ISSN 1195-8898

CMOS BULLETIN SCMO

Canadian Meteorological and Oceanographic Society

La Société canadienne de météorologie et d'océanographie

February / février 2008 Vol.36 No.1

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

Editor / Rédacteur: Paul-André Bolduc
Associate Editor / Rédactrice associée: Dorothy Neale
Canadian Meteorological and Oceanographic Society
Société canadienne de météorologie et d'océanographie
P.O. Box 3211, Station D
Ottawa, ON, Canada K1P 6H7
E-Mail: bulletin@cmos.ca; Courriel: bulletin@scmo.ca

Cover page : Shown on cover page are the three winning photos from the 2007 CMOS photo contest. This is to remember that the 2008 contest will soon be underway and to get your camera ready. Top photograph (first prize) is from Dave Sills and is entitled *Prairie Stormscape*. Left photograph (tied for second place), *Snow Ghost Family*, is from Steve Knott and right photograph (tied for second place), *Sunset Shower*, is from Pat McCarthy.

Page couverture : Nous illustrons en page couverture les trois photos gagnantes du concours de photographie 2007 de la SCMO. C'est pour vous rappeler que le concours 2008 sera annoncé sous peu et qu'il est temps de préparer votre caméra. La photo du haut (premier prix) est de Dave Sills et s'intitule *Prairie Stormscape*. Celle de gauche (deuxième prix ex-aequo), *Snow Ghost Family*, est de Steve Knott et celle de droite (deuxième prix ex-aequo), *Sunset Shower*, est de Pat McCarthy.

CMOS Executive Office / Bureau de la SCMO

P.O. Box 3211, Station D
Ottawa, Ontario, Canada, K1P 6H7
Fax / Fascimilé: 613-990-1617
homepage: http://www.cmos.ca
page d'accueil: http://www.scmo.ca

Dr. Ian Rutherford
Executive Director - Directeur exécutif
Tel/Tél.: 613-990-0300
E-mail/Courriel: cmos@cmos.ca

Dr. Richard Asselin
Director of / Directeur des Publications
Tel/Tél.: 613-991-0151
E-mail/Courriel: publications@cmos.ca

Ms. Qing Liao
Office Manager - Chef de bureau
Tel/Tél.: 613-991-4494
E-mail/Courriel: accounts@cmos.ca

Canadian Meteorological and Oceanographic Society (CMOS)

Société canadienne de météorologie et d'océanographie (SCMO)

Executive / Exécutif

President / Président
Dr. Paul G. Myers
University of Alberta
Tel: 780-492-6706; Fax: 780-492-2030
E-mail/Courriel: president@cmos.ca

Vice-President / Vice-président
Andrew Bush
University of Alberta
Tel: 780-492-0351; Fax: 780-492-2030
E-mail/Courriel: vice-president@cmos.ca

Treasurer / Trésorier
Ron Hopkinson
Custom Climate Services, Regina
Tel: 306-586-5489; Fax: 306-586-5489
E-mail/Courriel: treasurer@cmos.ca

Corresponding Secretary / Secrétaire-correspondant
Bob Kochtubajda
Environment Canada
Tel: 780-951-8811; Fax: 780-951-8634
E-mail/Courriel: corsec@cmos.ca

Recording Secretary / Secrétaire d'assemblée
Bill Hume
Tel: 780-989-4103
E-mail/Courriel: billhume@shaw.ca

Past-President / Président ex-officio
Dr. Geoff Strong
Tel: 780-922-0665; Fax: 780-922-0678
E-mail/Courriel: past-president@cmos.ca

Councillors-at-large / Conseillers
1) Dr. Neil Campbell
Tel: 613-731-4512
E-mail/Courriel: neiljc@rogers.com

2) Kent Johnson
Environment Canada, Kelowna
Tel: 604-763-3532
E-mail/Courriel: kent.johnson@ec.gc.ca

3) Brad Shannon
Environment Canada, Calgary
Tel: 403-299-3534;
E-mail/Courriel: bshannon@shaw.ca

....from the President's Desk

Friends and colleagues:

Dr. Paul Myers
CMOS President
Président de la SCMO

Happy New Year to everyone. Hopefully, you all had a restful holiday to put one in a good frame of mind for 2008! I would like to remind everyone that our Annual Congress is in Kelowna from May 25 to May 29. The theme this year is *Water, Weather, Climate: Science Informing Decisions*. Hopefully, I will see many of you there presenting (or taking in presentations) of the many exciting research projects being carried out in Canada. For those of you planning to attend our Congresses beyond this year, 2009 will be in Halifax and 2010 will be in Ottawa jointly with the Canadian Geophysical Union (CGU).

As many of you know, various CMOS awards are presented at our annual congress. And it is at this time of year that nominations are sought for these awards. Despite the fact that there are many top-notch Canadian meteorologists and oceanographers who are worthy nominees for such awards, the Society often receives a derth of nominations. Thus, I encourage you all, if you know worthy individuals, to nominate them for relevent awards. You can find details of the CMOS awards at http://www.cmos.ca/awards.html. I would also like to point out that CMOS awards (or helps administer) a number of scholarships and bursaries for students - again, I call on people to make sure the word gets out to eligible and suitable students.

Paul Myers,
CMOS President
Président de la SCMO

Volume 36 No.1
February 2008 — Février 2008

Inside / En Bref

from the President's desk
Allocution du président by/par Paul Myers **page 1**

Correspondence / Correspondance **page 2**

Highlights of Recent CMOS Meetings **page 3**

Articles

WMO Statement on the Status of Global Climate in 2007 **page 4**

Top 10 Canadian Weather Stories for 2007 by David Phillips **page 7**

Les 10 événements météorologiques canadiens les plus marquants pour 2007 par David Phillips **page 14**

Large-Scale Controls on Hydrologic Responses to Climatic Variability by Sean W. Fleming and R.D. Moore **page 15**

Our regular sections / Nos chroniques régulières

Book Review / Revue de littérature **page 20**

CMOS Business / Affaires de la SCMO **page 25**

CMOS Accredited Consultants / Experts-conseils accrédités de la SCMO **page 6**

Printed in Kanata, Ontario, by Gilmore Printing Services Inc.
Imprimé sous les presses de Gilmore Printing Services Inc., Kanata, Ontario.

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

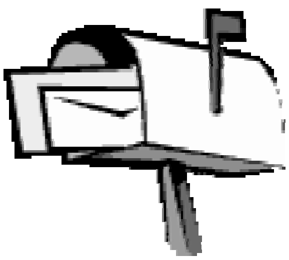
Le but de la SCMO est de stimuler l'intérêt pour la météorologie et l'océanographie au Canada.

Correspondence / Correspondance

Date: 20 November 2007

To: CMOS Executive Director

Subject: 2008 CMOS Membership Renewal



I am not too sure that I wish to remain a member of CMOS any longer. It seems to have developed into a tunnel vision IPCC progenitor rather than a free-thinking scientific body promoting scientific discussion and balanced appraisals.

Those of us who question the IPCC ever since the panel rejected the report of WG1 and rewrote it to be more politically acceptable, no longer recognise it as having scientific integrity.

SAR 1995 had gross errors.The chart showing areas of warming and cooling was not based on an equal area projection but a mercator. As the major areas of warming were around the 60^o N and 60^o S parallels this doubled their size.

Surely the Panel were not ignorant of this cartographic distortion so they must have been aware that they were issuing a false presentation.

As someone who has worked five years in the Southern Hemisphere and especially in the Antarctic Ocean, I know that no data is available in the Antarctic Ocean for 8 months of the year because ships only operate there in the summer months. Only five island stations operate continuously providing the circumpolar oceanic observational data base. However these are not representative of sea temperature distribution in such a large ocean sea area. Until the buoy programs of the 70s and satellites since 78 there was insufficient data for any annual temperature analysis to be derived between 1955 and 1975. If you go to any climate references of the Southern Hemisphere issued by researchers in accredited centres of expertise you will find the Antarctic Ocean as being blanked out as having no data available prior to the satellite era. So how did the IPCC show the Antarctic Ocean as an area of global warming having no data available for the first half of the period being analysed?

In that same chart you will find an area of excessive warming at Bouvet Island. An automatic station was established there by the Norwegians in 1977 but it only ran for 2 years and was abandoned. It reported to Capetown but it was so irregular and suffered from calibration errors that the data was never retained. The IPCC prints this location as an area of greatest warming in the Antarctic. Whose figment of imagination derived that temperature change over a 40-year period from a 2-year inaccurate data set?

Why does WMO (being an IPCC component) ignore its own established parameter for climate change comparisons which is the 30-year average?. Had it done so, warming in the past 50 years would have been less than 0.5^oC - so two 20-year intervals were chosen to get the preferable value of 0.7 by ensuring that the cooling was confined to the 1955-75 period and from 1975-95 was entirely warming. Proof has been achieved only by selection of the required data. I can name three more stations where I have obtained the official data and found that erroneous use of these has been made by the originators of that IPCC presentation. We were well aware in NATO that data for Russia and Siberia were deliberately being adulterated prior to the satellite era, in order to confuse USAF Strategic Air Command operations. Data for the NE Arctic Passage were never released until the late 1990s. So that largest area of warming in the Northern Hemisphere has only been accurately analysed since 1978.

So SAR 1995 was not the report by WG1scientists but by the Panel comprising mainly government appointed administrators in policy and planning and a load of duff information which was manipulated to meet preferred ends. After 1995 only members nominated by their government comprised the Panel and its WGs, so the IPCC became an incestuous organisation glorifying its unanimity and ridiculing criticism and dissent.
Scientific debate was heresy.

TAR 2001 was issued with the Mann "hockey stick" being published 4 times therein just to ensure that this pillar of proof was firmly established to justify other premises and models. Also to question the Medieval warming purported by paleoclimatologists to have been a global event of as great a significance as current global warming. Not only did Esper and Naurbaev using a near identical proxy data base find Mann's analysis erroneous but the Harvard Smithsonian Center for Astrophysics reviewed over 240 papers of global proxy data and found the majority confirmed this era of warming. The Parthian shot was delivered by Canadian university professors who found the data had been improperly collated and statistically processed erroneously.

So TAR 2001 was as erroneous in its guidance to policymakers and planners as SAR 1995.

Coming to 4AR 2007 based on more years of satellite data which determined that the last decade in that 20^{th} century was the warmest and 1998 the warmest year. All very convincing, until a Dr Fox in a UK research institute of metrology began to have doubts regarding satellite calibration procedures being used by NASA. This was followed up by Stewart McAvie in Canada who challenged NASA's accuracy too and in August Hansen of NASA GISS admitted that calibration errors had been made. The amended satellite data now show the 1990s to be less warm than the 1930s and 1934 was the warmest year.

To sum up, not a single report by the IPCC to policymakers and planners has been based on scientifically sound data since its inception.

Dick Morgan, Nova Scotia
CMOS Member

Date: 14 December 2007

To: Dick Morgan

Subject: 2008 CMOS Renewal

I am disappointed to hear that you think both CMOS and the IPCC discourage scientific discussion and balanced appraisals. I think you are wrong on both counts.

None of the IPCC WG REPORTS has ever been re-written for political acceptability. They stand on their own unchanged as written by the scientists involved. On the other hand, the SUMMARIES for POLICY MAKERS are the result of discussion between the scientists who wrote the WG reports and government-appointed policy people. It is abundantly clear from those who were actually present that there is always a lot of give and take between the scientists and the government reps, but in the end both groups have had to accept the resulting summaries. The scientists will tell you that none of their scientific conclusions were really compromised and that the process had the useful result that governments actually had to buy into the summaries.

I have just come from a luncheon meeting of the CMOS Ottawa Centre where a presentation was made by John Stone who was just back from the IPCC meeting in Valencia that drafted the Final Synthesis report and its summary for policy makers. He presented the conclusions, which in his view are probably unnecessarily conservative because of pressure from certain governments, but nevertheless those conclusions are now owned by all. Because of the process, those governments must live with the conclusions and in doing so they lay themselves open to criticism for lack of action if they fail to deal with the issues identified. Today's presentation was just the latest in a series on climate change topics sponsored by the Ottawa Centre, several of which were decidedly against the conclusions of the IPCC. I can assure you that there were attendees representing all points of view at these meetings and lively debate.

I would argue that there is no better forum in Canada for presentation and discussion on climate science than the annual CMOS Congresses and the meetings of our local centres. CMOS regards scepticism as the foundation of good science and encourages scientists of all persuasions to present the evidence supporting their case.

I am sorry that you do not share this point of view.

Ian D Rutherford, PhD
Executive Director, CMOS

P.S. If you have a change of heart, our doors are always open.

Highlights of Recent CMOS Meetings

November - December 2007

<u>November Executive and December Council Meetings</u>

- Debriefing of issues related to 2007 St. John's congress;
- Decision that 2010 will be a joint congress with CGU and will be held in Ottawa;
- News that the Vancouver Island Centre has agreed to host the executive from 2009;
- Creation of a CMOS Audit Committee on the recommendation from CMOS' auditor, to help with the annual audit of the society, with Douw Steyn as chair;
- A report was received from the Accreditation committee outlining discussions to formalize more of the review process;
- Discussions were held on the relative merits of local versus central control of different budgetary items for congresses;
- A paper outlining the accreditation application procedure for flight service specialists was discussed, which will potentially lead to flight service specialists becoming part of CMOS;
- The society received the CFCAS semi-annual report;
- Discussions were held on changes to the constitution and Bylaws that will be published in the upcoming bulletin for members to consider;
- Confirmed that Ed Hudson of MSC Edmonton will be the CMOS 2008 Tour Speaker;
- Discussion of proposed changes to the CMOS membership structure to be presented to members;
- Discussion of national executive nominations for 2008/09;
- Appointment of John Reid to a one-year term as CMOS Privacy Officer;
- Discussion of CMOS investment strategy based upon a white paper from the Finance and Investment Committee - no consensus was achieved, with this topic to receive further discussion.

Paul Myers,
CMOS President
Président de la SCMO

URGENT - URGENT - URGENT - URGENT

Next Issue *CMOS Bulletin SCMO*

Next issue of the *CMOS Bulletin SCMO* will be published in **April 2008.** Please send your articles, notes, workshop reports or news items before **March 7, 2008** to the address given on page ii. We have an <u>URGENT</u> need for your written contributions.

URGENT - URGENT - URGENT - URGENT

Prochain numéro du *CMOS Bulletin SCMO*

Le prochain numéro du *CMOS Bulletin SCMO* paraîtra en **avril 2008.** Prière de nous faire parvenir avant le **7 mars 2008** vos articles, notes, rapports d'atelier ou nouvelles à l'adresse indiquée à la page ii. Nous avons un besoin <u>URGENT</u> de vos contributions écrites.

REMINDER - REMINDER - REMINDER

CMOS has negotiated great membership deals for its members. CMOS members are eligible for a 25% discount off membership fees for the Royal Meteorological Society (RMetS) and the Canadian Geophysical Union (CGU) as associate members. Members of both these societies are also eligible for associate membership in CMOS; so please encourage your colleagues in those societies to join CMOS too.

WMO Statement on the Status of Global Climate in 2007 ***

Résumé: La décennie 1998-2007 est la plus chaude jamais enregistrée. La température moyenne à la surface du globe en 2007 présente actuellement une anomalie positive estimée à 0,41°C par rapport à la normale calculée pour la période 1961-1990 (14.00°C).

Parmi les autres phénomènes climatiques majeurs observés à ce jour en 2007 figurent la diminution record de l'étendue de la banquise de l'Arctique, qui s'est traduite par l'ouverture, pour la première fois dans l'histoire, du passage du Nord-Ouest canadien, le trou dans la couche d'ozone au dessus de l'Antarctique, relativement peu étendu, le développement d'un épisode La Niña dans le centre et l'est du Pacifique équatorial ainsi que des inondations, sécheresses et tempêtes dévastatrices dans de nombreuses régions du monde.

BALI/GENEVA, 13 December, 2007 (WMO) – The decade of 1998-2007 is the warmest on record, according to data sources obtained by the World Meteorological Organization (WMO). The global mean surface temperature for 2007 is currently estimated at 0.41°C above the 1961-1990 annual average of 14.00°C.

Other remarkable global climatic events recorded so far in 2007 include record-low Arctic sea ice extent, which led to first recorded opening of the Canadian Northwest Passage; the relatively small Antarctic Ozone Hole; development of La Niña in the central and eastern Equatorial Pacific; and devastating floods, drought and storms in many places around the world.

The preliminary information for 2007 is based on climate data up to the end of November from networks of land-based weather stations, ships and buoys, as well as satellites. The data are continually collected and disseminated by the National Meteorological and Hydrological Services (NMHS) of WMO's 188 Members and several collaborating research institutions. Final updates and figures for 2007 will be published in March 2008 in the annual WMO brochure for the Statement on the Status of the Global Climate.

WMO's global temperature analyses are based on two different sources. One is the combined dataset maintained by both the Hadley Centre of the UK Meteorological Office, and the Climatic Research Unit, University of East Anglia, UK, which at this stage ranked 2007 as the seventh warmest on record. The other dataset is maintained by the US Department of Commerce's National Oceanic and Atmospheric Administration (NOAA), which indicated that 2007 is likely to be the fifth warmest on record.

Since the start of the 20th century, the global average surface temperature has risen by 0.74°C. But this rise has not been continuous. The linear warming trend over the last 50 years (0.13°C per decade) is nearly twice that for the last 100 years.

According to the Intergovernmental Panel on Climate Change's 4th Assessment (Synthesis) Report, 2007, "warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level".

2007 global temperatures have been averaged separately for both hemispheres. Surface temperatures for the northern hemisphere are likely to be the second warmest on record, at 0.63°C above the 30-year mean (1961-90) of 14.6°C. The southern hemisphere temperature is 0.20°C higher than the 30-year average of 13.4°C, making it the ninth warmest in the instrumental record since 1850.

January 2007 was the warmest January in the global average temperature record at 12.7°C, compared to the 1961-1990 January long-term average of 12.1°C.

Regional temperature anomalies

2007 started with record breaking temperature anomalies throughout the world. In parts of Europe, winter and spring ranked amongst the warmest ever recorded, with anomalies of more than 4°C above the long-term monthly averages for January and April.

Extreme high temperatures occurred in much of Western Australia from early January to early March, with February temperatures more than 5°C above average.

Two extreme heat waves affected south-eastern Europe in June and July, breaking previous records with daily maximum temperatures exceeding 40°C in some locations, including up to 45°C in Bulgaria. Dozens of people died and fire-fighters battled blazes devastating thousands of hectares of land. A severe heat wave occurred across the southern United States of America during much of August with more than 50 deaths attributed to excessive heat. August to September 2007 was extremely warm in parts of Japan, setting a new national record of absolute maximum temperature of 40.9° on 16 August.

In contrast, Australia recorded its coldest ever June with the mean temperature dropping to 1.5°C below normal. South America experienced an unusually cold winter (June-August), bringing winds, blizzards and rare snowfall to various provinces with temperatures falling to -22°C in Argentina and -18°C in Chile in early July.

Prolonged drought

Across North America, severe to extreme drought was present across large parts of the western U.S. and Upper Midwest, including southern Ontario/Canada, for much of 2007. More than three-quarters of the Southeast U.S. was in drought from mid-summer into December, but heavy rainfall led to an end of drought in the southern Plains.

In Australia, while conditions were not as severely dry as in 2006, long term drought meant water resources remained extremely low in many areas. Below average rainfall over the densely populated and agricultural regions resulted in significant crop and stock losses, as well as water restrictions in most major cities.

China experienced its worst drought in a decade, affecting nearly 40 million hectares of farmland. Tens of millions of people suffered from water restrictions.

Flooding and intense storms

Flooding affected many African countries in 2007. In February, Mozambique experienced its worst flooding in six years, killing dozens, destroying thousands of homes and flooding 80,000 hectares of crops in the Zambezi valley.

In Sudan, torrential rains caused flash floods in many areas in June/July, affecting over 410,000 people, including 200,000 left homeless. The strong southwesterly monsoon resulted in one of the heaviest July-September rainfall periods, triggering widespread flash floods affecting several countries in West Africa, Central Africa and parts of the Greater Horn of Africa. Some 1.5 million people were affected and hundreds of thousands homes destroyed.

In Bolivia, flooding in January-February affected nearly 200,000 people and 70,000 hectares of cropland. Strong storms brought heavy rain that caused extreme flooding in the littoral region of Argentina in late March/early April. In early May, Uruguay was hit by its worst flooding since 1959, with heavy rain producing floods that affected more than 110,000 people and severely damaged crops and buildings. Triggered by storms, massive flooding in Mexico in early November destroyed the homes of half a million people and seriously affected the country's oil industry.

