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SCMO

Canadian Meteorological and Oceanographic Society

La Société canadienne de météorologie et d'océanographie

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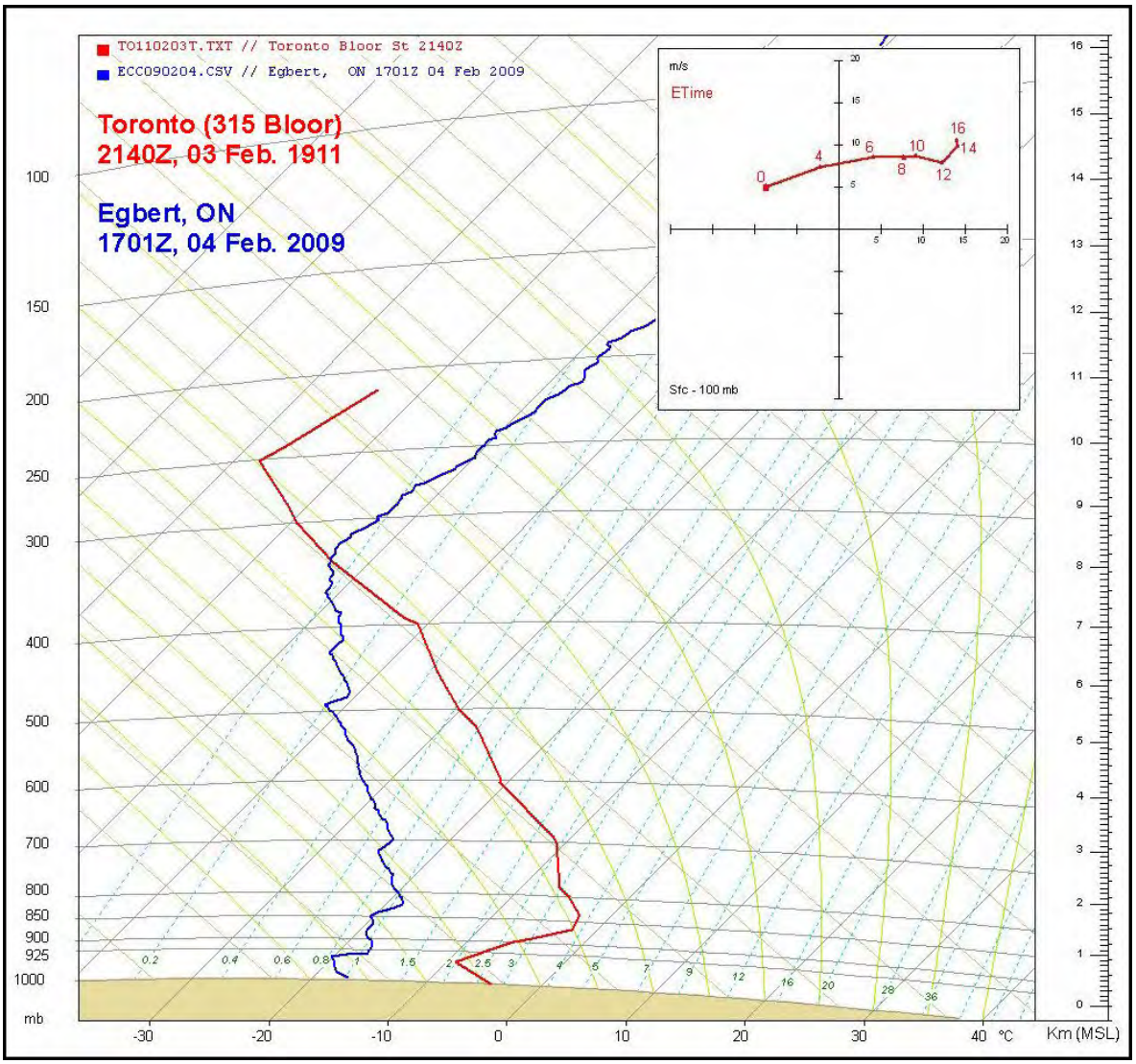

