.

While a student at University of Toronto, he met a beautiful Ontario farm girl, Audrey Clyde, and they married in 1959. They spent many happy summers at the family cottage at Tasso Lake, and enjoyed cross-country skiing, hiking, camping and traveling together. They were active in Victoria's Outdoor Club and were both volunteer park wardens for CRD Parks. Maurice was the devoted father of daughters Sharon (Tim) and Susan (James). He is predeceased by brother Doug, survived by sisters Enid and Marlene, and will be remembered fondly by countless cousins, nieces, nephews and friends. An opera lover and wine connoisseur, Maurice lived with great spirit and determination despite advancing Parkinson's disease in his later years. He never lost his irreverent sense of humour.

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Oups!

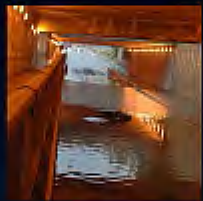
In the last issue (Vol.39, No.6, page 228), we were listing the names of Canadians shining on the international scene. Unfortunately, one person was forgotten: **Dr. David Hik**, University of Alberta, Chair, International Arctic Science Committee (IASC). Also, **Mr. Brian Day**, President, HydroMeteorological Equipment Industry Association (HMEI), is also CEO, Campbell Scientific Canada.

We apologize for this oversight and we thank **Claude Labine** for bringing this to our attention.

La Société canadienne de météorologie et d'océanographie
Canadian Meteorological and Oceanographic Society
American Meteorological Society







46e congrès SCMO | 46th CMOS Congress
25th Conference on Weather Analysis and Forecasting
21st Conference on Numerical Weather Prediction

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

L'Environnement en évolution et son impact sur les services pour le climat, les océans et la météo

The Changing Environment and its Impact on Climate, Ocean and Weather Services

American Meteorological Society 1919

Montréal 2012
29 mai - 1er juin / May 29 - June 1