In Indonesia, massive flooding on Java in early February killed dozens and covered half of the city of Jakarta by up to 3.7 metres of water. Heavy rains in June ravaged areas across southern China, with flooding and landslides affecting over 13.5 million people and killing more than 120. Monsoon-related extreme rainfall events caused the worst flooding in years in parts of South Asia. About 25 million people were affected in the region, especially in India, Pakistan, Bangladesh and Nepal. Thousands lost their lives. However, rainfall during the Indian summer monsoon season (June-September) for India was, generally, near normal (105% of the long-term average), but with marked differences in the distribution of rainfall in space and time.

A powerful storm system, *Kyrill*, affected much of northern Europe during 17-18 January 2007 with torrential rains and winds gusting up to 170km/h. There were at least 47 deaths across the region, with disruptions in electric supply affecting tens of thousands during the storm.

England and Wales recorded its wettest May-July period since records began in 1766, receiving 415 mm of rain compared to the previous record of 349 mm in 1789. Extensive flooding in the region killed nine and caused more than US$6 billion in damages.

Development of La Niña

The brief El Niño event of late 2006 quickly dissipated in January 2007, and La Niña conditions became well established across the central and eastern Equatorial Pacific in the latter half of 2007.

In addition to La Niña, unusual sea surface temperature patterns with cooler than normal values across the north of Australia to the Indian Ocean, and warmer than normal values in the Western Indian Ocean, were recorded. These are believed to have modified the usual La Niña impacts in certain regions around the world.

The current La Niña is expected to continue into the first quarter of 2008 at least.

Devastating tropical cyclones

Twenty-four named tropical storms developed in the North-West Pacific during 2007, below the annual average of 27. Fourteen storms were classified as typhoons, equalling the annual average. Tropical cyclones affected millions in south-east Asia, with typhoons *Pabuk, Krosa, Lekima* and tropical storms like *Peipah* among the severest.

During the 2007 Atlantic Hurricane season, 14 named storms occurred, compared to the annual average of 12, with 6 being classified as hurricanes, equalling the average. For the first time since 1886, two category 5 hurricanes (*Dean* and *Felix*) made landfall in the same season.

In February, due to tropical cyclone *Gamède*, a new worldwide rainfall record was set in French La Reunion with 3,929 mm measured within three days.

In June, cyclone *Gonu* made landfall in Oman, affecting more than 20,000 people and killing 50, before reaching the Islamic Republic of Iran. There is no record of a tropical cyclone hitting Iran since 1945.

On 15 November, tropical cyclone *Sidr* made landfall in Bangladesh, generating winds of up to 240 km/h and torrential rains. More than 8.5 million people were affected and over 3,000 died. Nearly 1.5 million houses were damaged or destroyed. Often hit by cyclones, Bangladesh has developed a network of cyclone shelters and a storm early-warning system, which significantly reduced casualties.

Australia's 2006/2007 tropical season was unusually quiet, with only five tropical cyclones recorded, equalling the lowest number observed since at least 1943-44.

Relatively small Antarctic ozone hole

The 2007 Antarctic ozone hole was relatively small due to mild stratosphere winter temperatures. Since 1998, only the 2002 and 2004 ozone holes were smaller. In 2007, the ozone hole reached a maximum of 25 million square kms in mid-September, compared to 29 million square kms in the record years of 2000 and 2006. The ozone mass deficit reached 28 megatonnes on 23 September, compared to more than 40 megatonnes in the record year of 2006.

Record-low Arctic sea ice extent opened the Northwest Passage

Following the Arctic sea ice melt season, which ends annually in September at the end of the northern summer, the average "sea ice extent" was 4.28 million square kms, the lowest on record. The "sea ice extent" at September 2007 was 39% below the long-term 1979-2000 average, and 23% below the previous record set just two years ago in September 2005.For the first time in recorded history, the disappearance of ice across parts of the Arctic opened the Canadian Northwest Passage for about five weeks starting 11 August. Nearly 100 voyages in normally ice-blocked waters sailed without the threat of ice. The September rate of sea ice decline since 1979 is now approximately 10% per decade, or 72,000 square kms per year.

Sea level rise continues

The sea level continued to rise at rates substantially above the average for the 20th century of about 1.7 mm per year. Measurements show that the 2007 global averaged sea level is about 20 cm higher than the 1870 estimate. Modern satellite measurements show that since 1993 global averaged sea level has been rising at about 3 mm per year.

***** Information sources**

This is a joint press release issued in collaboration with the Hadley Centre of the UK Meteorological Office, the Climatic Research Unit, University of East Anglia, UK, and in the USA: NOAA's National Climatic Data Centre, National Environmental Satellite and Data Information Service, National Snow and Ice Data Centre and NOAA's National Weather Service. Other contributors are WMO Member states: Argentina, Australia, Brazil, Canada, China, Fiji, France, Germany, Iceland, India, Japan, the Netherlands, New Zealand, Sweden and Tunisia. The African Centre of Meteorological Applications for Development (ACMAD, Niamey), the Australian Commonwealth Scientific and Industrial Research Organization (CSIRO), the Centro Internacional para la Investigación del Fenõmeno El Niño (CIIFEN, Guayaquil), the IGAD Climate Prediction and Applications Centre (ICPAC, Nairobi), the SADC Drought Monitoring Centre (SADC DMC, Gabarone) and the World Climate Research Programme (WCRP) also contributed.

Source: WMO Website http://www.wmo.ch on December 15, 2007. WMO Press Release # 805.

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

CMOS Accredited Consultants
Experts-Conseils accrédités de la SCMO

Top 10 Canadian Weather Stories for 2007

by David Phillips[1]

Abstract: Canadians might remember 2007 as the year that climate change began biting deep and hard on the home front. At the top of the world, the dramatic disappearance of Arctic sea ice - reported in September - was so shocking that it quickly became our number one weather story. Indeed, the United Nations declared the record loss of ice as one of the world's biggest events. The thinning and shrinking of the ice, largely a result of too many consecutive warm years, has had a profound impact on northern residents - people, plants and wildlife alike. The disappearance of water from the Great Lakes system is also a concern, especially Lake Superior where water levels in September dipped to their lowest point since measurements began in 1900. In many ways, the record loss of ice and water is more about climate than weather and underlines that climate change is beginning to affect Canada in a very real way.

At times in 2007, the West had too much weather. Residents on the Prairies witnessed a record number of severe summer weather warnings, with tornadoes, intense rainfalls, wind storms and hail storms. August's destructive hailstorm in Dauphin, Manitoba, for example, was only one of 279 hailers that affected the Prairies in 2007. Crop-hail losses approached $200 million and, for the first time, exceeded premiums. There was also an enduring high humidity on the Prairies that became unbearable and suffocating, culminating in a new Canadian record humidex of 53 set at Carman, Manitoba. On the other hand, southern Ontario had very little weather with one of its driest summers in over 50 years - part of a ten-month dry spell that lasted from January to October and produced record dry conditions in many locations in the region.

Winters at the beginning and end of the year provided stark contrasts and two more weather stories. The shocker of a green Christmas Day in 2006 in Quebec City, Timmins and Thunder Bay - where a white Christmas is all but guaranteed - turned out to be a one-year blip. For snow and ice enthusiasts, the beginning of 2007 continued the quest for winter. When it did come, while persistent, it was too late. Nature tried to make amends at the end of 2007 with some pre-winter blasts of cold, freezing rain and lots of snow, making the first half of December 2007 a white one to remember.

Also dominating this year's top weather stories were menacing floods in British Columbia. With a record deep mountain snow pack, the threat of flooding tormented thousands of residents for months. But while devastating floods occurred in the central interior and north coast, lucky residents along the Fraser River were spared when a major storm changed direction at the last moment. Luck was also a factor in Elie, Manitoba, when Canada's first documented F5 intensity (the highest rating on the internationally recognized Fujita tornado damage scale) tornado with winds above 420 km/h touched down on June 22. Most residents were away when the tornado struck.

In Atlantic Canada, one of the big stories was the passage of Hurricane Noel in November. While no Juan, Noel's winds and waves destroyed several beaches, wharves and docks. Fortunately, there were no casualties. People were well prepared and seemed respectful of the potential destructive power of the massive storm. While property damage from weather extremes like Hurricane Noel cost Canadians millions of dollars in 2007, the price tag was less than we've seen in recent years. Thankfully, deadly tornadoes, devastating hurricanes, widespread droughts and plagues were a "no show" for this year.

In general, it was another warm year for Canada - the 11th year in a row - although not as warm as it has been in recent years. The year tied for the second warmest winter on record, some 3°C warmer than normal. Summer was the seventh warmest at about 1.0°C warmer than usual, and from January to November the national average temperature was around 1.0°C above normal. Every region was warmer, especially the Eastern Arctic, which experienced its fourth warmest January-to-November period on record. Globally, it was also another warm year according to the World Meteorological Organization (WMO). Surface temperatures averaged 0.4°C above the annual average of 1961-1990 and the northern hemisphere was estimated to be the second warmest on record since the beginning of the 20th century.

The following Top 10 Canadian Weather Stories for 2007 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.

[1] Senior Climatologist, Meteorological Service of Canada, Downsview, Ontario, Canada

Top Ten Weather Stories for 2007

1	**Vanishing Ice at the Top of the World**
2	**BC's Long Flood Threat**
3	**Pre-Winter Weather Mayhem from Coast to Coast**
4	**Tropical Summer on the Prairies**
5	**Oh So Dry in Southern Ontario**
6	**Big Bad Noel but No Juan**
7	**Great Lakes - How Low Will They Go ?**
8	**A Winter that Wasn't - Almost !**
9	**Record Prairie Hailer**
10	**Canada's First F5 Tornado**

1. Vanishing Ice at the Top of the World

On September 12, satellite images over Arctic waters revealed that sea ice in the area had shrunk to about 4 million square km - a minimum not seen for possibly more than a century. The ice shrinkage stunned scientists, who found 23 per cent less sea ice than the previous record of 5.3 million square km in 2005. It was as if an ice chunk the size of Ontario had disappeared in one year. Since 1971, and particularly since 1990, sea ice in the Arctic Ocean has been decreasing significantly on a hemispherical scale. But this year's "big melt" was a shocker.

The main channel through the Canadian waters of the Northwest Passage was nearly ice-free and completely navigable for about five weeks in August and September. Of its 2,300 km length, there was only about 20 km of ice instead of the usual 400 km. In 2007, ships as small as sailboats could have plied the normally ice-infested waters of the venerable Passage -- and nearly 100 vessels did.

The unprecedented shrinkage of Arctic sea ice is a direct response to several years of favourable Arctic winds pushing old ice into the Atlantic, as well as persistent, year-round warming of the North and a dramatic transformation of its surface from a highly reflective white snow or ice to dark heat-absorbing sea water. The last two winters were the warmest on record in northern Canada, with 2005-2006 the warmest in the past 60 years. Further, 5 of the 10 warmest years in the past 60 have occurred since 2001. The last cold winter occurred nearly 15 years ago.

This year's Arctic ice shrinkage (similar to what some climatologists envisioned would happen 30 years from now) meant the 2007 fall freeze-up started from a huge deficit, making it harder for the ice to grow back and increasing the likelihood that sea ice will shrink even more next summer. Scientists are now even more convinced that the Arctic climate system is heading toward a more ice-free state during the summer months, and that human-caused global warming is playing a significant role. And while the disappearing ice is having an immediate impact on northern peoples, the effects of this unprecedented loss outside the Arctic is uncertain. What we do know is that ice exerts an enormous control on global climate and its sudden loss could have profound impacts on weather well beyond the Arctic's borders.

2. BC's Long Flood Threat

In early spring, experts from the British Columbia River Forecast Centre began bracing for and warning of the potential for the worst flooding in the province's history. While most were focussed on wild wind storms and falling trees, the mountain snowpack was accumulating at a record rate. It was great news for skiers and unprecedented numbers enjoyed the deep snow, but the growing snowpack was a threatening menace to those along swollen water courses, especially in north-coastal British Columbia and in the south along the Fraser River. Adding concern was the loss over years of huge tracts of lodgepole pine decimated by the pine beetle, reducing the watershed's ability to store and slow release meltwater.

Snow water content ranged from a low of 83 per cent of normal in the Okanagan to 130 to 165 per cent of normal along the coast, in the north and in central regions. In the Fraser River, basin snowpack was amongst the largest measured since 1953, when detailed snow measurements began, and only slightly below that of 1972 when major flooding occurred. Officials began distributing close to five million sandbags to various "hot spots" and soldiers were ordered into the Lower Mainland in anticipation of rising waters.

In early April, unseasonably cool, wet weather not only delayed the melt but continued the build-up of snow. A month later, the snowpack had not diminished much and was ripening rapidly. Experts outlined a worst-case scenario: week-long heat followed by heavy rains before the usual peak river flow in June. Right on cue, hot weather arrived in late May with five days of +30°C temperatures. Scorching weather from Vancouver to Burns Lake smashed more than two dozen temperature records by 3 to 5°C, rapidly melting the mountain snowpack and swelling water courses in the Fraser River system and in the North-West. Behind the heat was more bad news – a widespread rain-bearing storm poised to move inland from the Pacific Ocean, escalating the flood risk for the Fraser River and the Lower Mainland. As it happened, the frontal system largely missed the Fraser watershed concentrating instead on the Bulkley and Skeena basins to the north.

Over the course of the spring, the British Columbia River Forecast Centre reported a number of significant flood events:

- The Nechako River peaked near a 50-year return period flow, and stayed at that extreme high for a five- to six-week period.

- The Bulkley River (at Smithers) exceeded its 100-year return period.

■ The Skeena River experienced a 35-year return period event.

Along the banks of the Skeena, the City of Terrace was nearly marooned when rising waters and landslides forced the closure of several roads and highways and swamped rail lines. In the Bulkley-Nechako and Kitimat-Stikine basins, rising waters washed out secondary roads, shut down a bridge and cable ferry and led to the closure of a highway. Food and fuel hoarding started in Prince Rupert and Smithers, where flood waters rose to their highest levels in more than 80 years.

In the south, the long worry was over. By June 11, all monitored rivers had peaked or were falling. In the end, levels on the Fraser River never challenged the heights of near-flood years. The Fraser Valley avoided a catastrophe when cooler temperatures returned and a soppy storm diverted away at the last moment, sparing thousands of hectares of farm and residential land, avoiding the evacuation of tens of thousands of residents and saving an estimated cost-loss of $6 billion.

3. Pre-Winter Weather Mayhem from Coast to Coast

Before winter officially got underway on December 22, winter weather struck with vengeance right across the country. On the first days of December, up to 50 centimetres of snow fell on parts of Vancouver Island followed by a warm soppy rain in excess of 100 mm. It was brutally cold across the Prairies with a -40 wind chill and a massive storm from Colorado spread meteorological mayhem into Ontario and Quebec. In Atlantic Canada, a fierce winter storm was already underway, just ahead of the Colorado low that struck with a one-two wallop. For a time at the beginning of December, a white Christmas mantle covered Canada from coast to coast to coast.

Almost overnight on December 2, the Pacific coast swung wildly from one extreme to the other as warm tropical rains replaced a winter storm. Victoria and Vancouver avoided the big snow dump with only 12 cm, but the Vancouver Island community of Campbell River was buried under more than 50 cm of snow. The day after winter's first blast, a subtropical airmass from Hawaii -- dubbed the Pineapple Express -- ushered in warm air and drenching rains. With a forecast for 100 to 150 mm of rain in 24 hours, the British Columbia Ministry of the Environment issued a flood watch for Greater Vancouver, south and central Vancouver Island, Howe Sound and the lower Fraser Valley. In the interior, flood and avalanche watches were issued for upper reaches of the Fraser River where more than 200 mm of rain soaked the snowpack. The heavy snow-rain deluge kept students home from school, closed roads, cut power and created deadly driving conditions. Rising waters and avalanches isolated several interior communities for days.

On December 3, Ontario struggled through its first big winter storm that featured an ugly mixture of snow, freezing rain, ice pellets and rain. London got 60 cm of snow from the initial storm and from almost continuous lake-effect squalls over the next couple of days. Thousands of students stayed home for two days as icy roads and blowing snow made travel treacherous, especially north of London. Almost 200 drivers in the London area showed up at a local collision reporting centre on December 3, setting a record for the worst day ever for crashes. In Ottawa, the storm dropped 24 cm of snow in a 24-hour period. Montrealers dug out of more than 35 cm of snow, which was a record for December 3. Whipped by strong northeasterly winds up to 50 km/h, road surfaces in southern Quebec became treacherous and visibility was at times minimal.

The storm then moved on to Atlantic Canada, where residents were still recovering from a two-day blast to the region featuring snow and strong winds. During the initial storm, parts of northern mainland Nova Scotia and most of Cape Breton got 10 to 20 cm of snow and winds gusted to 90 km/h. When the second storm moved in from Ontario and Quebec, it focussed its force and misery all over Atlantic Canada. In New Brunswick, an additional 40 cm of snow fell onto what had already fallen a day before in blustery 70 km/h winds. Moncton ground to a halt with a combined two-day snowfall of 55 cm swirled in wind gusts peaking at 83 km/h. A storm-surge along the coast from Escuminac to Cape Tormentine coincided with the high tide, adding an extra 1.3 to 1.5 metres to the depth of the water. Halifax and Charlottetown were hit with 20 cm of snow fanned by winds of 90 km/h. Repair costs to electricity lines and towers in Prince Edward Island exceeded $1.5 million and were expected to take months to complete. Maritime Electric said it was by far the worst storm the utility has seen since the 1970s, if not the worst ever.

And it only got worse in Newfoundland and Labrador. Winds gusting up to 124 km/h created blizzard-like conditions along the Bonavista Peninsula and the southern part of the Avalon Peninsula. As much as 25 cm of snow blanketed the ground on December 2. The entire downtown of St. John's, Newfoundland was plunged into darkness. In eastern Newfoundland, snow and wind from a weekend storm toppled about two kilometres of transmission lines along with seven two-pole towers. The fact these main lines were in a remote and difficult terrain hampered repair efforts. Newfoundland Power officials said the storm - with its heavy, wet snow, thick ice and high winds - was one of the most damaging in the past 10 years. Close to 10,000 customers on the Bonavista Peninsula were without power for up to a week. In terms of snowfall, the largest on the Island was in Terra Nova National Park, where it was estimated close to 65 cm fell.

Then, a week before the first day of winter, winter-weary Easterners were digging out from another mammoth storm.

4. Tropical Summer on the Prairies

Each summer across the Prairies a couple of weeks of warm, sunny weather is expected and welcomed. But for several weeks this summer, hot, thick, and unusually sticky air tried the patience of many Prairie residents, playing havoc with everything from hospital surgeries to people's hair.

Calgarians suffered through their second hottest July on record, a mark set more than 70 years ago in 1936. Edmonton International Airport recorded its highest average July temperature at 18.4°C, eclipsing the high mark set only last year. It was a scorcher in the Alberta capital. On seven days, the maximum temperature soared above 30°C. Normally, only one day would hit that high in July, if at all. In Regina, it wasn't the hottest July on record, but the warmest most residents could remember. Three hotter Julys occurred in 1886, 1936, and 1937. The big talk was the uncharacteristically high humidity. The controlling weather system - a huge upper ridge situated in the American Midwest - was a little farther east than normal, enough to tap moisture from the Gulf of Mexico and move it into the Prairies. Combined with local sources from transpiring crops and evaporating surfaces soaked by copious spring rains, it filled the air with insufferable humidity. From July 22 to 24, Regina recorded 29 hours of humidex values above 40, including a reading of 48 for two consecutive hours, shattering the previous record of 44.5. Without question, it was the most uncomfortable spell of weather in Regina's history.

If it was sultry in Regina, it was downright oppressive in Carman, Manitoba. On July 25 at 3:00 p.m. CDT, Carman registered the day's maximum temperature at a sizzling 34°C with a dew point of 30° - literally jungle humidities. (It is unconfirmed, but the 30° dew point might be a new record high in Canada.) The combination of excessive heat and humidity generated a humidex rating of 53, breaking the all-time Canadian record of 52.1 set in Windsor, ON on June 20, 1953. On the same day, Winnipeg's humidex reached 48, breaking its all-time record of 46.1 set in 1996.

Unsafe humidity levels forced the cancellation of hundreds of elective surgeries at several hospitals across the west. High humidity compromises sterile equipment and increases the risk of post-operative infection. The elderly found it hard to cope with the high heat-humidity, which often causes nausea and dizziness from exhaustion and dehydration. Horses at Winnipeg's Assiniboia Downs were given time off because of the danger of heat stroke. Stores struggled to keep fans and air conditioners in stock. Finding air conditioning was only half the battle; getting it installed or serviced was a two-week wait. The warm moist air put a strain on utilities and helped establish a new summer record for power consumption, coming close to winter's record peak load. In some spots, bloated fish floated onto the shores of several overheated lakes, streams and reservoirs. "Summer kill" occurs when high temperatures and little or no wind create oxygen depletion, suffocating fish. Hundreds of dead ducks also turned up in lakes east of Calgary, probable victims of a toxin that thrives in hot, dry weather.