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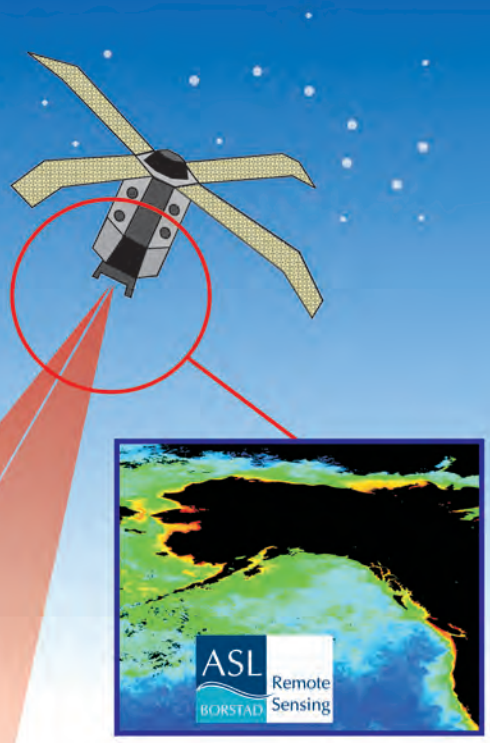

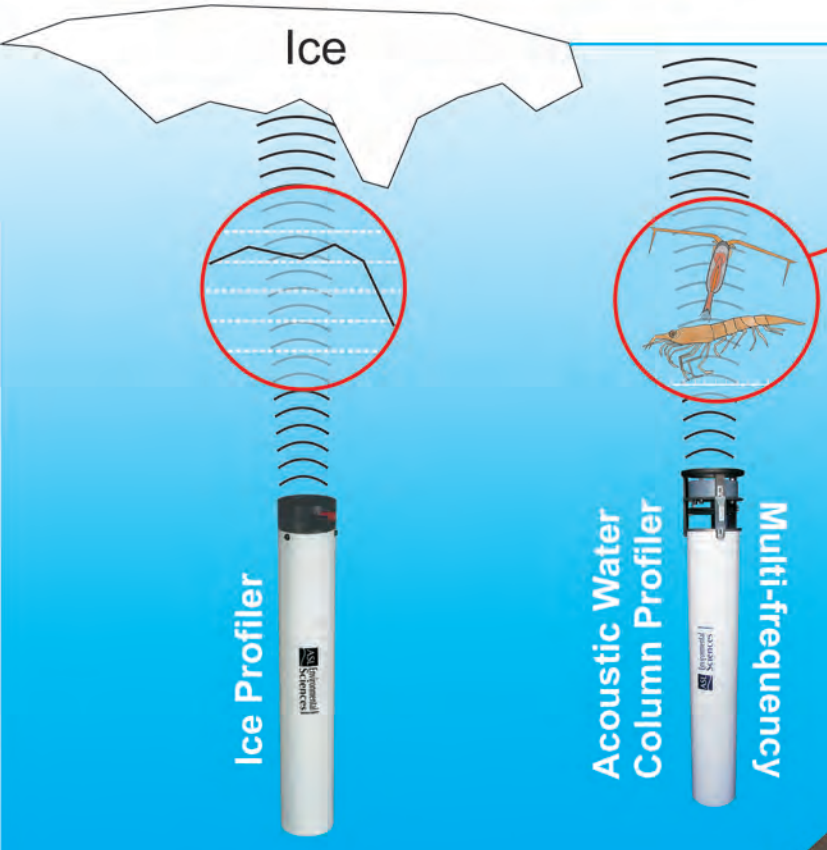

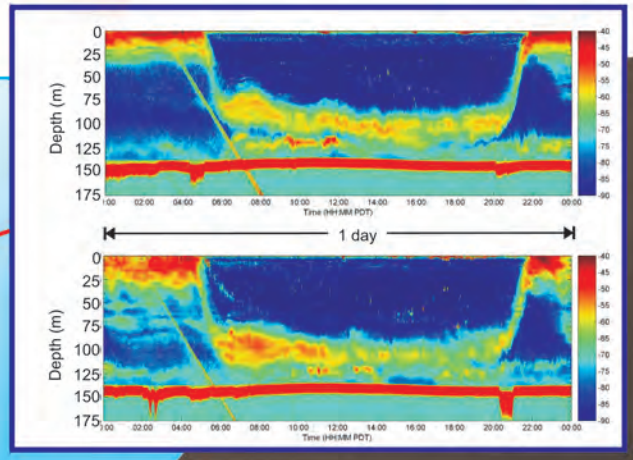

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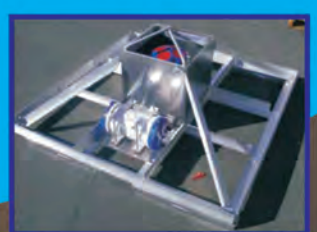

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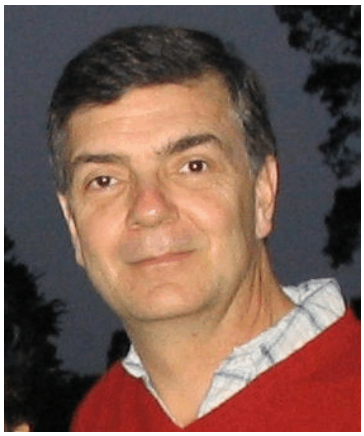
....from the President's Desk



Bill Crawford
CMOS President Président de la SCMO

Friends and colleagues:

During the summer the members of CMOS Council prepared a Brief to the House of Commons Standing Committee on Finance. The *Call for Briefs* from this committee asked for proposals to consider in the next federal budget. The writing was led by Sylvie Gravel (Chair of our Scientific Committee) and me, and you can read our final product on page **160** in English (**163** en français) of this issue of the *CMOS Bulletin SCMO.* This may have been a first ever Brief presented by CMOS. It is our opportunity to represent the interests of CMOS members to decision-makers in Canada.

This issue will arrive in your mailbox at about the time of our request for renewal of CMOS membership. Of course, I urge you to renew your membership. As well, why not recruit some of your colleagues into CMOS, to share the benefits and to further the vision of CMOS? **Membership forms are on-line**, along with a listing of all our classes of membership: http://www.cmos.ca/membershipform.html. As an incentive, we offer a prize of one hundred dollars to the local CMOS Centre that increases its membership by the greatest percentage this calendar year. Here is what your membership provides:

- **Reduced registration fees at our Annual Congress**. These meetings attract about 400 to 500 participants to present new insight into all our sciences, from weather forecasting to arctic meltdown. It is also a chance to reconnect with friends across the country. We will share our next Congress in June 2010 with the Canadian Geophysical Union in Ottawa;

- **CMOS Bulletin**: the official newsletter of the Society, published every two months. It offers information of professional interest to the Society's members and contains book reviews and a variety of technical, historical and general articles related to meteorology and oceanography;

- **Professional accreditation**. We provide accreditation for CMOS Consultants and endorsement for CMOS weathercasters. In addition, we defend the right of CMOS Consultants to practise in their field of environmental science. Engineering societies are sometimes aggressive in defending their members' sole right to practise engineering, and CMOS successfully defends the right of our accredited consultants to consult in environmental sciences.

(Continued on page 139 / Suite à la page 139)

Volume 37 No.5
October 2009 — octobre 2009

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Articles

Reports / Rapports

Our regular sections / Nos chroniques régulières

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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: John Patterson started making upper air measurements with balloon-launched Dines meteorographs near the Toronto MSC headquarters in 1910. Instruments had to be recovered in order to retrieve data, sometimes requiring as long as six months. Pictured is a plot of temperature and winds for the first successful sounding on 03 February 1911; the winds are shown in the window along with a comparable sounding from Egbert last February. Humidity data were not available until later. The meteorograph was used for research purposes in Canada for nearly three decades until near real-time data became available with radiosondes. To learn more, read the article on **page 143.**