The extreme heat and humidity also wreaked havoc on crops, hitting canola and peas the hardest. Scorching temperatures and dry skies reduced grain yields and lowered quality across the West. In some areas, it was a disappointing year with a double weather whammy - a wet spring and torrid heat in summer. Excessive heat and dryness, however, meant fewer crop diseases and pest problems and advanced crop development.

5. Oh So Dry in Southern Ontario

For the majority of city dwellers in southern Ontario, it was a summer to remember with record warmth, perfect weekends and little weather. The number of hot days above 30°C ranged between 20 and 30 -- two to three times the normal. On the 31 weekend days and holiday Mondays from June 1 to Labour Day, Toronto had only five wet ones (often just a sprinkle). Most residents in the south didn't want summer to end. It was so pleasantly warm for so long that they either felt guilty or concerned that somehow they were soon going to pay for the excess of delightful weather.

What was good for campers and beach bums, though, was bad for farmers and gardeners. Although not a drought by Prairie standards, southern Ontario's drier weather could only be rivaled by conditions not seen in the region since the 1930s. You didn't need to be a climatologist to know record dryness was underway. Burnt grass, cracked soil, curled up leaves, shriveled corn cobs, and dying trees were the giveaways. Even dandelions were dying. Grass fires sparked by dry conditions prompted many local fire departments to slap bans on open fires. Water alerts were issued early and often. Scanty precipitation ravaged thousands of trees. Many died, while others just hung on or were badly stressed making them vulnerable to pests and disease. Arborists warned the disaster would be better revealed over the next two years.

Blessed with near-perfect spring weather, Ontario farmers planted a record corn crop estimated at 880,000 ha. The results were disappointing but yields varied as much as the rainfall, ranging between 40 and 550 bushels per hectare just a few concession roads over. On the other hand, fruit and grape growers in Niagara were delighted by the warmth, abundant sunshine and disease-free conditions. They couldn't recall a year with better fruit flavour.

The prolonged drought prevailed across a broad swath of Ontario from Chatham north to Peterborough. No area showed the wear-and-tear of drought more than Toronto. Toronto Pearson International Airport experienced its driest summer in nearly 50 years and a string of 95 consecutive days without a significant rainfall (above 12 mm) in the middle of summer. Moreover, it was a 10-month drought. Between January 1 and October 31, the Greater Toronto Area (GTA) experienced its second driest on record. Toronto received only 413.2 mm of precipitation, which is about two-thirds of normal levels. To the north in York Region, it was even drier. Aurora's rainfall totals from May to September amounted to a paltry 136 mm (compared to 215 mm in Toronto) and only 1/3 of the total rainfall in 2006. In Hamilton, between May and August inclusive, 141 mm of rain fell, which is only 37 per cent of the normal accumulation. It was the lowest rainfall total since record-keeping began in 1959, smashing the record set in 1966. In the country-side of Norfolk County, it was even drier with only 35 per cent of normal amounts from May to July inclusive -- the worst since 1936 when heat baked fruit on trees. It was so dry at times that the Ontario Ministry of Natural Resources asked anglers not to fish in some creeks, because water levels were so low it stressed fish. And so dry that the Delhi Horticultural Society had to cancel its flower show because the blooms had wilted.

6. Big Bad *Noel* but No *Juan*

Fifteen named storms, including six hurricanes, occurred in the North Atlantic during the 2007 hurricane season. Tropical storms numbered five more than usual, although their accumulated energy was well below normal because many of the storms were either weak or short-lived. While there were fewer hurricanes than anticipated, *Dean* and *Felix* reached Category 5 status and were big killers along with *Noel*.

Hurricane *Noel* was the most powerful storm to hit Atlantic Canada in 2007. Until its arrival in early November, the tropical storm season in Eastern Canada was looking like one of the quietest in 20 years. The only other tropical visitor was *Chantal*. It slammed into eastern Newfoundland and Labrador on July 31 causing several millions of dollars in damages. At Argentia, almost 200 mm of rain fell in 12 hours -- double the historic rainfall amount. Flooding rains washed out bridges and submerged roads, basements and parking lots. In St. John's, the storm forced the cancellation of the annual Royal St. John's Regatta, one of the oldest continuous sporting events in North America.

Noel was the second last of the year's tropical storms and also the deadliest. It wreaked havoc on the Dominican Republic, Haiti, Cuba and the Bahamas and in doing so killed more than 147 people before heading north. In Canadian waters, *Noel* was neither a hurricane nor a tropical storm but a huge, vigorous storm referred to by meteorologists as a post-tropical storm. Its centre moved into Canada near Yarmouth, Nova Scotia, crossing southeastern New Brunswick, the Gulf of St. Lawrence and finally moving through central Labrador. Fortunately, the storm arrived during the low monthly tide cycle, minimizing the danger of tidal surges or flooding. Ocean-wave heights peaked at 14 metres on Georges Bank. Sustained winds exceeded 135 km/h. In the Wreckhouse area of southwestern Newfoundland -- one of the windiest places in the world -- local winds gusted as high as 180 km/h.

The sprawling system extended over a million square kilometres. It dumped 60 to 80 mm of rain through southern New Brunswick and western Nova Scotia, and as much as 130 mm in northern Cape Breton Island, generating some minor street flooding and filling basements. The storm brought heavier rains to Québec's Gaspé -- 90 to 100 mm. Farther north, heavy snow in excess of 35 cm fell from Sept-Iles to Rimouski. In northern Labrador, about 20 cm of snow fell.

Noel was a nasty storm -- bigger than Hurricane *Juan* four years earlier, but much weaker -- causing a lot of damage and inconveniencing thousands of people, but sparing life and limb. Powerful winds took thousands of trees down, scattered fences and downed power lines across Atlantic Canada. At one point, almost 200,000 homes and businesses were without electricity. The greatest impact from *Noel* was the coastal damage done by huge powerful waves along the entire western half of Nova Scotia's Atlantic coast. Wind and wave action destroyed several beaches, hurled rocks and obliterated or severely damaged countless wharves, docks and fishing sheds. A mitigating factor was the storm's late arrival after most trees had lost their leaves. Still, Halifax's scenic Point Pleasant Park, which bore the brunt of Hurricane Juan, was hit again but with far less damage.

7. Great Lakes - How Low Will They Go ?

Trillions of litres of water have recently vanished from the Great Lakes -- a system containing 20 per cent of the world's fresh surface water. In September, Lake Superior set a record for its lowest water level for this time of year since measurements began in 1900. Persistent drought and warmer temperatures pushed levels 10 cm beneath the previous monthly low reached in 1926. Further, water flow from its outlet on the St. Marys River plunged, which bodes ill for the Great Lakes system because Lake Superior is the single largest source of water replenishing the four downstream lakes and the St. Lawrence River.

By December 1, water levels on Lakes Michigan-Huron were also sagging, more than two-thirds of a metre below average and about a metre lower than a decade ago. Water levels were just 8 cm higher than their 1964 record low for the same time and the lowest they have been in December since then. Whereas Ontario and Erie were down one-quarter and one-fifth of a metre from the long-term average, respectively, levels of the St. Lawrence River at Montreal were more than one metre below average -- its lowest since modern records began in 1967.

But it was Lake Superior that garnered most of the attention and explanation. Its levels have been consistently below average for 10 years. More telling though, from June 2006 to May 2007, water supply to the lake was the lowest for any 12-month period on record. Of note, Superior's precipitous decline was halted dramatically in October when the northern basin got a "monsoonal" drenching of twice its normal rainfall. The water supply in October was a new record maximum with some 20 per cent more than the previous record for that month. Instead of falling 4 cm, which it normally does in October, Superior's watermark rose 14 cm. On November 1, levels were 20 cm higher than they were six weeks before. However, by month's end, low supply conditions had returned to Lake Superior.

Rapidly shrinking water levels were a big challenge for commercial navigation. Freighters had to reduce their draft, thus lightening their loads by upwards of 10 per cent. Shallower waters also disrupted spawning grounds for fish and wetland wildlife, and created hardship for recreational boaters. Several marinas undertook dredging, while many private owners were left high and dry. As well, hydro-electric generation was reduced due to lower flows in the system.

Falling water levels in the Great Lakes have raised questions about the impact of climate change. Are we seeing much sooner what scientists forecasted would happen decades from now? There is no question that Superior's levels are being driven down in part by a lack of precipitation. In 2006, Lake Superior basin-wide precipitation was at its lowest since the mid-1920s, pushed down even further in early 2007. In recent years, the snowpack has been unusually scanty. Further, the lake is getting warmer, both above and below the surface. From 1979 to 2006, summer water temperatures rose about 2.5°C, twice as much as the overriding air. With half the winter ice cover found 30 years ago, more of Lake Superior's water is being lost to evaporation year-round. All this is setting up a pattern of "warmer water, less ice, more evaporation" that is leading to lower water levels.

8. A Winter That Wasn't - Almost !

At mid January, the ground in Eastern Canada was soft, lakes and rivers were free of ice, there was no snow, and leaves were still on trees. Nature was confused and snow fans were depressed. Generally, Canadian winters have become warmer and drier, but following the warmest winter on record in 2005-2006, there was a sense and hope by some outdoor enthusiasts that this winter would be more typical. With the emergence of a warm El Niño, the odds increased for another soft and open winter. Owing to a persistent flow from the south and west, much of Canada experienced an incredibly mild beginning to winter. Until the third week of January, winter's temperatures were closer to those expected in fall and spring. In Alberta, warm winds heightened the avalanche threat. In normally frozen Winnipeg, it rained in January and spring-like weather encouraged hordes of golfers in Montreal. In Niagara region, ice wine producers sat idly by as birds ate their grapes. In Québec, the maple sap ran for two weeks in January – puzzling growers as to whether it was good or bad news. In Halifax, buds were swelling and bulbs were sprouting.

The beginning of winter in December 2006 was spectacularly mild across Canada, setting a record for the warmest in the past sixty years. By the first official day of winter, most Easterners still hadn't experienced any significant cold or snow. Less than a centimetre of snow had fallen in Toronto. Similarly, Montréal had 11 cm by December 21 compared to 75 cm by the first day of winter in 2005. And it wasn't until January 16, before Montréal recorded its first cold day below -20°C. By that time, the city should have had eight or more on record.

It wasn't winter's record warmth that became the big talk, but its persistence - day-after-day, week-after-week and now month-after-month. Was this the year when winter would be cancelled? Was the Canadian reputation as the great white north in question?

It was even too warm to fake or make the white stuff. A protracted January thaw dealt a crippling blow to Ontario ski operators. Blue Mountain Resorts laid off over 1,300 seasonal and part-time employees for more than three weeks. It was the first time the resort had been forced to shut down after a season opening. With such mildness, a lot of mice, bats, rats and other pests were busy breeding not sleeping. Even frogs, flies and bees were out and about. African animals at the Toronto Zoo were spending hours outdoors. The mindset was that winter was cancelled. For beleaguered retailers, long underwear sales stalled and snow shovels and winter boots filled store shelves. The good news was that the mild weather meant lower heating bills. In the first half of winter, residents in Ontario and Québec saved 15 to 20 per cent on their home heating bills. Municipalities saved millions in snow removal costs and re-deployed workers for pothole repair. With air temperatures more like April than January and the ground free of frost, construction workers put in long hours in unseasonably mild and dry conditions. Paramedics reported fewer cases of frostbite and hypothermia. And it wasn't cold or snowy enough to warrant weather-induced heart attacks.

Apart from areas directly to the lee of the Great Lakes, total seasonal snow didn't amount to much. At Toronto, it was the second least snow amount ever in winter - 60.3 cm compared to a norm of 115.4 cm. Prince Edward Island broke an all-time record for low snowfall totals. Charlottetown's total snowfall barely got above 100 cm by the end of February (46 per cent of its normal amount). Halifax and Sydney, Nova Scotia and Moncton, New Brunswick also received less than half their normal snow totals to the end of February. For Montréal, arguably the snowiest major city in the world, only 56 per cent of its normal October-to-February snowfall occurred.

As an aside, snow was plentiful in Western Canada. Alberta cities were white most of the winter. In Calgary, nearly 50 per cent more snow than normal fell, and in Edmonton snowfalls amounted to 28 per cent higher than normal. At British Columbia's ski resorts, snowfall totals approached record amounts and the number of skier visits was way up. With two months of skiing to go at some resorts, they were already about to surpass last year's nearly six million visits. Snow bases at Grouse and Seymour near Vancouver varied between 400 and 500 cm in early spring. Whistler boasted its best year ever with a snow base of 300 cm well into June.

Eventually, winter did come to the East. During the second half of January, cold Arctic air began to inch across central and eastern Canada. It had been the longest delay of winter weather in eastern Canadian history. Winter's first storm, albeit two months late, created the usual "first storm" chaos with traffic snarls, flight delays and cancellations, slips and falls, parked school buses, and long waits for road-service battery boosts and tows. On January 20, Montréal received its first major snowfall of 20 cm. Throughout the day, hundreds of cars slid off snow-covered highways or slammed into other vehicles in a rash of minor fender-benders as snow blanketed southern Québec. Winter's cold might have been late coming but it persisted for weeks. By February 18, Toronto counted 30 straight non-melting days. The cold caused thousands of residential and city pipes to freeze and break. For patient backyard ice makers, it was the best six weeks ever without a thaw.

In the final wrap-up, winter in the East lasted about six weeks - not even close to the six months it can sometimes feel like.

9. Record Prairie Hailers

Weather forecasters were kept busy on the Prairies with the most active summer ever for severe weather. Abundant spring rains followed by excessive heat and humidity and an active jet stream was the perfect recipe for violent weather. Alberta, Saskatchewan and Manitoba had the most number of summer severe weather events ever (410 in total) eclipsing the previous high of 297 set only last year. Especially frequent were the number of hail events, setting record numbers for all three provinces.

It was a "hail" of a summer for the insurance sector. Summer storms pulverized crops, battered homes and businesses and pockmarked vehicles at a rate not seen in more than a decade. According to the Canadian Crop Hail Association, Albertans filed over 4,700 crop-related hail claims - the highest ever by far, exceeding $60 million or 27 per cent more than that collected from premiums. Saskatchewan counted nearly 14,000 crop-damaged hail claims, exceeding the five-year average but lower than the total recorded in 2006. Total payouts were estimated at $115 million for an 87 per cent loss-to-premium ratio. Hail storms were so frequent in Saskatchewan that many farmers reported multiple hits, especially in the Kindersley and Biggar area. In some instances, the first claim was still being settled when hailers struck a second or third time. The frequency of storms was up and so was the severity. In places, crops were totaled and property damage was extensive to homes, vehicles and farm equipment. Next door in Manitoba, crop claims topped $14 million, shattering the previous record of $10.6 million in 2002. Total claims were just shy of 5,000, which was very close to the record in 2000.

The most spectacular hailer occurred on August 9 in Dauphin, Manitoba and nearby communities. The 30-minute storm featured a multitude of lightning flashes, intense rain, screaming winds and enormous hailstones - some the size of grapefruits. Around Grandview, Roblin and Ste. Rose, it took only minutes to destroy healthy crops only days from harvest. In Dauphin, the storm triggered about 13,000 claims to Manitoba Public Insurance (MPI) with an estimated loss of $53 million - one of the single largest catastrophic events in MPI history. More than 60 per cent of damaged vehicles in town were total write-offs. Truckloads of replacement windshields and dozens of workers were brought in from Brandon and Winnipeg to handle repairs. Most buildings suffered dented roofs and lost shingles. Contractors estimated property repairs could take as long as two years to complete. The hailer shredded backyard gardens into cole slaw, denuded trees, smashed greenhouses and punched fist-size holes in once-inflatable plastic roofs.

10. Canada's First F5 Tornado

An F5 tornado is the most powerful tornado in the Fujita intensity-scale, packing winds that exceed 420 km/h. They account for less than 1 per cent of all tornadoes in the world and, until 2007, none had ever been officially recorded in Canada. On June 22, Canada's first F5 tornado touched down at 6:25 p.m. just north of the Trans-Canada Highway near Elie, Manitoba, about 40 km west of Winnipeg. The localized tornado, 300 metres wide, stayed on the ground for about 35 minutes and tracked about 5.5 km, before lifting into the air. Its top wind speed was estimated between 420 and 510 km/h. Thankfully, there were no fatalities or serious injuries. Many residents were out of town attending a high school graduation ceremony, and those who were home knew what to do, seeking shelter in basements and placing mattresses over their head.

The force and devastation of the tornado were unbelievable. Its strong winds sandblasted the bark off trees and severed utility poles as if they were toothpicks. The tornado picked up an entire house and carried it a few hundred metres through the air, where it exploded. Streets and nearby fields were littered with debris from trashed buildings. Winds pushed two semi-trailers off the highway, leaving one truck twisted like a pretzel a few hundred metres away in the middle of a field.

The next day another night of severe weather occurred when multiple tornadoes ripped through southern and western Manitoba. The worst damage was south of Baldur, 75 km southeast of Brandon, where an F3 twister struck with wind speeds between 253 and 330 km/h. The winds snapped more than 200 hydro poles across the south and uprooted hundreds of trees in Whiteshell Provincial Park. Winds also knocked over several Manitoba Hydro towers and damaged more than 1,000 cottages. At least three people from a RV park went to hospital. Eight tornadoes in one weekend is highly unusual in Manitoba - that's two-thirds of the tornadoes reported in the province in all of 2007.

Canada ranks second in the world for tornado occurrences, experiencing an annual average of 80 to 100. The United States is number one with an average of 1,000 to 1,200 each year. While Canada has never recorded an F-5 tornado before this year, the United States usually reports one or two yearly.

Source: Meteorological Service of Canada - Environment Canada - Government of Canada, The Green Lane™ Website, 27 December 2007.

Les dix événements météorologiques canadiens les plus marquants de 2007

par David Philips[2]

Les Canadiennes et les Canadiens se souviendront peut-être de 2007 comme de l'année durant laquelle les changements climatiques ont commencé à se faire sérieusement sentir dans leur pays. Au “sommet du monde”, la disparition des glaces marines de l'Arctique - remarquée en septembre - a été si frappante qu'elle a rapidement été classée comme l'événement météorologique le plus marquant. En effet, les Nations Unies ont déclaré que la perte de glace record constituait l'un des principaux événements mondiaux. L'amincissement et le rétrécissement de la banquise, résultant en grande partie d'un trop grand nombre d'années chaudes consécutives, ont eu un impact majeur sur les résidents du Nord - tant sur les personnes que sur les plantes et les espèces sauvages. La disparition de l'eau du réseau des Grands Lacs est aussi une préoccupation, particulièrement en ce qui a trait au lac Supérieur, où les eaux sont tombées en septembre aux niveaux les plus bas depuis 1900, année où l'on a commencé à prendre des mesures. À divers égards, la perte de glace et d'eau record est liée plutôt au climat qu'aux conditions météorologiques, et elle met en relief le fait que les changements climatiques commencent à avoir des effets tangibles au Canada.

À certains moments de l'année 2007, l'Ouest a connu trop d'intempéries. Les résidents des Prairies ont reçu un nombre record d'avertissements de temps violent au cours de l'été, notamment pour des tornades, des pluies abondantes, des tempêtes de vent et des tempêtes de grêle. Par exemple, la tempête de grêle dévastatrice du mois d'août à Dauphin, au Manitoba, n'a été que l'une des 279 averses de grêle qui ont frappé les Prairies en 2007. Les récoltes perdues en raison de la grêle ont été évaluées à près de 200 millions de dollars et, pour la première fois, elles ont dépassé les primes demandées. Les habitants des Prairies ont aussi dû tolérer une humidité très élevée, devenue insoutenable et suffocante, qui a établi un nouveau record humidex canadien de 53 dans la ville de Carman, au Manitoba. À l'inverse, le sud de l'Ontario a eu droit à peu d'intempéries, l'été 2007 ayant été l'un des plus secs depuis plus de 50 ans, s'inscrivant dans une période de sécheresse qui a duré dix mois, de janvier à octobre. Durant cette période, des conditions de sécheresse records ont été enregistrées dans plusieurs lieux de la région.

Les hivers du début et de la fin de l'année ont créé un contraste frappant et constituent deux autres événements météorologiques retenus. Le choc causé par un jour de Noël vert en 2006 à Québec, à Timmins et à Thunder Bay - là où un Noël blanc est généralement garanti - s'est avéré le phénomène d'une seule année. Les amateurs de neige et de glace ont continué au début de l'année 2007 leur quête d'un hiver digne de ce nom. Et lorsque l'hiver est arrivé, bien que persistant, il était trop tard. La nature a semblé vouloir se racheter à la fin de 2007 en nous envoyant des périodes de froid préhivernales, de la pluie verglaçante et de grandes quantités de neige, faisant ainsi de la première moitié de décembre 2007 une période enneigée dont on se souviendra.

Dix événements météorologiques marquants en 2007

1	**Disparition des glaces au " sommet du monde "**
2	**Menace persistante d'inondations en Colombie-Britannique**
3	**Conditions météorologiques préhivernales chaotiques d'un océan à l'autre**
4	**Été tropical dans les Prairies**
5	**Ah que le sud de l'Ontario est sec !**
6	**Tempête *Noël* dévastatrice, contrairement à *Juan***
7	**Les Grands Lacs : jusqu'où le niveau de l'eau baissera-t-il ?**
8	**Un hiver manqué - ou presque !**
9	**Grêle record dans les Prairies**
10	**Première tornade de catégorie F5 au Canada**

Parmi les autres événements météorologiques marquants de cette année, mentionnons les crues menaçantes en Colombie-Britannique. En raison d'une accumulation annuelle de neige record en montagne, des milliers de résidents ont craint durant des mois d'être inondés. Et alors que des inondations dévastatrices ont eu lieu dans la région centrale intérieure et sur la côte nord, des résidents chanceux des abords du fleuve Fraser ont quant à eux été épargnés puisqu'une tempête importante a changé de direction au dernier instant. La chance a été une fois de plus au rendez-vous lorsque la première tornade de catégorie F5 enregistrée au Canada (la catégorie la plus élevée de l'échelle Fujita sur l'intensité des tornades, échelle reconnue internationalement), avec ses vents de plus de 420 km/h, a touché le sol le 22 juin à Elie, au Manitoba. La plupart des résidents étaient absents lorsque la tornade a frappé la ville.

(Suite en page 19)

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

Local-Scale Controls on Hydrologic Responses to Climatic Variability

by Sean W. Fleming[1] and R.D. (Dan) Moore[2]

Résumé (traduit par la direction): Les configurations de la circulation atmosphérique sont devenues un sujet clé bien organisé dans l'évaluation des impacts hydrologiques de la variabilité climatique interannuelle. Par contre, des chercheurs, travaillant dans une direction opposée, ont souvent utilisé les mesures hydrologiques (particulièrement pour l'écoulement fluvial) pour arriver à définir des signes climatiques associés aux configurations de la circulation, et ceci est valable aussi pour des tendances à long terme (Ebbesmayer *et al,* 1991). Dans les deux cas, il est important de comprendre le pourquoi et le comment du filtrage des signes climatiques provenant des caractéristiques hydrologiques terrestres à l'échelle locale. On rencontre de plus en plus d'articles qui traitent de l'effet des propriétés du bassin hydrographique sur les liens entre les configurations de l'écoulement fluvial et les modes organisés de la variabilité du climat. Les résultats suggèrent que l'effet final (grandement non linéaire dans quelques cas) du filtrage à l'échelle du bassin démontre que les réactions hydrologiques pour éliminer des modes - ainsi que les conséquences concomitantes aux écosystèmes, à l'alimentation en eau, aux ressources halieutiques, à la production d'énergie électrique, et ainsi de suite - peuvent différer fortement entre des bassins hydrographiques adjacents. Le but de cet article est de faire la promotion pour une prise de conscience du sujet et de ses implications, et aussi d'identifier des orientations pour la recherche à venir.

Atmospheric circulation patterns have become a key organizing theme for assessing the hydrologic impacts of interannual climate variability. Working in the opposite direction, hydrologic metrics (particularly streamflow) have often been used to help define climatic signals associated with circulation patterns, as well as longer term trends (*e.g.*, Ebbesmayer *et al.*, 1991). In both cases, it is important to understand whether and how local terrestrial hydrologic characteristics filter climatic signals. A small but growing literature has been exploring the effects of watershed properties on the linkages between streamflow patterns and organized modes of climate variability. Results to date suggest the net effect of this (in some cases, highly nonlinear) basin-scale filtering is that hydrologic responses to climate modes – and thus the attendant consequences to ecosystems, water supplies, fisheries resources, hydroelectric power generation, and so forth – can differ strongly between even adjacent watersheds. The purpose of this article is to promote awareness of the subject and its implications, and identify some key directions for future research.

Circulation patterns and terrestrial hydrology

Climate modes can be defined as repeating patterns of time–space variability in the climate system (Wang and Schimel, 2003), and may comprise the dominant forms of global climate variability (Wallace and Thompson, 2002). Some of the more widely known and hydroclimatologically relevant circulation patterns include El Niño-Southern Oscillation, the Arctic Oscillation, Pacific-North America pattern, North Atlantic Oscillation, and the Pacific Decadal Oscillation. Climate mode behaviour is generally characterized by an index time series (*e.g.*, Southern Oscillation Index for ENSO), and/or as a climatological event or shift history defined in a discrete manner (*e.g.*, PDO regime shifts). Associated timescales depend greatly on the circulation pattern, but for our purposes generally range from a couple of years to decades. These coherent modes of climatic variability affect regional surface meteorology, and thus hydrologic dynamics, via complex teleconnection patterns. Such teleconnections are generally assessed using a variety of statistical or time series analysis or modelling techniques, including but not limited to correlation analysis, empirical predictive (*e.g.*, regression or neural network) models, spectral and cross-spectral analysis, wavelet analysis, singular spectrum analysis, and composite analysis. A large body of work, developed over about the last 20 years, has directly demonstrated the profound effects of large-scale organized atmospheric circulation patterns upon river flows, and that the patterns provide a holistic, compact and convenient way to capture climate effects on hydrological systems.

As useful as they are, however, most of the hydroclimatological analyses and interpretations to date have assumed, usually implicitly, that (1) a watershed behaves as a simple, more-or-less linear bucket, and (2) streamflow responses to low-frequency climatic forcing should be strongly regionally coherent, directly reflecting the strong spatial correlation typically present in climatic variability. In reality, watersheds are complex, open, nonlinear, spatially extended dynamical systems, with properties that can vary greatly between individual catchments. Additionally, unlike most meteorological variables, streamflow is not a continuous spatiotemporal field but an inherently discretized one, with the watershed divide forming the most fundamental discontinuity.

[1] BC Hydro, Burnaby, BC & Department of Geography, University of British Columbia Vancouver, B.C.

[2] Department of Geography, University of British Columbia, Vancouver, B.C.

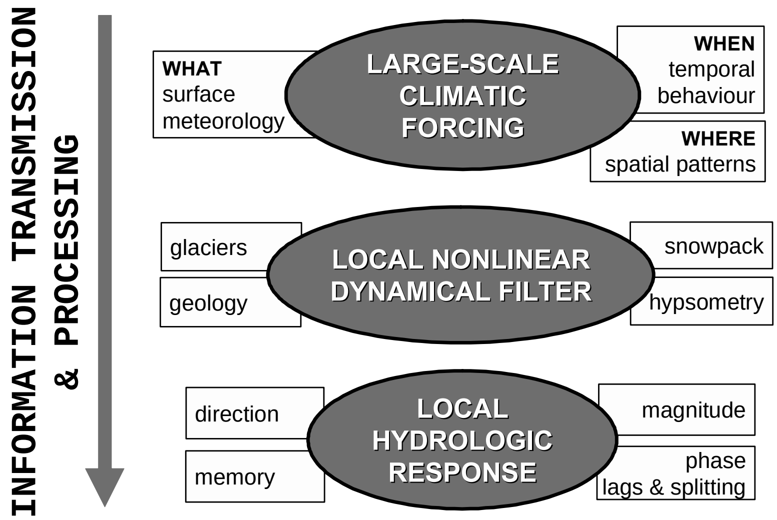


Figure 1. Schematic representation of how local-scale terrestrial hydrologic properties and processes control the direction, magnitude and timing of streamflow responses to low-frequency climatic signals, often resulting in fundamental differences in hydroclimatic dynamics between even adjacent watersheds.

These elementary truths raise the possibility that adjacent watersheds could respond differently to the same climatic forcing. This premise has recently been borne out by a series of studies. Below, we briefly summarize work which has demonstrated how hydrologic responses to circulation patterns can differ systematically from one basin to the next within a given hydroclimatic region.

Effects of local watershed characteristics

Neal *et al.* (2002), Lafrenière and Sharp (2003), and Fleming *et al*. (2006) considered the comparative responses of glacier- and snowmelt-fed rivers to (respectively) PDO, ENSO, and the Arctic Oscillation in Alaska, Alberta, and Yukon. Each found hydroclimatic effects fundamentally different between the two fluvial regimes. For example, Lafrenière and Sharp (2003) discovered diametrically opposite streamflow responses to an El Niño event between close-by glacial and nival rivers, loosely consistent with work elsewhere considering longer timescales (Fleming and Clarke, 2003). Such contrasting responses arise primarily from the presence or absence of a glacial ice reservoir that is available for melt production.

In a continental-scale study, Chen and Kumar (2002) demonstrated that local terrestrial hydrologic regimes modulate the timing of North American fluvial responses to ENSO. ENSO is phase-locked to the annual cycle, and associated North American meteorological anomalies tend to be strongest in winter. Rainfall-driven watersheds respond relatively quickly to such anomalies. In contrast, the wintertime precipitation impacts of ENSO in colder, snowmelt-driven watersheds are generally stored as snowpack until the spring-summer melt season, inducing a phase lag between ENSO forcing and fluvial response.

A particularly diverse set of behaviours was identified by Fleming *et al*. (2007), who considered the detailed monthly responses of 21 rivers in the Georgia Basin-Puget Sound transboundary ecoregion of southwest British Columbia, Canada and northwest Washington State, USA under ENSO and PDO forcing. The combination of a relatively temperate, maritime climate with strong elevation differences – ranging from sea level to > 1000 m over horizontal distances of a few kilometres – has long been known to yield three hydrologic regimes. These are pluvial (single, rainfall-driven wintertime freshet in lower-elevation catchments), nival (single, snowmelt-driven spring-summer freshet in higher-elevation catchments), and hybrid (both rainfall-driven winter, and snowmelt-driven spring-summer, freshets in catchments spanning a wider elevation range). In general, the spatial distribution of these different types of catchments does not follow any straightforward horizontal gradient, and different regime types often occur in adjacent watersheds. Similar to the findings of Chen and Kumar (2002), ENSO and PDO streamflow anomalies in pluvial systems generally showed little or no phase lag relative to the (dominantly winter-season) timing of the associated meteorological anomalies, whereas nival systems exhibited a discrete phase lag of several months. Additionally, however, hybrid systems exhibited a phase split, with the predominantly wintertime meteorological signal distributed between both the winter (rainfall) and spring-summer (snowmelt) freshets, and little or no hydrological effect in the two sets of intervening months. Moreover, an additional hydroclimatic regime was identified, dubbed the nival-supported pluvial regime, which shows nonlinear climate-driven state transitions. This watershed type has a pluvial regime under El Niño and (for some catchments) neutral ENSO states. Under La Niña and (for other catchments) neutral ENSO conditions, sufficient snow accumulated at higher elevations to yield a spring-summer freshet in addition to the winter freshet, “flipping” the river to a hybrid regime. The effect arises in watersheds which appear to span an elevation range intermediate between hybrid and strictly pluvial regimes.

In addition to the horizontal spatial discontinuity of the watershed divide, there is also vertical hydrologic heterogeneity. Water table fluctuations in shallow aquifers are important in terms of groundwater supply, and also through the fact that discharge from these aquifers tends to moderate temperature and flow variability in the streams to which they are coupled, with significant ecological consequences. Recent work in the lower Fraser Valley of British Columbia (Fleming and Quilty, 2006) illustrated that water tables show ENSO signals generally similar to those in adjacent pluvial-regime streams, but with both a discrete phase lag and significantly greater seasonal memory. That is, groundwater responses to ENSO are not only typically delayed relative to precipitation and streamflow responses, but are also “smeared out” over time. The effect presumably reflects the greater storage capacity of aquifers, and the lag and attenuation associated with vertical percolation through the unsaturated zone (Jackson *et al.*, 1973; Gottschalk, 1977; Fleming, 2007).

The foregoing suite of results has two important implications. First, local-scale terrestrial characteristics can result in the hydrological processing of climatic information in distinctive and potentially nonlinear ways (Figure 1). In response to a given climatic forcing function, streamflow anomalies may show little phase lag (pluvial regime), a strong phase shift (nival regime), or phase splits (hybrid regime). Selective or inverse teleconnectivity to a given climate mode can also arise between close-by rivers (glacial versus nival regimes); nonlinear, climate-driven flow regime transitions can consistently occur (nival-supported pluvial regime); and spatially superimposed, and hydrologically linked, surface water and shallow groundwater systems may exhibit quite different degrees and types of climatic memory.

Second, even regionally coherent anomalies in meteorological forcing associated with a given climate mode can elicit different magnitudes, directions, and/or timing of hydrologic response within a region and even between adjacent watersheds – a fact that may have far-reaching practical consequences. For instance, in a region with interspersed glacial and nival rivers (such as much of BC and western Alberta), it may be difficult to transfer information from gauged to ungauged basins, a common approach for regional assessment of water resources. Another example is the geographically diverse suite of no-phase-lag, large-phase-lag, and phase-splitting behaviour observed for various rivers in the Georgia-Puget region. Streamflow strongly influences quantity and quality of fish habitat. However, salmonid life histories are generally phase-locked to the annual cycle, so that the ecological implications of high- or low-flow anomalies, as associated for instance with ENSO and PDO, can differ fundamentally depending on what time of year they occur. Thus, the lotic ecological impacts of ENSO and PDO may differ fundamentally from one stream to the next in that region. Other implications include river-to-river differences in potential climatic implications for hydroelectric power and water resource planning and management.

Directions for future work

Future studies should extend the approaches described above to other regions. In mountainous regions, where most of the previous work has been conducted, catchment relief tends to be the dominant ultimate control on differential response to climate modes. In other areas with less relief, other catchment characteristics may become important, such as the volume of lake storage within a catchment, the depth of surficial aquifers, or the types and extents of land uses such as agriculture, forestry, and urbanization.

For instance, the streamflow impacts of urbanization have been broadly recognized for generations, but it is not clear how such impacts interact with those from low-frequency climatic variability at watershed scales. Some preliminary work suggests complexities related to timescale: a strongly urbanized catchment appeared to show ENSO signals at least as strong as those observed for pristine rivers, but clearly attributable PDO signals were absent (Figure 2). If this initial finding holds up to further scrutiny, it may simply reflect the suite of hydrological changes well-known to be associated with urbanization, and in particular, how their timescales interact with those of ENSO *vs.* the PDO. Urbanization generally induces a loss of water storage capacity in the landscape, reducing the ability of watershed processes to buffer short-term meteorological variability. Thus, meteorological signals associated with ENSO, a quasi-periodic process with timescales of about 2-7 years and event durations of a few months or so, might be expected to be clearly expressed in composite analyses of ENSO streamflow signals in an urbanized catchment. Conversely, the process of land use change itself is typically a gradual process, and the landscape changes associated with urbanization thus tend to occur progressively over a period of decades. Their hydrologic impacts may thus obscure the hydrological signals associated with the PDO, which operates on timescales of roughly 40-50 years. Note that this result does not by any means imply that the PDO has no significant effect on urbanized streams, but rather that its signal may be obfuscated or overwhelmed by long-term land-use changes.

Further research should address the stationarity of the linkages between climate modes and hydrologic response. For example, in glacier-fed catchments, warming trends or cycles may cause streamflow increases (Fleming and Clarke, 2003) or, over longer time scales, decreases (Stahl and Moore, 2006). Transient glacier response to climate shifts may complicate the identification of coherent responses to climatic signals, analogous to the effect of gradual urban development as described earlier. Transient responses may be particularly important in regions subject to widespread forest disturbances, such as large forest fires and the ongoing Mountain Pine Beetle outbreak in western Canada.

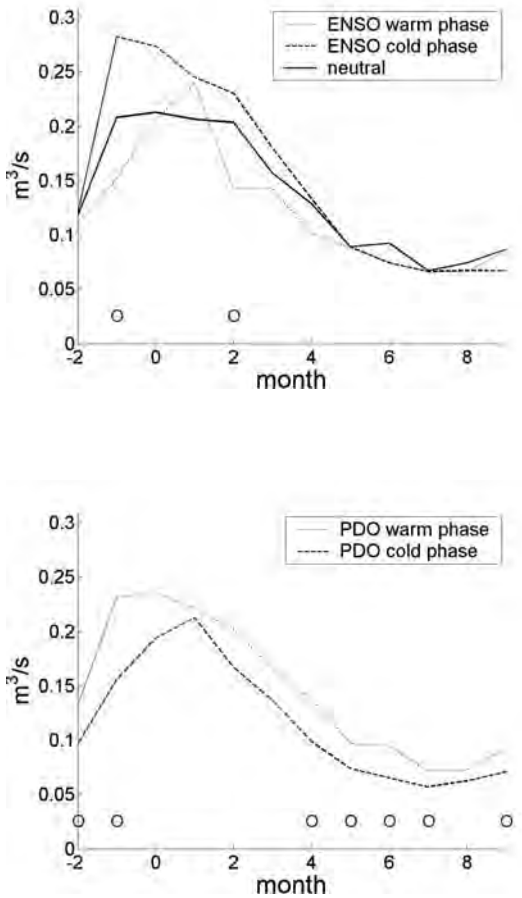


Figure 2. Composite analysis of streamflows for Leech Creek, a small watershed in the Seattle-Tacoma area of Washington State which has undergone extensive urbanization over the decades. Hydrologic years are considered (-2 = October, through 9 = September of the following calendar year). An open dot indicates mean conditions significantly different ($p < 0.05$, Monte Carlo bootstrap test) for that month between any two ENSO states, or between the two PDO states. ENSO responses for Leech Creek are similar to those for more pristine pluvial watersheds in the region, mainly reflecting greater winter rainfall in La Niña years. In contrast, PDO responses are opposite to those observed for more pristine pluvial streams in the Puget Sound region, and also opposite to those expected under the meteorological anomalies associated with PDO here (cooler and wetter in the PDO cold phase). The Leech Creek hydrometric record spans only a single PDO shift, so the PDO composite analysis amounts to a split-sample test for intervention (*i.e.*, a comparison of expectation values from the early, nominally cold-phase *vs.* late, nominally warm-phase parts of the hydrometric record). In this case, it seems the PDO composite analysis instead picked up the effects of gradual but ultimately strong changes in hydrologic dynamics under land use change and urban stormwater engineering, including but not limited to construction of both a detention pond for flood protection and a complex stormwater redistribution infrastructure (COT, 2007).

In addition to considering local watershed characteristics, future studies should examine spatially and temporally finer-scale complexities in local surface meteorological responses to climate modes. Meteorological teleconnection mapping has historically tended to focus on wintertime effects, as this is when such teleconnections are generally strongest and most widespread, but other effects may be present and hydrologically important. For example, Fleming and Whitfield (2006) demonstrated that although the central and southern interior (high plains to semi-arid) region of British Columbia shows on average a wintertime decrease in precipitation under El Niño conditions, similar to that observed in adjacent south coastal locations, the region also experiences a summertime precipitation increase during the ENSO warm phase, not seen on the coast. The local summer rainfall increase is conjectured to arise from ENSO-induced spring-summer temperature increases, and hence heightened summertime convective storm activity, which is not experienced to any significant degree by adjacent temperate coastal areas. This spatially localized pattern of seasonally opposite precipitation anomalies may have significance for streamflow patterns, though this has not yet been examined.

The water quality impacts of low-frequency climate variability have not been nearly as well studied as the water quantity implications. Only a few statistically meaningful examples of the former exist (*e.g.*, Foreman *et al.*, 2001; Kiffney *et al.*, 2002), likely due in large part to the relative scarcity of long-term, reliable water quality time series in watersheds with negligible local anthropogenic effects. By the same token, little or no effort has been made to identify whether and how local terrestrial biogeochemical characteristics modify such circulation pattern-driven temporal water quality variability between watersheds. Although a key direction for future analytical research, the first and foremost step may be to ensure that long-term, high-quality, high-frequency water quality datasets are collected and made freely and readily available to the open scientific community, with a particular emphasis on pristine catchments to serve as controls.

References

Chen, J., Kumar, P. 2002. Role of terrestrial hydrologic memory in modulating ENSO impacts in North America. *Journal of Climate*, 15, 3569–3585.

COT. 2007. *Surface Water Services*. City of Tacoma Public Works Department. At: http://www.cityoftacoma.org/Page.aspx?hid=924.

Ebbesmeyer, C.C., Cayan, D.R., Milan, D.R., Nichols, F.H., Peterson, D.H., Redmond, K.T. 1991. 1976 step in the Pacific climate: forty environmental changes between 1968-1975 and 1977-1984. *Proceedings of the Seventh Annual Climate (PACLIM) Workshop*, April 1990 (California Department of Water Resources, 1991).

Fleming, S.W. 2007. Artificial neural network forecasting of nonlinear Markov processes. *Canadian Journal of Physics*, 85, 279-294.

Fleming, S.W., Clarke, G.K.C. 2003. Glacial control of water resource and related environmental responses to climatic warming: empirical analysis using historical streamflow data from northwestern Canada. *Canadian Water Resources Journal*, 28, 69-86.

Fleming, S.W, Moore, R.D., Clarke, G.K.C. 2006. Glacier-mediated streamflow teleconnections to the Arctic Oscillation. *International Journal of Climatology*, 26, 619-636.

Fleming, S.W., Quilty, E.J. 2006. Aquifer responses to El Niño-Southern Oscillation, southwest British Columbia. *Ground Water*, 44, 595-599.

Fleming, S.W., Whitfield, P.H. 2006. Statistical identification of surface meteorological signals in British Columbia, Yukon, and southeast Alaska associated with Pacific ocean-atmosphere circulation patterns, *Canadian Water Resources Association Annual Conference*, Vancouver.

Fleming, S.W., Whitfield, P.H., Moore, R.D., Quilty, E.J. 2007. Regime-dependent streamflow sensitivities to Pacific climate modes across the Georgia-Puget transboundary ecoregion. *Hydrological Processes*, 21, 3264–3287.

Foreman, M.G.G., Lee, D.K., Morrison, J., Macdonald, S., Barnes, D., Williams, I.V. 2001. Simulations and retrospective analyses of Fraser watershed flows and temperatures. *Atmosphere-Ocean*, 39, 89-105.

Gottschalk, L. 1977. Correlation structure and time scale of simple hydrologic systems. *Nordic Hydrology*, 8, 129–140.

Jackson, R.E., Gilliland, J.A., Adamowski, K. 1973. Time series analysis of the hydrologic regimen of a groundwater discharge area. *Water Resources Research*, 9, 1411-1419.

Kiffney, P.M., Bull, J.P., Feller, M.C. 2002. Climatic and hydrologic variability in a coastal watershed of southwestern British Columbia. *Journal of the American Water Resources Association*, 38, 1437-1451.

Lafrenière, M., Sharp, M. 2003. Wavelet analysis of inter-annual variability in the runoff regimes of glacial and nival stream catchments, Bow Lake, Alberta. *Hydrological Processes*, 17, 1093–1118.

Neal, E.G., Walter, M.T., Coffeen, C. 2002. Linking the Pacific decadal oscillation to seasonal discharge patterns in southeast Alaska. *Journal of Hydrology*, 263, 188–197.

Stahl, K., Moore, R.D. 2006. Influence of watershed glacier coverage on summer streamflow in British Columbia, Canada. *Water Resources Research*, 42, W06201, doi:10.1029/2006WR005022.

Wallace, J.M., Thompson, D.W.J. 2002. Annular modes and climate prediction. *Physics Today*, 55, 28–33.

Wang, G., Schimel, D. 2003. Climate change, climate modes, and climate impacts. *Annual Review of Environment and Resources*, 28, 1–28.

Les dix événements météorologiques canadiens les plus marquants de 2007

Suite de la page 14

Dans le Canada atlantique, l'un des événements majeurs a été le passage de l'ouragan *Noël* en novembre. Bien que plus faible que *Juan*, *Noël* a amené des vents et des vagues qui ont détruit plusieurs plages, quais et docks. Heureusement, il n'y a eu aucune victime. Les gens étaient bien préparés et ont semblé bien saisir le pouvoir de destruction de cette grosse tempête. Bien que les dommages à la propriété résultant de phénomènes météorologiques extrêmes comme l'ouragan *Noël* aient entraîné en 2007 des pertes se chiffrant dans les millions de dollars, celles-ci étaient moindres que celles des dernières années. Nous pouvons remercier la nature de nous avoir fait grâce cette année de tornades mortelles, d'ouragans dévastateurs, de sécheresses de grande étendue et de fléaux.

En général, l'année 2007 a été une autre année chaude pour le Canada - la 11e année d'affilée - quoiqu'elle n'ait pas été aussi chaude que les dernières années. L'année a été marquée par le deuxième hiver le plus chaud jamais enregistré, dépassant de quelque 3 °C la température normale. Nous avons connu le septième été le plus chaud avec des températures excédant de près de 1 °C les températures normales et, de janvier à novembre, la température moyenne au niveau national était d'environ 1 °C au-dessus des normales. Toutes les régions ont connu du temps plus chaud et l'est de l'Arctique tout particulièrement : il a eu droit à sa quatrième période la plus chaude enregistrée pour les mois de janvier à novembre. Selon l'Organisation météorologique mondiale (OMM), l'année 2007 a aussi été, à l'échelle mondiale, une autre année chaude. Les températures moyennes à la surface étaient de 0,4 °C au-dessus de la moyenne annuelle enregistrée entre 1961 et 1990. De plus, on estime que l'hémisphère nord a connu cette année la deuxième température moyenne la plus chaude enregistrée depuis le début du XXe siècle.

Les événements météorologiques les plus marquants de 2007 énumérés en page 14 sont classés de un à dix en fonction de certains facteurs comme l'impact qu'ils ont eu sur le Canada et les Canadiennes et 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.

Source: Service Météorologique du Canada - Environnement Canada - Gouvernement du Canada, Site web La voie verteMC, 27 décembre 2007.

Precipitation
Theory, Measurement and Distribution

by Ian Strangeways

Cambridge University Press, New York, 2007
ISBN 0-521-85117-3, 290pp, Hard Cover, US$130

Book reviewed by Edwin Campos[1]

General description of sectio ns and chapters
The first section of this book starts by discussing past and current theories of precipitation formation, followed by a description on the methods used for measuring rain and snow. A summary of various climate analyses is then presented, which are based on raingauge measurements at various places around the globe. The last section gives recommendations on how raingauges should be used in the future.

Brief summary of content and critique of several or of each chapter, noting new idea s, strengths and weaknesses
Chapters 1 and 2 seem more like a careful summary of the work by Middleton (1965, "A History of the Theories of Rain and Other Forms of Precipitation", London, Oldbourne). The definition of diffraction, on page 36, is inaccurate. In chapter 3, the definitions of saturation mixing ratio, specific humidity and water vapour content (in page 59) need improvement. The concept of Rayleigh scattering is used (in page 61) without being previously explained. When commenting on net radiation (p.63), it should be recalled that melting snow and melting ice are also related to latent heat flux, and that the atmosphere and ocean convection also depend on the net radiation. Equations for the Reynolds number (in p.65) and the ideal gas laws (in p.67) are introduced in this chapter, but are not used anywhere else in the book.

Chapter 4 presents images of different cloud types, but the cloud classification becomes unclear sometimes, because there is no reference to distance in the pictures. For example, Figure 4.3 (upper) could be classified as stratocumulus instead of cumulus humilis, and Figure 4.5 could be classified as cumulus mediocris instead of cumulus congestus. Hurricanes, typhoons and cyclones are introduced here within the list of clouds formed by convection, which is misleading since tropical cyclones are much more than cloud types. The Coriolis force and vorticity words are used here (p. 84), even though its concepts have not yet been explained. Weather systems are again improperly mixed within cloud types, when discussing extratropical cyclones and warm fronts (pp.88-89). In the section on Measuring clouds (p.101), it will be important to mention the capabilities of vertically pointing radars (e.g., Fabry and Zawadzki, Journal of the Atmospheric Sciences, 1995). When discussing the searchlight technique (p.103), the equation "h = L tanE" is wrong, because we also have to consider the height of the Alidad (i.e., "h + h_alidad = L tanE").

Chapter 5 presents equations 5.1 and 5.2 for the nucleation energies, but the reader still needs a definition for the Gibbs free energy, the vapour pressure and the saturation vapour pressure. A better definition of coalescence is required in pp.108-109, and the caption in Figure 5.1 should recall that there are raindrops larger than 5 mm.

Chapter 6 provides a fair description on how lightning forms and how it is measured. However, the best part of the book is in Chapters 7 and 8. These two chapters describe the raingauge measurements in good detail, and these are adequate places to include an explanation on how one millimetre of rain corresponds to 1 kg of water per square metre. (Notice that the basic unit for measuring rainfall is the millimetre of rain, which may look obvious for the meteorologist or the hydrologist, but it is not a conventional unit of the international units system.) Somewhere in Chapter 8, the author should recognize that one of the best descriptions of the rain is given by its raindrop size distribution. This chapter is also a good place to include a description on other types of distrometers (different from the old impact-sizing models) and its current applications in radar calibration.

The inconveniences of measuring snow with gauges are briefly presented in Chapter 9, and more discussion should be included here about remote-sensing techniques. The inset image in Figure 9.1 (lower right section) is of poor resolution, and the reader cannot distinguish much from such a blurring picture.

A brief discussion on weather radar is given in Chapter 10. Unfortunately, it does not state the important differentiation between a volume rainfall measurement and a point rainfall measurement. Recall that a raingauge measurement corresponds to a point near the ground, while a radar rain measurement corresponds to a relatively-large volume located aloft. Given that "the purpose of measuring rain is usually to estimate areal averages rather than to obtain a single-point observation" (as stated in p.237 of this book), the radar then provides a superior representativeness than the raingauge. Therefore, this should be a fundamental chapter in the book. For that, this chapter needs to be extended further in topics such as vertically pointing radar, radar hardware and dual polarization. Definitions are required for the reflectivity (actually reflectivity factor,

[1] Research Scientist, Environment Canada, Toronto, Ontario, Canada

noticing in p.191 that Z is not the returned energy but a quantity proportional to the returned energy) and the Doppler velocity. In page 195, the differences between rainfall estimates by weather radar and by raingauge should not be called errors, since these are mostly differences due to instrument representativeness. Recall also that stratiform precipitation type can be identified simply by detecting the bright band (using the same radar), allowing an adjustment in the Z-R relation that increases the accuracy of radar rainfall estimates. It is true that raingauges are more precise, but the key point here is on accuracy. After the radar rainfall estimation has been optimized (e.g., by eliminating ground clutter and bright-band signals), the radar can provide a much more detailed and accurate estimation of the rainfall in a basin.

Chapter 11 deals with measuring precipitation from satellites. The reader will need an explanation of what is a Cassegrain telescope (p.209) and a dichroic mirror (p.210). When discussing sounders (p.216), the text does not explain how a radiation vertical profile is retrieved. Examples with values of these vertical profiles should be included as well. The equation in p.217, which tried to express the Plank's radiation law, is wrong.

On the global distribution of precipitation, Chapter 12 presents some datasets currently available for climate analyses. The chapter can be improved by adding more figures on information available in these datasets. Figure 12.1 is a good example, but it is also too small. The chapter discusses possible reasons for the present decrease in raingauge stations. However, the text should recognize that this decrease is also due to newer and better methods for precipitation measurements using remote sensors. It will be important to add a discussion on the current needs of precipitation estimation for weather forecasting, for hydrology forecasting, and for the analysis of precipitation patterns at the regional scale, at the mesoscale, and in complex terrain.

The following chapter (Chapter 13) provides conventional climate analyses of rainfall time series from raingauges. The Y axis and caption in Figure 13.1 need correction. They should read something like "annual mean from area averages of precipitation anomalies, expressed in number of standard deviations around the mean". The same axis correction is needed in Figure 13.3. It is not clear the specific station that corresponds to the data in Figure 13.4. This chapter should also include discussion on the spatial distribution of precipitation (information already present in New et al. 2000 and 2001, i.e., the publications used as source for various figures in this chapter), noticing that features such as tropical cyclones, the Inter-Tropical Convergence Zone, and orographic enhancements could be identified here using remote-sensing estimations of rainfall.

Chapter 14 gives a discussion on how the global precipitation patterns are affected by the El-Niño-Southern-Oscillation, the North Atlantic Oscillation, the Arctic and Antarctic Oscillations. The lower Y axis and caption in Figure 14.3 are misleading. These should correspond to something like "anomaly in pressure differences for Tahiti minus Darwin, given in number of standard deviations around the mean". A figure similar to 14.6 or 14.7 should be included when discussing the North Atlantic Oscillation.

The last chapter concludes the book with a biased opinion on the future of precipitation measurement. The chapter states that raingauges should remain as the gold standard for precipitation measurements, and proposes the utopia of a sophisticated raingauge network conformed by thousands of new stations. The discussion here requires a more objective and contemporary view, where raingauges are simply used as calibration tools for remote-sensing measurements of precipitation. The discussion should also include the numerous applications that are now possible in the fields of weather forecasting and cloud physics.

Note on style, organization and readability

The book is easy to read. A few acronyms needs to be defined in the text (although already defined after the Preface), such as RH (p.51), SVP (p.92), AWS (p.157), and RS (p.205).

The organization can be improved by presenting the satellite techniques (Chapter 11) before the weather radar techniques (Chapter 10). Another suggestion is to move all the history sections into an appendix or a separate section at the end of the book. In that way, the reader can first assimilate the current understanding of the subject matter, and after that appreciate better the challenges faced by scientists during the early stages of meteorology.

Overall appreciation

The book title implies a formidable task: To provide a contemporary discourse on the vast topic of precipitation science. This challenge is faced in a very unconventional way, since the book presents (meteorology) history and (atmospheric) physics in a mixed context. As well, the book minimizes the use of equations and provides a simple reading. Overall, the book overview is incomplete but sufficient (as reasonably expected from a first edition).

Recommendation for specific audiences

The first page of the book identifies as audience those researchers in environmental science and climatology, water and flood managers, policy makers in climate change, and scientific historians.

However, research scientists will find very little mathematics and only basic physical concepts in this book. Environmental managers may not appreciate the meteorology history, the instrumental details, or the physical theories on precipitation formation.

Certainly, the book is of interest for meteorologists, hydrologists, climatologists and scientific historians. They will enjoy a refreshing reading on concepts that should be familiar to them.

The Economics of Climate change: The Stern Review

by Nicholas Stern

Cambridge University Press, 2007
ISBN-13 978-0-521-700801, 692pp, Paperback

Book reviewed by Lewis Poulin[2]

This important book is one that elegantly connects the dots among the science, economics, mitigation, adaptation and policy aspects of climate change. It starts by saying it like it is: “Climate change is the greatest example of market failure we have ever seen”.

The book came about after the British Government “commissioned Sir Nicholas Stern in July 2005 to lead a major independent review of the economics of climate change, in order to develop a more comprehensive understanding of the nature of the economic challenges and how they can be met. The Stern Review reported on 30 October 2006.” (British Treasury web page) The report is online via http://www.hm-treasury.gov.uk/ (click on independent reviews). The book version appeared in 2007.

Don’t let its hefty 692 pages scare you away. Those with little reading time have a four-page Summary of Conclusions or a nine-page Postscript. The book’s 27 chapters can be quickly reviewed as they each start with blue-coloured boxes of key messages. And throughout the text, main points are presented as bold print sentences.

Any way you read it, it’s easy to appreciate the Review’s six main conclusions:

■ There is still time to avoid the worst impacts of climate change, if we take strong action **now**;

■ Climate change could have very serious impacts on growth and development (especially for the poorest countries and populations);

■ Costs of stabilizing the climate are significant but manageable; delay would be dangerous and much more costly;

■ Action is required across all countries and need not cap aspirations for growth of rich or poor countries;

■ A range of options exists to cut emissions: strong, deliberate policy action is required to motivate their take-up;

■ Climate change demands an international response, based on a shared understanding of long-term goals and agreement on frameworks for action.

The chapters themselves are grouped into six main parts.

In part 1, “The Science of Climate change: Scale of the Environmental Challenge”, Chapter 1 gives a comprehensive 16-page overview of the science of climate change dating from early 2007. In Chapter 2, “Economics, Ethics and Climate change” it is explained why climate change is a free market failure called an externality in economics jargon. “Producers of greenhouse gases impose climate change costs on the world and future generations without producers themselves having to face directly or via markets, the full consequence of the costs of their actions.” This helps explain why ethics and its connection to public policy are important in this global challenge.

In part 2, “Growth and Development around the world”, Chapter 3 describes how climate change will affect people including potential implications like access to food, water, stress, health, well-being and the environment. Chapter 4 confirms developing countries are the most vulnerable to climate change as it will also exacerbate poverty. Chapter 5 highlights impacts on the developed world. Those impacts will become increasingly negative if climate responds in non-linear fashion. Chapter 6 details the economics modeling work to estimate monetary costs of climate change along with extra work undertaken specifically for the Review.

In part 3, “The Economics of Stabilization”, Chapter 7 describes the many processes that generate greenhouse gases. Neat summary diagrams are included. It’s disconcerting to learn that though 2.7 trillion barrels of oil equivalent (boe) have been consumed to date, apparently 7 trillion more are within society’s reach and are likely to be consumed at an accelerating pace unless policies and economic tools stabilize emissions.

The next 3 chapters clearly show us that stabilization of CO_2 is within reach. Chapter 8 explores emission paths associated with stabilizing emissions in the 450-550 ppm CO_2 equivalent range, a difficult challenge: do we stabilize near 440 ppm (very costly and unlikely since we’re already at 430 ppm) or do we let concentrations rise to 550 ppm (with associated much higher risks of consequences)? Chapter 9 shows how rising fossil fuel costs coupled with practical technology-based estimates of achieving a low carbon economy could allow GHG emissions to be reduced to ¾ of current levels by 2050 at relatively low cost. “A globally rational world should be able to tackle climate change at low cost”. Chapter 10 compares international behavioural modeling exercises and reaffirms that climate change mitigation is ‘technically and

[2] Research Scientist, Meteorological Service of Canada, Dorval, Québec, Canada

economically feasible with 2050 costs most likely to be around 1% GDP, +/- 3 %.

The impacts of mitigation strategies are presented in Chapter 11. "Countries most reliant on energy-intensive goods and services may be the hardest hit". Chapter 11A presents carbon-intensity rankings for 123 U.K. production sectors. Most carbon-intensive scores go to: Fertilizers, Cement, Electricity production and distribution, Refined petroleum and Gas distribution. A table with Canadian data would be useful.

It's not all bad news. Climate change policies are good for business. Chapter 12 focusses on the many opportunities likely resulting from a shift to a low carbon economy: how good climate change policies help root out inefficiency, how energy policy can contribute to enhance energy security and lower air pollution.

Chapter 13 makes the case for taking bold steps now to put in place a Climate change policy: the science and economics are clear, strong action is necessary and urgent, current evidence suggests stabilization in the 450-550 CO_2e range, uncertainty is an argument for more demanding goals (to minimize adverse effects of climate change's worst case scenarios) and the more societies dislike risks and are concerned about developing countries then the more ambitious climate change policies should be.

In parts 4 to 6 of the book the focus now shifts to developing policy.

Part 4 "Policy response to Mitigation", starts with chapter 14 focussing on what should be the backbone of any mitigating policy: eliminate the GHG externality. A good policy will price carbon to ensure GHG emissions are priced to reflect the damage they cause. (Note: "Estimating volumes of air through various engines in an urban setting" *CMOS Bulletin SCMO Vol. 34, No. 4 Aug 2006, pp.116-124*, was the reviewer's attempt at describing how we could monitor our use of air, as a proxy for GHG, in an effort to personalize the impacts and costs associated using fossil fuels).

Chapter 15 discusses how markets for emissions reductions can be put in place to promote a shift to a low carbon economy. Advice is offered for dealing with Power and heavy industry, road transport, aviation and agriculture and land use sectors – all sectors also of interest to Canada.

Chapter 16 covers innovation and the importance of policies that harness and encourage innovation in developments of new technologies. Again, for innovation to work, the GHG market externality must be removed.

Chapter 17 identifies strategies that help remove barriers to action, particularly for encouraging opportunities for energy efficiency and behavioural changes.

In part 5, "Policy responses for Adaptation", Chapter 18 affirms that we are committed to unavoidable impacts from climate change and lays out reasons why adaptation policies should also not be denied. In most cases, the benefits from adaptation provide local benefits that go beyond the cost of adaptation strategies. This is a chapter for our urban planners.

Chapters 19 and 20 describe adaptation for developed and developing countries respectively. In both cases, the earlier adaptation strategies are put in place, the greater the benefits and the lower the costs. If temperature averages increase beyond the 3°C to 4°C range, then costs may increase exponentially and "very serious risks of abrupt and large-scale change come into play". The example is given of a society losing a vast but unsubstitutable resource (e.g. glacier meltwater) where populations may have little choice but to migrate to another region.

Developing countries need extra help for adaptation. They need ongoing development assistance that also takes climate change into account, the need to build wealth locally, and international assistance to pay for their likely higher costs of adaptation.

Part 6 on "International Collective Action" focusses on requirements for effective global policies. This portion of the book should be of interest to policy experts and foreign affairs.

Chapter 21 provides an overview of what is required for effective collective action. The Montreal Protocol is presented as a practical example that collective action can work. Chapter 22 examines "the challenge of creating a valid price for carbon around the world". Chapters 23 and 24 describe how the transition to a low carbon economy and innovation of low carbon technology can be accelerated. Chapter 25 considers policies that may provide opportunities to reverse emissions from land use, like economic incentives to reduce deforestation. Chapter 26 examines how international agreements can often go hand in hand with national efforts. So we can think and act locally and globally.

Chapter 27, with only 5 pages, reiterates the challenge: action is urgently required, very strong reductions in carbon emissions are necessary, there is a need for clear long-term goals for stabilisation, countries need to agree on mutual responsibilities and participation must be broadened at every opportunity. Collective action is required starting from now.

So how can all this information be used?

The online copy makes it accessible to all. It's easy to mine the text for particular topics. A local community group mined the online Review for the word "aviation" and used their results to enhance their dossier on a local airport issue by including concerns relating to aviation and climate change.

The book can be useful as a reference document on development issues at all levels. I wish I had read the Review before formally asking my borough to include risk management and adaptation strategies associated with climate change impacts in our urban plan. I could have presented a more solid case. Progressive communities will have already familiarized themselves with the concepts of the Stern Review. All levels of government should make use of its insights.

The book is a great knowledge-based economy example that shows how one government, by thinking globally and acting locally, managed to produce a landmark document for the global community.

The Stern Review lays down solid points and arguments for those interested in resolving Climate change problems. The British, since then, have already published "Moving to a global low carbon economy: implementing the Stern Review", describing what they've done to date and plan on doing, at home and abroad, to reduce greenhouse gas emissions. Canada should do the same, and more.

The developed world became very rich by using the free market. We owe it to Planet Earth to address climate change by correcting our "greatest example of market failure we have ever seen".

Oups !

In the Book Review written by Ken Devine *(CMOS Bulletin SCMO*, Vol.35, No.6, pp. 187-188, the last sentence for Chapter 13 should have read:

"A two and a half century of annual rainfall in the UK showed an upward trend of more then one percent per CENTURY".

The author of the review apologizes for this error.

Books in search of a Reviewer
Livres en quête d'un critique

Nonlinear Dynamics and Statistical Theories for Basic Geophysical Flows, by Andrew J. Majda and Xiaoming Wang, Cambridge University Press, 2006, pp.551, ISBN 0-521-83441-4, Hardback, US$90.

The Equations of Oceanic Motions, by Peter Müller, Cambridge University Press, ISBN # 0-521-85513-6, 2006, pp.291, Hardback, US$80.

The Chronologers' Quest: The Search for the Age of the Earth, by Patrick Wyse Jackson, Cambridge University Press, ISBN # 0-521-81332-8, 2006, pp.291, Hardback, US$30.

The Gulf Stream, by Bruno Voituriez, IOC Ocean Forum Series, UNESCO publishing, ISBN# 978-92-3-103995-9, Paris, 2006, pp.223.

Solitary Waves in Fluids, Editor: R.H.J. Grimshaw, Wessex Institute of Technology Press, ISBN 978-1-84564-157-3, pp.183, Hardback, February 2007, US$130.

Inter-Basin Water Transfer, Case Studies from Australia, United States, Canada, China and India, Fereidoun Ghassemi and Ian White, International Hydrology Series, Cambridge Universtiy Press, ISBN 978-0-521-86969-0, Hardback, pp.435, US$165.

Numerical Modeling of Ocean Circulation, Robert B. Miller, Cambridge University Press, ISBN 978-0-521-78182-4, Hardback, pp.242, US$65.

Radiation in the Atmosphere: A Course in Theoretical Meteorology, by Wilford Zdunkowski, Thomas Trautmann and Andreas Bott, Cambridge University Press, ISBN 978-0-521-87017-5, Hardback, 2007, pp.482, US$135.

Human Impacts on Weather and Climate, by William R. Cotton and Roger A. Pielke Sr., Second Edition, Cambridge University Press, ISBN 978-0-521-60056-9, Paperback, US$55, pp.308 + 12 colour plates.

Fishers' Knowledge in Fisheries Science and Management, Edited by Nigel Haggan, Barbara Neis and Ian G. Baird, Coastal Management Sourcebooks 4, UNESCO Publishing, ISBN 978-92-3-104029-0, 2007, Hardback, pp.437.

Marine Habitat and Cover, Their Importance for Productive Coastal Fishery Resources, John F. Caddy, Oceanographic Methodology Series, UNESCO Publishing, ISBN 978-92-3-104035-1, 2007, Hardback, pp.253.

Seeking Sustainability in an Age of Complexity, by Graham Harris, 2007, Cambridge University Press, ISBN 978-0-521-87349-9, pp.366, US$130.

The Geomorphology of the Great Barrier Reef, by David Hopley, Scott G. Smithers and Kevin E. Parnell, Cambridge University Press, ISBN 978-0-521-85302-6, 2007, pp.532, US$150.

Lagrangian Analysis and Prediction of Coastal and Ocean Dymanics, Edited by Annalisa Griffa, A.D. Kirman, Jr,, Arthur J. Mariano, Tamay Özgökmen, and Thomas Rossby, Cambridge University Press, ISBN # 978-0-521-87018-4, 2007, Hardback, US$160.

An Introduction to Atmospheric Thermodynamics, by Anastasios A., Tsonis, Cambridge University Press, ISBN 978-0-521-69628-9, 2007, pp.187, US$55.

Ebb and Flow: Tides and Life on our Once and Future Planet, by Tom Koppel, The Dundurn Group, Toronto, Canada, ISBN 978-1-55002-726-6, Paperback, pp.292, CDN$26.99.

Atelier d'été en météorologie
Projet Atmosphère 2008

Demande de candidats professeurs 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 en 2008. Il s'agit d'un atelier d'été à l'intention des enseignants 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 20 juillet au 1er août 2008 au centre de formation du National Weather Service à Kansas City au Missouri.

La plupart des dépenses de l'enseignant choisi 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 canadien choisi.

Les anciens participants 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 enseignants sont revenus avec du matériel, des ressources et des modules didactiques qu'ils peuvent facilement adapter dans leurs cours.

Les enseignants intéressés peuvent obtenir plus d'information en visitant le site de la SCMO sur la toile à www.scmo.ca/hsworkshop.html où ils peuvent obtenir un formulaire d'application. Ils peuvent également obtenir un formulaire en le demandant le plus tôt possible à l'adresse suivante:

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

Ces demandes doivent être soumises au bureau ci-haut mentionné au plus tard le **31 mars 2008**.

Summer Meteorology Workshop
Project Atmosphere 2008

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 in 2008. 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 July 20-August 1, 2008 at the National Weather Training Center, Kansas City, Missouri.

Most of the 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.

Interested teachers can obtain more information on the workshop from the CMOS website www.cmos.ca/hsworkshop.html from where they can also download an application form. They can also request an application form by writing, as soon as possible, to the following address:

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

These requests should be submitted to the above office not later than **March 31, 2008**.

A-O Abstracts Preview

Avant Première des résumés de A-O

The following abstracts will soon be published in your ATMOSPHERE-OCEAN publication.

Les résumés suivants paraîtront sous peu dans votre revue ATMOSPHERE-OCEAN.

Dynamics, Stratospheric Ozone, and Climate Change

THEODORE G. SHEPHERD

Abstract
Dynamics affects the distribution and abundance of stratospheric ozone directly through transport of ozone itself and indirectly through its effect on ozone chemistry via temperature and transport of other chemical species. Dynamical processes must be considered in order to understand past ozone changes, especially in the northern hemisphere where there appears to be significant low-frequency variability which can look "trend-like" on decadal time scales. A major challenge is to quantify the predictable, or deterministic, component of past ozone changes. Over the coming century, changes in climate will affect the expected recovery of ozone. For policy reasons it is important to be able to distinguish and separately attribute the effects of ozone-depleting substances and greenhouse gases on both ozone and climate. While the radiative-chemical effects can be relatively easily identified, this is not so evident for dynamics — yet dynamical changes (e.g., changes in the Brewer-Dobson circulation) could have a first-order effect on ozone over particular regions. Understanding the predictability and robustness of such dynamical changes represents another major challenge. Chemistry-climate models have recently emerged as useful tools for addressing these questions, as they provide a self-consistent representation of dynamical aspects of climate and their coupling to ozone chemistry. We can expect such models to play an increasingly central role in the study of ozone and climate in the future, analogous to the central role of global climate models in the study of tropospheric climate change.

Résumé [traduit par la rédaction]
La dynamique influence la distribution et l'abondance de l'ozone stratosphérique, directement par le transport de l'ozone même et indirectement par ses effets sur la chimie de l'ozone, effets qui sont liés à la température et au transport d'autres espèces chimiques. Il faut prendre en compte les processus dynamiques pour comprendre les changements passés dans l'ozone, en particulier dans l'hémisphère Nord, où il semble y avoir une importante variabilité de basse fréquence qui peut avoir l'air d'une tendance à une échelle de temps décennale. Quantifier la composante prévisible, ou déterministe, des changements passés dans l'ozone est un défi majeur. Au cours du siècle à venir, les changements climatiques modifieront le remplacement attendu de l'ozone. Pour des raisons d'ordre politique, il importe de pouvoir distinguer et de pouvoir attribuer séparément les effets des substances destructrices de l'ozone et des gaz à effet de serre tant sur l'ozone que sur le climat. Bien qu'il soit assez facile d'identifier les effets radiatifs-chimiques, il est plus difficile de le faire pour la dynamique — encore que les changements dynamiques (p. ex. les changements dans la circulation de Brewer-Dobson) pourraient avoir un effet de premier ordre sur l'ozone dans certaines régions. Comprendre la prévisibilité et la robustesse de tels changements dynamiques est un autre grand défi. Les modèles de chimie climatique ont récemment fait leur apparition en tant qu'outils utiles pour l'étude de ces questions, car ils fournissent une représentation cohérente en elle-même des aspects dynamiques du climat et de leur couplage avec la chimie de l'ozone. On peut s'attendre à ce que, dans le futur, de tels modèles jouent un rôle de plus en plus central dans l'étude de l'ozone et du climat, un rôle analogue à celui des modèles climatiques globaux dans l'étude du changement climatique troposphérique.

Ozone in the Troposphere: Measurements, Climatology, Budget, and Trends

D.W. TARASICK and R. SLATER

Abstract
An improved understanding of the global tropospheric ozone budget has recently become of great interest, both in Canada and elsewhere. Improvements in both modelling and measurement have made it possible for weather centres to begin to forecast air quality using numerical weather prediction models. Despite substantial progress, there are many open questions regarding tropospheric ozone photochemistry, long-range transport and the importance of the stratospheric source; this remains an area of very active research. Since ozone in association with particulate matter causes respiratory problems in humans, trends and forecasting of future surface ozone levels are also of great importance. The current status of measurement and modelling, as well as the current understanding of tropospheric ozone budgets and trends, is reviewed with an emphasis on Canada within the global context.

Résumé
Récemment, au Canada comme ailleurs dans le monde, on a vivement ressenti l'importance d'une meilleure compréhension du bilan de l'ozone troposphérique à l'échelle planétaire. De meilleures méthodes de modélisations et de mesures ont permis aux centres météorologiques de commencer à prévoir la qualité de l'air à l'aide de modèles de prévision météorologique numériques. Malgré des progrès importants, plusieurs

questions subsistent à propos de la photochimie de l'ozone troposphérique, de son transport à grande distance et de l'importance de la source stratosphérique; ces points continuent à faire l'objet d'une recherche très intensive. Comme l'ozone, de pair avec les particules en suspension, occasionne des problèmes respiratoires chez les humains, il est également très important de connaître les tendances et de prévoir les niveaux futurs de l'ozone en surface. Nous faisons un tour d'horizon de l'état actuel des méthodes de mesure et de modélisation de même que de la compréhension actuelle des bilans et des tendances de l'ozone troposphérique, en mettant l'accent sur le Canada dans le contexte mondial.

Surface Ultraviolet Radiation

J.B. KERR and V.E. FIOLETOV

Abstract
One of the main concerns regarding a decrease in stratospheric ozone is the consequential increase in the amount of ultraviolet (UV) radiation that reaches the lower atmosphere and the Earth's surface. Radiation at UV wavelengths where ozone absorbs strongly is detrimental to most biological species, including human beings, so a decrease in stratospheric ozone could have a significant impact on the biosphere. This concern has led to a significant increase in surface UV radiation research over the last two decades since the ratification of the Montreal Protocol. Studies include investigations into understanding the complicated absorption and scattering processes involved in the radiative transfer of UV through the atmosphere as well as research on the impacts of changes in UV radiation. Factors affecting surface UV radiation will be discussed, resources used to study surface UV radiation will be described and progress made in our understanding of surface UV radiation over the past two decades will be reviewed.

Résumé [traduit par la rédaction]
L'une des principales inquiétudes concernant une diminution de l'ozone stratosphérique est l'augmentation consécutive de la quantité de rayonnement ultraviolet (UV) qui atteint la basse atmosphère et la surface de la terre. Le rayonnement de longueurs d'onde UV dans la région où il se trouve fortement absorbé par l'ozone est préjudiciable à la plupart des espèces biologiques, y compris les êtres humains, de sorte qu'une diminution de l'ozone stratosphérique pourrait avoir des conséquences importantes sur la biosphère. Cette inquiétude a mené à une augmentation importante de la recherche sur le rayonnement UV à la surface au cours des deux dernières décennies, depuis la ratification du Protocole de Montréal. Les études comprennent des investigations visant à comprendre les processus compliqués d'absorption et de diffusion qui jouent un rôle dans le transfert radiatif de l'UV à travers l'atmosphère de même que des recherches sur les conséquences de changements dans le rayonnement UV. Nous discuterons des facteurs ayant une influence sur le rayonnement UV à la surface, nous décrirons les ressources utilisées pour étudier le rayonnement UV à la surface et nous examinerons les progrès réalisés dans la compréhension du rayonnement UV à la surface au cours des deux dernières décennies.

Ozone Climatology, Trends, and Substances that Control Ozone

V.E. FIOLETOV

Abstract
Ozone decline observed in the stratosphere over the past three decades has resulted from the accumulation of chlorine- and bromine-containing ozone-depleting substances (ODSs) in the atmosphere. Production of most of these gases is regulated by the Montreal Protocol and its Amendments and Adjustments. The latest observations show a decline in major ODSs in the troposphere as a result of these regulations. Observed changes in global ozone are in line with those expected based on changes in stratospheric levels of chlorine and bromine. A change in the rate of ozone decline was observed in the mid-1990s. This paper gives a brief overview of the present knowledge of distribution, variability, and long-term trends in column ozone and ozone profiles, with a focus on observational results and particularly on Canadian data analysis.

Résumé
La diminution de l'ozone observée dans la stratosphère au cours des trois dernières décennies a été causée par l'accumulation dans l'atmosphère de substances destructrices de la couche d'ozone (SACO) contenant du chlore et du brome. La production de la majorité de ces gaz est réglementée par le Protocole de Montréal et ses modifications et ajustements. Les plus récentes observations montrent que ces réglementations ont mené à une diminution des principales SACO dans la troposphère. Les changements observés dans l'ozone à l'échelle planétaire correspondent à ceux auxquels on s'attendait d'après les changements dans les niveaux stratosphériques de chlore et de brome. Un changement dans le taux de diminution de l'ozone a été observé au milieu des années 1990. Cet article donne un bref aperçu des connaissances actuelles sur la répartition, la variabilité et les tendances à long terme dans la colonne d'ozone et dans les profils d'ozone, en mettant l'accent sur les résultats observés et en particulier sur les analyses de données canadiennes.

Ozone: From Discovery to Protection

C.T. McElroy and P.F. Fogal

Abstract
Within one hundred and fifty years, ozone has gone from an unknown quantity to a protected species. This paper traces the evolution of the science of the ozone layer and follows modern research efforts to the point where the Montreal Protocol to Protect the Ozone Layer was put into place. The Montreal Protocol deserves special consideration because it is the best example of a case where science rapidly drove policy development to bring about the implementation of a global agreement to protect the environment.

Résumé [traduit par la rédaction]
Il y a 150 ans, l'ozone était un illustre inconnu; c'est aujourd'hui une espèce protégée. Le présent article raconte l'évolution de la science de la couche d'ozone et retrace les efforts de recherche modernes jusqu'au moment où le Protocole de Montréal visant à protéger la couche d'ozone a été mis en place. Le Protocole de Montréal mérite une attention spéciale parce que c'est le meilleur exemple d'un cas où la science a rapidement mené à l'élaboration de politiques ayant pour but la mise en œuvre d'une entente mondiale destinée à protéger l'environnement.

Dynamics, Stratospheric Ozone, and Climate Change

Theodore G. Shepherd

Abstract
Dynamics affects the distribution and abundance of stratospheric ozone directly through transport of ozone itself and indirectly through its effect on ozone chemistry via temperature and transport of other chemical species. Dynamical processes must be considered in order to understand past ozone changes, especially in the northern hemisphere where there appears to be significant low-frequency variability which can look “trend-like” on decadal time scales. A major challenge is to quantify the predictable, or deterministic, component of past ozone changes. Over the coming century, changes in climate will affect the expected recovery of ozone. For policy reasons it is important to be able to distinguish and separately attribute the effects of ozone-depleting substances and greenhouse gases on both ozone and climate. While the radiative-chemical effects can be relatively easily identified, this is not so evident for dynamics — yet dynamical changes (e.g., changes in the Brewer-Dobson circulation) could have a first-order effect on ozone over particular regions. Understanding the predictability and robustness of such dynamical changes represents another major challenge. Chemistry-climate models have recently emerged as useful tools for addressing these questions, as they provide a self-consistent representation of dynamical aspects of climate and their coupling to ozone chemistry. We can expect such models to play an increasingly central role in the study of ozone and climate in the future, analogous to the central role of global climate models in the study of tropospheric climate change.

Résumé [traduit par la rédaction]
La dynamique influence la distribution et l'abondance de l'ozone stratosphérique, directement par le transport de l'ozone même et indirectement par ses effets sur la chimie de l'ozone, effets qui sont liés à la température et au transport d'autres espèces chimiques. Il faut prendre en compte les processus dynamiques pour comprendre les changements passés dans l'ozone, en particulier dans l'hémisphère Nord, où il semble y avoir une importante variabilité de basse fréquence qui peut avoir l'air d'une tendance à une échelle de temps décennale. Quantifier la composante prévisible, ou déterministe, des changements passés dans l'ozone est un défi majeur. Au cours du siècle à venir, les changements climatiques modifieront le remplacement attendu de l'ozone. Pour des raisons d'ordre politique, il importe de pouvoir distinguer et de pouvoir attribuer séparément les effets des substances destructrices de l'ozone et des gaz à effet de serre tant sur l'ozone que sur le climat. Bien qu'il soit assez facile d'identifier les effets radiatifs-chimiques, il est plus difficile de le faire pour la dynamique — encore que les changements dynamiques (p. ex. les changements dans la circulation de Brewer-Dobson) pourraient avoir un effet de premier ordre sur l'ozone dans certaines régions. Comprendre la prévisibilité et la robustesse de tels changements dynamiques est un autre grand défi. Les modèles de chimie climatique ont récemment fait leur apparition en tant qu'outils utiles pour l'étude de ces questions, car ils fournissent une représentation cohérente en elle-même des aspects dynamiques du climat et de leur couplage avec la chimie de l'ozone. On peut s'attendre à ce que, dans le futur, de tels modèles jouent un rôle de plus en plus central dans l'étude de l'ozone et du climat, un rôle analogue à celui des modèles climatiques globaux dans l'étude du changement climatique troposphérique.

Effects of Ozone Depletion and UV-B on Humans and the Environment

Keith R Solomon

Abstract
There are important effects of changes in intensity of solar UV-radiation resulting from stratospheric ozone depletion, particularly UV-B radiation, on all organisms on the planet. Biological and ecological responses to increases in UV-B radiation may be deleterious and result in harm to humans, particularly in terms of the incidence of cataracts of the eye and cancers of the skin, such as malignant melanoma. UV-B radiation is important in the production of vitamin D which

has beneficial effects on human health, not only in terms of calcium balance and bone development but it also appears to have a protective effect in several other human diseases. UV-B radiation may have adverse effects on individual organisms in the environment and on ecosystem processes, or these may be compensated for in individual species or groups of species, resulting in little overall harm. These compensation mechanisms may have implications for other herbivores and predators that depend on the affected organism for food or habitat. When coupled with changes in the distribution and biology of organisms that will result from climate change, the resulting interactions may cause significant ecological changes that have implications for the sustainability of natural populations as well as human activities that depend on ecosystem services that are provided by the affected organisms. This has implications for human activities such as fisheries, agriculture, and forestry that are economically important in Canada and many other countries. In addition to these direct effects on humans and the ecosystem, increases in UV-B radiation may have effects on nutrient and material cycling in terrestrial and in fresh and salt surface waters. Many of these processes involve dissolved organic matter (DOM) and coloured DOM (CDOM) and their production in terrestrial systems and inputs to surface waters where they have protective effects on plants and animals. Atmospheric chemistry has also been affected by increased UV-B radiation; some of these effects will result in increased biological availability of toxic metals such as mercury. However, the resultant product of the breakdown of the "ozone-friendly" hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs) – trifluoroacetic acid – presents a negligible risk to humans and the environment. Increased UV-B radiation has implications for a number of human-made materials such as plastics used in construction and outdoor materials. The effects of UV-B radiation can be counteracted by protective filters but there may be interactions with increased environmental temperatures that affect the efficiency of these protectants. Overall, the effects of UV-B radiation on organisms, the environment, and materials are expected to decrease as stratospheric ozone recovers; however, the potential effect of climate change on these endpoints is uncertain and it is possible that increases in temperature may combine in additive, synergistic, and antagonistic ways with the effects of UV-B radiation that are currently unpredictable.

Résumé [traduit par la rédaction]
Les changements dans l'intensité du rayonnement UV solaire, en particulier du rayonnement UV-B, causés par l'appauvrissement de l'ozone stratosphérique produisent d'importants effets sur tous les organismes de la planète. Les réactions biologiques et écologiques aux augmentations du rayonnement UV-B peuvent s'avérer nocives pour la santé des humains, notamment en ce qui concerne l'incidence des cataractes de l'œil et des cancers de la peau, comme le mélanome malin. Le rayonnement UV-B joue un rôle important dans la production de la vitamine D, qui a des effets bénéfiques sur la santé humaine, non seulement pour l'équilibre du calcium et la formation des os mais aussi parce qu'elle semble avoir un effet protecteur dans plusieurs autres maladies humaines. Le rayonnement UV-B peut avoir des effets préjudiciables sur les organismes présents dans l'environnement et sur les processus de l'écosystème ou encore ces effets peuvent être compensés chez certaines espèces ou certains groupes d'espèces et ne produire que peu de préjudices dans l'ensemble. Ces mécanismes de compensation peuvent avoir des répercussions sur d'autres herbivores ou prédateurs dont la nourriture ou l'habitat dépendent de l'organisme affecté. Lorsque ces mécanismes seront couplés avec les modifications qu'entraînera le changement climatique dans la distribution et la biologie des organismes, les interactions résultantes pourront produire des changements écologiques importants qui auront un effet sur la viabilité des populations naturelles de même que sur les activités humaines qui dépendent des services écosystémiques fournis par les organismes affectés. Tout cela a des conséquences sur les activités humaines comme la pêche, l'agriculture et la foresterie, qui ont une grande importance économique au Canada et dans plusieurs autres pays. En plus de ces effets directs sur les humains et l'écosystème, des augmentations du rayonnement UV-B peuvent avoir des effets sur le cycle des nutriants et de la matière en milieu terrestre et dans les eaux superficielles douces et salées. Plusieurs de ces processus mettent en jeu de la matière organique dissoute (MOD) et de la MOD colorée (MODC) ainsi que leur production dans les systèmes terrestres et leur introduction dans les eaux superficielles où elles ont des effets protecteurs sur les plantes et les animaux. La chimie atmosphérique a aussi été modifiée par le rayonnement UV-B accru; certains de ces effets entraîneront une plus grande disponibilité biologique de métaux toxiques, comme le mercure. Cependant, le produit résultant de la dégradation chimique des hydrochlorofluorocarbures (HCFC) et des hydrofluorocarbures (HFC) – acide trifluoroacétique – « bons pour l'ozone » ne présente qu'un risque négligeable pour les humains et l'environnement. Un rayonnement UV-B accru a des effets sur un certain nombre de matériaux fabriqués par les humains, comme les plastiques utilisés en construction et les matériaux extérieurs. Les effets du rayonnement UV-B peuvent être neutralisés par des filtres protecteurs, mais il peut se produire des interactions avec les températures plus élevées de l'environnement qui réduiront l'efficacité de ces moyens de protection. Dans l'ensemble, on s'attend à ce que les effets du rayonnement UV-B sur les organismes, l'environnement et les matériaux diminuent au fur et à mesure de la reformation de l'ozone stratosphérique; cependant, les conséquences possibles du changement climatique sur ces effets sont incertaines et il se peut que des augmentations de la température se combinent avec les effets du rayonnement UV-B d'une manière cumulative, synergique et antagoniste impossible à prévoir.

New Associate Editor for ATMOSPHERE-OCEAN

With the departure of Dr. Richard Greatbatch for Kiel, Germany where he will be a Professor of Theoretical Oceanography, it became necessary to find a new Associate Editor in the field of Oceanography for ATMOSPHERE-OCEAN. Fortunately, Dr. Denis Gilbert has accepted the challenge and, therefore, becomes the new Associate Editor for Oceanography.

Dr. Denis Gilbert completed a B.Sc. in Physics at the University of Québec at Chicoutimi in 1985, and a Ph.D. in physical oceanography in 1990 at Dalhousie University in Halifax. For the past sixteen years, he has worked as a research scientist for Canada's Department of Fisheries and Oceans, at the Maurice-Lamontagne Institute in Mont-Joli, Québec. His main field of expertise is the study of ocean climate variability at seasonal, interannual and interdecadal time scales. He has also written papers on internal gravity waves, fisheries oceanography, and the physical and biogeochemical processes responsible for oxygen concentration variability in coastal and open ocean waters. He chairs the international SCOR (*Scientific Committee for Oceanic Research*) working group on "Natural and human-induced hypoxia and consequences for coastal areas". He is a member of the steering committee of the Canadian Argo program that ensures a better monitoring of world ocean climate through the deployment of drifting, profiling buoys. You can contact him by email at gilbertd@dfo-mpo.gc.ca

.

Dr. Denis Gilbert

Nouveau Directeur associé pour ATMOSPHERE-OCEAN

Avec le départ du Dr Richard Greatbatch pour Kiel, Allemagne, où il sera professeur d'océanographie théorique, il devenait nécessaire de trouver un nouveau directeur associé pour ATMOSPHERE-OCEAN dans le domaine de l'océanographie. Heureusement, Dr. Denis Gilbert a bien voulu relever le défi et, par conséquent, deviendra le nouveau directeur associé dans le champ de l'océanographie.

Le Dr Denis Gilbert a complété un B.Sc. en physique à l'Université du Québec à Chicoutimi en 1985 et un Ph.D. en océanographie physique en 1990 à l'Université Dalhousie de Halifax. Il travaille depuis les 16 dernières années à l'Institut Maurice-Lamontagne de Pêches et Océans Canada à Mont-Joli, Québec, en tant que chercheur scientifique. Son principal champ d'expertise est l'étude de la variabilité climatique saisonnière, interannuelle et interdécennale en milieu océanique. Il a également écrit des articles sur les ondes de gravité internes, sur l'océanographie des pêches et sur les mécanismes physiques et biogéochimiques responsables de la variabilité des concentrations en oxygène dans les eaux côtières et hauturières. Il dirige le groupe de travail international SCOR (*Scientific Committee for Oceanic Research*) sur « Les causes naturelles et humaines de l'hypoxie et ses conséquences dans les régions côtières ». Il fait partie du comité directeur du programme Argo canadien de bouées/profileurs à la dérive dans l'océan mondial permettant un meilleur suivi du climat océanique mondial. Vous pouvez entrer en communication avec lui par courriel à gilbertd@dfo-mpo.gc.ca.

Une nouvelle responsable administrative pour la SCMO

Lise Harvey, qui a été responsable administrative pour la SCMO depuis juin 2004, nous a prévenu en septembre de sa décision de démissionner afin de poursuivre son ambition contenue depuis longtemps de changer de carrière pour le domaine de la décoration intérieure. Lise a apporté une énorme contribution à la SCMO pendant ses trois années avec nous, comme nous tous, les membres, les abonnés et les participants au congrès qui ont eu des contacts avec elle pendant cette période le savent. Elle a gardé nos comptes en bonne et due forme, a fait de nombreuses suggestions pour améliorer le logiciel et les procédures de gestion des renouvellements et des inscriptions et elle a réorganisé tous nos dossiers, mis en place un système de dossiers individuels pour tous les membres et contacts clés. Elle a su faire fonctionner le service intérieur de façon efficiente et efficace. L'implication de Lise avec la SCMO remonte en fait à 2000 lorsqu'elle a été engagée comme première responsable administrative pour la FCSCA et elle a fait un si bon travail que lorsque le poste de responsable administratif à la SCMO est devenu vacant, elle était le choix évident. Nous lui souhaitons tous de réussir dans sa nouvelle carrière qui a débuté le 14 novembre avec un programme de formation à Montréal.

À la suite d'une compétition tenue fin septembre et début octobre, Mme Qing Liao a été choisie pour devenir la nouvelle responsable administrative de la SCMO. Elle est arrivée le 20 octobre, a reçu une formation en procédures administratives de la part de Lise Harvey pendant ses deux premières semaines et fonctionne par elle-même depuis le 7 novembre. Qing vient à nous avec d'excellentes qualifications y compris un diplôme de comptable professionnel du Collège Algonquin à Ottawa et une maîtrise en génie électrique de l'Université de Xi'an JiaoTong à Xi'an en Chine. Elle a travaillé en tant qu'ingénieure au développement d'un logiciel financier pour une entreprise de Singapour et de ce fait, elle a développé un intérêt pour la comptabilité avant de venir au Canada. En plus de détenir un diplôme en comptabilité, elle dispose d'une expérience de travail pour des organisations à but non-lucratif locales ainsi que pour un bureau comptable local. Depuis son arrivée à la SCMO, elle a pris rapidement les traces de Lise et bien que l'on soit dans une période très chargée du fait du flot de renouvellement d'adhésions et d'abonnements, la transition s'est faite sans heurts. Je suis persuadé que tous les membres de la SCMO se joignent au personnel administratif de la SCMO pour souhaiter la bienvenue à Qing dans notre équipe.

Les numéros de téléphone et de télécopieur ainsi que l'adresse de courriel pour la responsable administrative de la SCMO restent les mêmes qu'auparavant.

Note from the Editor: The English version of this announcement was published in the December issue of the *CMOS Bulletin SCMO* on page 194.

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

CMOS-SCMO, P.O. Box / C.P. 3211, Stn./Succ. D, Ottawa ON, Canada K1P 6H7

Tel: (613) 990-0300; Fax: (613) 990-1617; e-mail: CMOS@cmos.ca

THE CMOS - WEATHER RESEARCH HOUSE NSERC SCHOLARSHIP SUPPLEMENT

The CMOS - Weather Research House Scholarship Supplement was established in 1997 by Dr. Neil Campbell, then Executive Director of CMOS and Dr. Ambury Stuart, President of Weather Research House and founding Chair of the CMOS Private Sector Committee to recognise the best student in Meteorology or Oceanography who had won an NSERC Postgraduate Scholarship in the year of the award. The scholarship supplement is valued at $10,000 over a two-year period and is funded equally by CMOS and Weather Research House. By making this award, CMOS hopes that individual members of CMOS and other private sector companies will be encouraged to establish similar awards to support graduate students in meteorology or oceanography.

Only those students who have succeeded in winning an NSERC Postgraduate Scholarship or a Canada Graduate Scholarship are eligible. An initial award of $5,000 is renewable for a second year provided that the student continues to hold the scholarship.

The winning student will be selected by a committee of the Society made up of representatives of the CMOS Scientific Committee and the CMOS Private Sector Committee. The scholarship supplement will be announced and presented at the CMOS annual Congress.

More information and instructions on how to apply may be found at: www.nserc.ca/sf_e.asp?nav=sfnav&lbi=2b_4

Applications must be sent to arrive by **15 April** to:

Executive Director CMOS
PO BOX 3211 STN D
OTTAWA ON K1P 6H7
Fax: 613 990 1617
Email: cmos@cmos.ca

LE SUPPLÉMENT SCMO - WEATHER RESEARCH HOUSE AUX BOURSES CRSNG

Le supplément SCMO-Weather Research House a été établi en 1997 par le docteur Neil Campbell, directeur exécutif de la SCMO à l'époque et le docteur Ambury Stuart, président de Weather Research House et président-fondateur du comité SCMO pour le secteur privé, afin de reconnaître le meilleur étudiant en météorologie ou océanographie titulaire d'une bourse d'études supérieures du CRSNG dans l'année du supplément. Le supplément peut attendre 10 000 $ si détenu pour une période de deux ans. Il est financé également par la SCMO et Weather Research House. En établissant ce prix, la SCMO espère d'encourager d'autres membres ou compagnies privées à établir de prix semblables pour les étudiants en études supérieures en météorologie ou océanographie.

Seulement les gagnants d'une bourse d'études supérieures (ÉS) du CRSNG ou d'une bourse ÉS du Canada sont admissibles à présenter une demande. Un supplément initial de 5 000 $ peut être renouvelé pour une deuxième année à la condition que l'étudiant continue à détenir la bourse.

Un comité de membres choisis des comités scientifique et du secteur privé de la SCMO évaluera les demandes et recommandera le candidat jugé le plus qualifié. L'annonce et la présentation du supplément seront fait au congrès annuel de la SCMO.

Pour de plus amples informations et des instructions comment présenter une demande vous devez visiter www.crsng.gc.ca/sf_f.asp?nav=sfnav&lbi=2b_4.

Les demandes doivent parvenir au plus tard le **15 avril** à :

Le directeur exécutif de la SCMO
C.P. 3211 Succursale D
Ottawa, ON, K1P 6H7
Télécopieur: 613 990 1617
Courriel: scmo@scmo.ca

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

CMOS-SCMO, P.O. Box / C.P. 3211, Stn./Succ. D, Ottawa ON, Canada K1P 6H7

Tel: (613) 990-0300; Fax: (613) 990-1617; e-mail: CMOS@cmos.ca

THE CMOS – CNC/SCOR NSERC SCHOLARSHIP SUPPLEMENT

The Canadian National Committee (CNC) for the Scientific Committee on Oceanic Research (SCOR), in partnership with DFO and CMOS, invites applications for the NSERC Scholarship Supplement for Ocean Sciences in the amount of $5,000/year for a period of two years. Only those students who have succeeded in winning an NSERC Postgraduate Scholarship or a Canada Graduate Scholarship are eligible. The initial award of $5,000 is renewable for the second year provided that the student continues to hold the NSERC postgraduate scholarship.

In establishing the Scholarship Supplement, CNC/SCOR intends to use already established mechanisms to solicit applications through NSERC and use adjudication procedures established through CMOS. The winning student will be selected by representatives of the CMOS Scientific Committee. The Supplement will be awarded at the annual banquet of the CMOS Congress. By using the well established NSERC and CMOS solicitation and adjudication procedures, CNC/SCOR will ensure that administrative overhead will on the one hand remain within the overall comfort level of the academic community, and on the other, will be fair, rigorous and transparent.

More information and instructions on how to apply may be found at: www.nserc.ca/sf_e.asp?nav=sfnav&lbi=2b_4

Applications must be sent to arrive by **15 April** to:

Executive Director CMOS
PO BOX 3211 STN D
OTTAWA ON K1P 6H7
Fax: 613 990 1617
Email: cmos@cmos.ca

LE SUPPLÉMENT SCMO – CNC/SCOR AUX BOURSES CRSNG

Le Comité national canadien (CNC) pour le Comité scientifique pour les recherches océaniques (SCOR), en partenariat avec le MPO et la SCMO, invite des applications pour un Supplément à la bourse du CRSNG pour les sciences de la mer, d'un montant de 5 000 $ par année, à un étudiant méritant pour une période de deux ans. Seuls sont éligibles les étudiants ayant remporté une bourse d'études supérieures du CRSNG ou une bourse d'études supérieures du Canada. Le Supplément initial de 5 000 $ est renouvelable pour la seconde année à condition que l'étudiant continue de détenir la bourse d'études supérieures du CRSNG

Pour décerner le Supplément à une bourse, le CNC/SCOR a l'intention d'utiliser les mécanismes déjà en place pour solliciter des candidatures par l'entremise du CRSNG et d'utiliser les modalités d'adjudication établies à la SCMO. L'étudiant gagnant sera choisi par des représentants du Comité scientifique de la SCMO. Le Supplément sera accordé lors du banquet annuel du Congrès de la SCMO. En utilisant les modalités de sollicitation et d'adjudication bien établies du CRSNG et de la SCMO, le CNC/SCOR s'assurera que l'administration générale, d'une part, restera dans la zone de confort du milieu de l'enseignement et, d'autre part, sera juste, rigoureuse et transparente.

Pour de plus amples informations et des instructions comment présenter une demande vous devez visiter www.crsng.gc.ca/sf_f.asp?nav=sfnav&lbi=2b_4.

Les demandes doivent parvenir au plus tard **le 15 avril** à :

Le directeur exécutif de la SCMO
C.P. 3211 Succursale D
Ottawa, ON, K1P 6H7
Télécopieur: 613 990 1617
Courriel: scmo@scmo.ca

THE CANADIAN METEOROLOGICAL AND OCEANOGRAPHIC SOCIETY (CMOS)

THE WEATHER NETWORK / MÉTÉOMÉDIA SCHOLARSHIP

The Scholarship

The Weather Network/MétéoMédia Scholarship is designed to encourage and support Canadians toward establishing or furthering a career in the field of Meteorology. The Weather Network/MétéoMédia are wholly owned and operated by Pelmorex Media Inc, Canada's leading private sector weather information provider. Pelmorex is committed to the personal growth of Canada's future Meteorologists. The scholarship is offered to a female student, and provides educational assistance in pursuit of a career in the field of Meteorology. The Weather Network/MétéoMédia makes an annual donation of $1,500 to CMOS who coordinates the selection process. The first scholarship was presented during the 2003/04 academic year.

Eligibility and Criteria

- officially registered in the 3rd year of an Atmospheric Science degree program at a Canadian University;
- female student;
- Canadian citizen or permanent resident status;
- student must be in "good academic standing", not failing any courses and have an average of 75% or more;
- career aspirations as a Forecast Meteorologist, On-Air Meteorologist or Meteorological Briefer.

Application Process

Students are required to submit transcripts of academic studies, a personal letter of interest and intent and resume. One sealed letter of recommendation (in confidence) from a university professor who is directly acquainted with and knowledgeable of the work of the student is to accompany the application. Please provide the following information. Pelmorex is committed to diversity in the workplace.

- Name:
- Address/City/Postal Code:
- Telephone:
- e-mail:
- University & Program:
- Graduating year:
- Citizenship:
- Signature & Date:

Applications should be sent to:

Office of the Executive Director
Canadian Meteorological and Oceanographic Society
P.O. Box 3211
Station D Ottawa, ON, K1P 6H7

For additional information please e-mail: cmos@cmos.ca
Please note applications are to be sent in by mail.
Deadline for receipt of application forms is 15 April.

LA BOURSE MÉTÉOMÉDIA / THE WEATHER NETWORK

LA SOCIÉTÉ CANADIENNE DE MÉTÉOROLOGIE ET D'OCÉANOGRAPHIE (SCMO)

La Bourse

La bourse MétéoMédia/The Weather Network a été conçue afin d'encourager et soutenir les Canadiennes qui tentent d'établir ou de se diriger vers une carrière dans le domaine de la météorologie. Pelmorex Media Inc., chef de file des fournisseurs privés en météorologie, est l'unique propriétaire de MétéoMédia/The Weather Network dont il assure la gestion complète. Pelmorex s'engage dans la croissance personnelle des futurs météorologues du Canada. La bourse est offerte à une étudiante, et fournit un support éducatif dans la poursuite d'une carrière dans le domaine de la météorologie. MétéoMédia/The Weather Network font une donation annuelle de 1 500 $ à la SCMO qui coordonne le processus de sélection. La première bourse fut présentée pendant l'année académique 2003/2004.

Éligibilité et critères

- être officiellement inscrite dans la 4^{e} année d'un programme de Sciences atmosphériques dans une université canadienne;
- étudiante (de sexe féminin);
- citoyenne canadienne ou statut de résidente permanente;
- l'étudiante ne doit pas avoir échoué aucun cours et doit avoir une moyenne de 75 % ou plus;
- aspirations de carrière en tant que Météorologue prévisionniste, Météorologue ''en-ondes'' ou Météorologue ''briefer''.

Processus de candidature

Les étudiantes sont tenues de fournir des copies de leurs relevés de notes, une lettre démontrant de leur intérêt, ainsi que leur curriculum vitae. Une lettre de recommandation (sous pli confidentiel) d'un professeur d'université qui connaît directement l'étudiante et qui est renseigné sur son travail doit accompagner la candidature. Veuillez SVP fournir les informations suivantes. Pelmorex souscrit à la diversité en matière d'emploi.

- Nom:
- Adresse/ville/ code postal:
- Téléphone:
- Courriel:
- Université & Programme:
- Année de graduation:
- Citoyenneté:
- Signature & date:

Les candidatures doivent être envoyées au :

Bureau du Directeur exécutif
La Société canadienne de météorologie et d'océanographie
C.P. 3211 Succursale D
Ottawa, ON, K1P 6H7

Pour plus d'information veuillez SVP écrire à l'adresse suivante : scmo@scmo.ca. Veuillez noter que les candidatures doivent être envoyées par la poste. La date limite pour la réception des candidatures est le 15 avril.

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

CMOS-SCMO, P.O. Box / C.P. 3211, Stn./Succ. D, Ottawa ON, Canada K1P 6H7

Tel: (613) 990-0300; Fax: (613) 990-1617; e-mail: CMOS@cmos.ca

CMOS UNDERGRADUATE SCHOLARSHIPS ($500)

Two Undergraduate scholarships, valued at $500 each, may be offered by the Canadian Meteorological and Oceanographic Society to successful student applicants planning a career in atmospheric, hydrological, oceanographic or limnological sciences. These scholarships are tenable at any Canadian university.

Applicants must be Canadian citizens or have landed immigrant status and be in their penultimate undergraduate year; the scholarships are to support the students' final university year.

To be qualified, students should be taking four or more half courses in one or more of the following areas in their final year: meteorology, oceanography, limnology, hydrology or climatology.

Details are to be provided in the application.

Students are required to submit transcripts of academic studies, a statement of interest and intent and details of relevant work experience.

Two sealed letters of recommendation (in confidence) from university professors who are directly acquainted with and knowledgeable of the work of the student are to accompany the application.

Find application forms at http://www.cmos.ca/undergradschole.html and send to arrive by **15 April** to:

Executive Director CMOS
PO BOX 3211 STN D
OTTAWA ON K1P 6H7
Fax: 613 990 1617
Email: cmos@cmos.ca

BOURSES D'ÉTUDES DE PREMIER CYCLE SCMO (500 $)

Deux bourses d'études de premier cycle, chacune d'un montant de 500 $, peuvent être offertes par la Société canadienne de météorologie et d'océanographie aux étudiants dont la demande a été acceptée et qui planifient faire carrière dans les sciences atmosphériques, hydrologiques, océanographiques ou limnologiques. Ces bourses d'études ne sont valides que dans les universités canadiennes.

Les candidats doivent être citoyens canadiens ou détenir le statut d'immigrant admis et être dans l'avant-dernière année du premier cycle; ces bourses serviront à appuyer les étudiants lors de leur dernière année universitaire.

Afin d'être admissibles, les étudiants doivent suivre au moins quatre cours de 3 crédits chaque dans au moins un des domaines suivants durant leur dernière année: météorologie, océanographie, limnologie, hydrologie ou climatologie.

Les renseignements doivent être indiqués sur le formulaire de demande.

Les étudiants doivent soumettre leurs relevés de notes d'études universitaires, un exposé d'intérêt et d'intention et les détails d'expérience de travail pertinent.

La demande doit être accompagnée de deux lettres de recommandation scellées (à titre confidentiel) de professeurs distingués qui connaissent personnellement le travail de l'étudiant.

Les formulaires de demandes se trouvent à http://www.cmos.ca/undergradscholf.html et doivent être envoyées pour arriver au plus tard **le 15 avril** à :

Le directeur exécutif de la SCMO
C.P. 3211 Succursale D
Ottawa, ON, K1P 6H7
Télécopieur: 613 990 1617
Courriel: scmo@scmo.ca

Proposed changes to the CMOS membership fees and benefits for 2009

The following proposed changes to the CMOS membership fees and benefits for 2009, in a slightly different form, were discussed by Council on 18 December 2007 and approved for further refinement, discussion and presentation to the CMOS membership at the AGM 26 May 2008 for final approval. Only Canadian fees are discussed here but the usual supplements to cover postage to non-Canadian destinations would continue to apply.

1. Lower fees for students:

a. The current student fee of $40 compares with $15 charged by AGU, CGU and AMS, however in addition to the Bulletin, it includes a subscription to paper and electronic editions of A-O.

b. It is proposed to reduce the student fee to $20 and drop the paper subscription to A-O.

2. Separate fees for Corporate and Library members:

a. Currently, commercial corporations and libraries pay the same corporate fee ($333) and both receive all publications. Most corporations don't really want all the publications and libraries don't really want membership but do want a bundle of publications. It is proposed to separate corporate memberships and library memberships as follows.

b. It is proposed that corporate members would be charged two times the rate for individual members or $160 but would receive only the Bulletin. Other publications could be ordered at the institutional rate.

c. Library members would continue to pay the current fee of $333 and receive all CMOS paper publications. If ordered separately these cost: Bulletin $80, A-O $125, CD $50, Congress P&A $60, for a total of $315. Electronic access to A-O (separately $110) is included for one site or range of IP addresses. Additional sites or ranges cost $110 each.

3. Require corporate membership for Private Sector Directory Listings:

a. Non-member companies currently pay an additional fee of $25 for non-member listing of only $25 plus a set-up fee of $100.

b. It is proposed to eliminate non-member listings and fee supplements and to require all companies to be corporate members, as re-defined above, in order to qualify for listing.

4. Require membership for Accredited Consultants:

a. currently accredited consultants (unlike endorsed weathercasters) do not have to be CMOS members. Non-members pay an additional annual fee of $75.

b. It is proposed to simply require that all accredited consultants be CMOS members.

Modifications proposées aux cotisations et aux avantages des membres de la SCMO pour 2009

Les modifications proposées aux cotisations et aux avantages des membres de la SCMO pour 2009 suivantes, dans une forme légèrement différente, ont été discutées par le Conseil le 18 décembre 2007 et approuvées pour être raffinées, discutées et présentées aux membres de la SCMO lors de la AGA du 26 mai 2008 pour une approbation finale. Seules les cotisations canadiennes sont abordées ici, mais les compléments usuels pour couvrir les frais d'envoi vers des destinations non-canadiennes restent pertinents.

1. Cotisations moins élevées pour les étudiants :

a. La cotisation étudiant actuelle de 40 $ se compare aux 15 $ demandés par l'UGA, l'UGC et l'AMS; cependant en plus du bulletin, elle inclut un abonnement aux éditions imprimées et électroniques de A-O.

b. Il est proposé de réduire la cotisation étudiant à 20 $ et de ne pas offrir l'abonnement à l'édition imprimée de A-O.

2. Cotisations séparées pour les membres corporatifs et les bibliothèques :

a. Actuellement, les entreprises commerciales et les bibliothèques payent la même cotisation corporative (333 $) et les deux reçoivent toutes les publications. La plupart des entreprises ne veulent pas vraiment toutes les publications et les bibliothèques ne veulent pas vraiment être membres mais veulent recevoir un ensemble de publications. Il est proposé de séparer l'adhésion des corporations et des bibliothèques de la façon suivante.

b. Il est proposé que la cotisation pour les membres corporatifs sera deux fois la cotisation pour des membres individuels, soit 160 $, mais qu'ils ne recevront que le Bulletin. Les autres publications pourront être commandées au tarif institutionnel.

c. Les bibliothèques membres continueront à payer la cotisation actuelle de 333 $ et recevront toutes les éditions papier des publications de la SCMO. Commandées séparément, celles-ci coûtent : 80 $ pour le Bulletin, 125 $ pour A-O, 50 $ pour le CD-ROM A-O, 60 $ pour le Programme et résumés du Congrès, soit un total de 315 $. L'accès électronique à A-O (110 $ séparément) est inclus pour un site ou une gamme d'adresses IP. Chaque site ou gamme d'adresses supplémentaire coûte 110 $.

3. Cotisation corporative requise pour les répertoires du secteur privé :

a. Les entreprises non-membres payent actuellement des frais supplémentaires de 25 $ pour des frais de répertoire de non-membres de seulement 25 $ plus des frais de départ de 100 $.

b. Il est proposé de supprimer les répertoires et les frais supplémentaires de non-membre et de demander à toutes les entreprises de devenir des membres corporatifs, comme défini ci-dessus, de manière à pouvoir faire partie des répertoires.

4. Adhésion requise pour les consultants accrédités :

a. Les consultants accrédités actuels (au contraire des présentateurs météo agréés) n'ont pas besoin de devenir des membres de la SCMO. Les non-membres payent des frais annuels supplémentaires de 75 $.

b. Il est proposé de simplement exiger que tous les consultants accrédités soient membres de la SCMO.

Report of the Nominating Committee

The nominating committee consisted of Geoff Strong (Chair, and President 2006-07), Susan Woodbury (President 2005-06), and Hal Ritchie (President 2004-05). The following people have agreed to let their names stand for election to the CMOS Council for 2008-09.

President Président	***Andrew Bush***, Professor, Department of Earth & Atmospheric Sciences, University of Alberta, Edmonton, AB
Vice-President Vice-Président	***William (Bill) Crawford***, Oceanographer, Institute of Ocean Sciences, DFO, Sidney, B.C.
Treasurer Trésorier	***Ron Hopkinson***, Meteorological Consultant, Regina, SK
Corresponding Secretary Secrétaire correspondant	***Bob Kochtubajda***, Meteorologist, Environment Canada, Edmonton, AB
Recording Secretary Secrétaire d'assemblée	***William (Bill) Hume***, Meteorologist (MSC retired), Edmonton, AB
Past President Président d'office	***Paul Myers***, Associate Professor, Department of Earth & Atmospheric Sciences, University of Alberta, Edmonton, AB
Councillors-at-Large Conseillers	• ***Brad Shannon***, Meteorologist (MSC retired), Calgary, AB • ***Kent Johnson***, Manager, NSO, Environment Canada, Kelowna, B.C. and LAC Chair for the 2008 CMOS Congress in Kelowna. • ***John Parker***, Environment Canada (MSC) Dartmouth, NS and LAC Chair for the 2009 CMOS Congress in Halifax.

The Vancouver Island Centre has agreed to accept the invitation to lead the CMOS Executive from 2009 to 2011, and the proposed new Vice-President for 2008-09 is from that Centre.

Rapport du Comité de mise en candidature

Le comité de mise en candidature était formé cette année de Geoff Strong (Président du comité et Président 2006-2007), Susan Woodbury (Présidente 2005-2006) et Hal Ritchie (Président 2004-2005). Nous sommes heureux d'annoncer que les personnes suivantes ont accepté que leur nom soit mis en candidature pour l'élection de l'Exécutif de la SCMO pour 2008-2009 (Voir tableau ci-contre).

De plus, le Centre de l'Île de Vancouver a accepté l'invitation de prendre en charge la composition de l'Exécutif de 2009 à 2011. Le Vice-président proposé pour 2008-2009 vient d'ailleurs de ce Centre.

Geoff Strong
Chair, Nominating Committee
Ardrossan, AB

Susan Woodbury
President, Woodbury Management Solutions Inc.
Halifax, NS

Hal Ritchie
Senior Scientist, Environment Canada
Dartmouth, NS

Proposed Amendments to the CMOS Constitution and By-Laws with rationale

BY-LAW 8 - Prizes, Awards and Scholarships Replace all references in the by-law and in appendix I to “prizes and awards” by “prizes, awards and scholarships”.	To recognize scholarships as a separate category of award.
APPENDIX I TO BY-LAWS **PRIZES, AWARDS AND SCHOLARSHIPS** *Replace* f) **The Graduate Student Prizes** One or more graduate student prizes may be awarded each year for contributions of special merit by graduate students registered at a Canadian university or by Canadian graduate students registered at a foreign university. One of these prizes should be named the **Tertia MC Hughes Memorial Prize**. *by* f) **The Tertia MC Hughes Memorial Graduate Student Prizes** One or occasionally more than one prize ($500) may be awarded each year for contributions of special merit by graduate students registered at a Canadian university or by Canadian graduate students registered at a foreign university.	The current wording creates a situation where the ordinary CMOS Graduate Student Prizes are reduced to secondary status because they carry no monetary award, whereas the T. Hughes Prize includes a $500 award. It is proposed to drop the ordinary CMOS graduate student prizes and allow more than one Tertia Hughes prize to be awarded in any one year. The Tertia Hughes Fund has already been combined with the Scholarship Fund.
Replace j) **Postgraduate Scholarship** The CMOS Postgraduate Scholarship is awarded annually in association with the Natural Sciences and Engineering Research Council of Canada as a Postgraduate Supplement. The successful student must be eligible for an NSERC Scholarship and indicate his/her intention to pursue advanced studies and research in atmospheric or oceanographic sciences at a recognized Canadian university with postgraduate studies in these fields. The award is tenable for a maximum of 24 months, provided that the holder continues to be a full time candidate for a higher degree in a Canadian University. *by* j) **Postgraduate Scholarship Supplements** The CMOS Postgraduate Scholarship Supplements are awarded in association with the Natural Sciences and Engineering Research Council of Canada (NSERC). The successful students must have been awarded an NSERC Postgraduate Scholarship or Canada Graduate Scholarship. The supplements are tenable for a maximum of 24 months, provided that the holder continues to hold the NSERC scholarship. Two new supplements may be awarded each year, as follows: ● The CMOS - Weather Research House NSERC Scholarship Supplement in atmospheric or ocean sciences; ● The CMOS - CNC/SCOR NSERC Scholarship Supplement in Ocean Sciences.	To reflect the fact that these scholarships are actually supplements to NSERC awards and that there are now two supplements awarded each year.

Insert k) The CMOS Undergraduate Scholarships Two CMOS undergraduate scholarships ($500) may be offered annually to students planning a career in atmospheric, hydrological, oceanographic or limnological sciences. These scholarships are tenable at any Canadian university. Applicants must be Canadian citizens or have landed immigrant status and be in their penultimate undergraduate year; the scholarships are to support the students' final university year. To be qualified, students should be taking four or more half courses in one or more of the following areas in their final year: meteorology, oceanography or limnology, hydrology or climatology. l) The CMOS - The Weather Network/Météomédia Scholarship This Scholarship ($1500) is offered to a 3rd or 4th year female student at a Canadian university who intends to pursue a career in the fields of Forecast Meteorologist, On-Air Meteorologist or Meteorological Briefer.	To add to the list two scholarships that have been awarded for several years but never listed.

Proposition d'amendements à la Constitution et aux Règlements de la SCMO et rationalisation

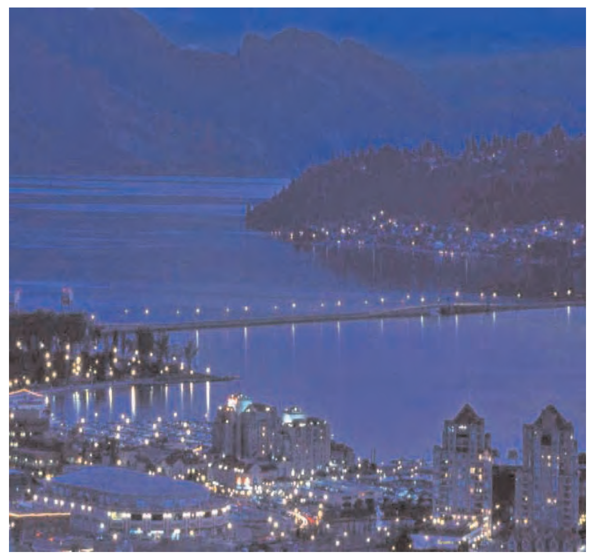
RÈGLEMENT 8 - Prix, honneurs <u>et bourses</u> Remplacer toute référence dans le règlement et dans l'appendice I à "prix et honneurs" par "prix, honneurs et bourses".	Pour reconnaître les bourses comme catégorie distincte.
APPENDICE I AUX RÈGLEMENTS **Prix, honneurs <u>et bourses</u>** *Remplacer* f) **Les Prix pour étudiants diplômés** Un ou plusieurs prix pour étudiants diplômés peuvent être décernés aux étudiants diplômés, inscrits à une université canadienne ou aux étudiants canadiens inscrits à une université étrangère, ayant accompli un travail exceptionnel. Un de ces prix devrait être dénommé **le prix commémoratif Tertia M. C. Hughes**. *par* f) **le prix commémoratif Tertia M. C. Hughes** Un ou occasionnellement plusieurs prix (500 $) peuvent être décernés aux étudiants diplômés, inscrits à une université canadienne ou aux étudiants diplômés canadiens inscrits à une université étrangère, ayant accompli un travail exceptionnel.	Le texte actuel crée une situation où les prix pour étudiants diplômés sont réduits à un statut secondaire parce qu'ils n'impliquent aucun prix monétaire alors que le prix commémoratif T. Hughes inclut une somme de $500. On propose de laisser tomber les prix ordinaires pour étudiants diplômés et d'admettre la possibilité de plus d'un prix T. Hughes. Les fonds Tertia Hughes sont déjà amalgamés aux fonds de bourses d'étude.

Remplacer j) **Bourse de troisième cycle** La Bourse de troisième cycle de la SCMO est décernée chaque année en collaboration avec le Conseil de recherches en sciences naturelles et en génie (CRSNG) comme supplément de troisième cycle. Le candidat doit être récipiendaire d'une bourse du CRSNG et avoir indiqué son intention de poursuivre des études supérieures en sciences atmosphériques ou océanographiques dans une université canadienne reconnue, possédant un programme d'études gradués dans ces domaines. Ce prix est offert pendant une période maximale de 24 mois, pourvu que le récipiendaire poursuive ses études supérieures à temps plein dans une université canadienne. *par* j) **Suppléments aux bourses de troisième cycle du CRSNG** Les suppléments SCMO aux bourses de troisième cycle du CRSNG sont décernés chaque année en collaboration avec le Conseil de recherches en sciences naturelles et en génie (CRSNG). Les candidats doivent être récipiendaires d'une bourse ES du CRSNG ou une Bourse d'études supérieures du Canada. Ces suppléments sont offerts pendant une période maximale de 24 mois, pourvu que le récipiendaire continue de tenir la bourse. Deux nouveaux suppléments peuvent être décernés chaque année : ● Supplément SCMO – Weather Research House en sciences de l'atmosphère ou des océans; ● Supplément CMOS – CNC SCOR pour les sciences de la mer.	En reconnaissance du fait que ces bourses sont vraiment des suppléments aux bourses du CRNSNG et que maintenant il y a deux suppléments disponibles chaque année.
Insérer k) **Bourses d'études de premier cycle** Deux bourses d'études de premier cycle (500 $) peuvent être offertes aux étudiants qui planifient leur carrière dans les sciences atmosphériques, hydrologiques, océanographiques ou limnologiques. Ces bourses d'études ne sont valides que dans les universités canadiennes. Les candidats doivent être citoyens canadiens ou détenir le statut d'immigrant admis et être dans l'avant-dernière année du premier cycle; ces bourses serviront à appuyer les étudiants lors de leur dernière année universitaire. Afin d'être admissibles, les étudiants doivent suivre au moins quatre cours de 3 crédits dans au moins un des domaines suivants durant leur dernière année: météorologie, océanographie ou limnologie, hydrologie ou climatologie. l) La bourse SCMO - The Weather Network/Météomédia Cette bourse (1 500 $) est offerte à une étudiante dans la 3e ou 4e année d'un programme de Sciences atmosphériques dans une université canadienne, avec aspirations de carrière en tant que Météorologue prévisionniste, Météorologue "en-ondes" ou Météorologue "briefer".	Pour ajouter deux bourses d'études qui sont disponible depuis plusieurs années sans avoir été mentionné formellement.

2008 Congress   Congrès 2008

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

May 25-29, 2008 Kelowna, B.C.
25-29 mai, 2008   Kelowna, C.-B.



Water, Weather, and Climate:
Science Informing Decisions

Eau, météo, et climat:
La science comme outil de décision

The Grand Okanagan Lakefront Resort and Conference Centre
(www.grandokanagan.com)
www.cmos2008.ca


SERVICE
9/10 de l'équation de ventes 9/10 of the sales equation
www.campbellsci.ca