Page couverture: John Patterson a commencé à faire des mesures en altitude au moyen de metéographes Dines portés par ballon près du siège social du SMC de Toronto en 1910. Il fallait retrouver les instruments afin de récupérer les données, ce qui pouvait prendre jusqu'à six mois. On montre ici un diagramme de la température provenant du premier lancement réussi le 3 février 1911 à côté d'un sondage comparable pris à Egbert en février dernier. En vignette, l'hodographe de 1911. Les données d'humidité ne furent disponibles que plus tard. Le météographe fut utilisé pour la recherche durant près de trois décades, jusqu'à ce que les données des radiosdondes deviennent disponibles en temps quasi-réel. Pour en apprendre plus, lire l'article en **page 143.**

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

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

● **For students, reduced fees and free subscription to ATMOSPHERE-OCEAN**. We subsidize the memberships of students and the on-line version of our research journal is free with this membership. In addition, many students receive travel subsidies to our annual congress.

● **Your chance to network with other meteorologists and oceanographers**. Keep up with others through the CMOS Bulletin, or set up a CMOS Facebook page. A test version of CMOS on Facebook is now up and running for our Alberta Centre, called "Canadian Meteorological and Oceanographic Society-Alberta Chapter", managed by Steph Watson, a student member of CMOS.

● **A chance to promote oceanography and meteorology in Canada**. CMOS promotes the views of the membership in scientific fora, lobbies government bodies on behalf of meteorology and oceanography, issues policy statements, and provides opportunities to meet and exchange ideas with colleagues. One example is the Brief we submitted this summer to the House of Commons Standing Committee on Finance. (Look for it on page 160, page 163 en français).

Bill Crawford
President / Président

Jargon of **Carbon Offset Credits** and **Carbon Reduction Credits**

by Bill Crawford[1]

The text below is based on an article on **Carbon Offset** in Wikipedia.

A **carbon footprint** is "the total set of greenhouse gas (GHG) emissions caused directly and indirectly by an individual, organization, event or product". For simplicity of reporting, it is often expressed in terms of the amount of carbon dioxide, or its equivalent of other GHGs, emitted.

Carbon trading is an application of an emissions trading approach. Greenhouse gas emissions are capped and then markets are used to allocate the emissions among the group of regulated sources. The idea is to allow market mechanisms to drive industrial and commercial processes in the direction of low emissions or less "carbon intensive" approaches than are used when there is no cost to emitting carbon dioxide and other GHGs into the atmosphere. Since GHG mitigation projects generate credits, this approach can be used to finance carbon reduction schemes between trading partners and around the world.

Carbon credits are a key component of national and international attempts to mitigate the growth in concentrations of greenhouse gases (GHGs). One Carbon Credit is equal to one ton of Carbon. There are two distinct types of Carbon Credits: Carbon Offset Credits (COCs) and Carbon Reduction Credits (CRCs). **Carbon Offset Credits** consist of clean forms of energy production, wind, solar, hydro and biofuels. **Carbon Reduction Credits** consists of the collection and storage of carbon from our atmosphere through reforestation, forestation, ocean and soil collection and storage efforts. Both approaches are recognized as effective ways to reduce the Global Carbon Emissions crises.

How to purchase quality **carbon offsets**

A Google search for carbon offsets brings up more than 2,000,000 hits, and the information can be overwhelming. Wikipedia defines most of the terms and processes (see the glossary above). In my searching I found that one of the best, concise overviews is provided by the David Suzuki Foundation (*www.*davidsuzuki.org), and much of the material below derives from this foundation. The Government of Canada provides valuable, detailed information on its web site: http://www.ec.gc.ca/doc/virage-corner/2008-03/526_eng.htm.

What makes a good offset? Opinions vary on some of the finer points, but most experts agree that several conditions are necessary. Good offsets are **additional**; that is, they result in greenhouse gas reductions that wouldn't have otherwise occurred without the incentive of carbon offsets. For example, if a company is required by regulation to install technology to reduce emissions from its factory, the resulting emission reductions should not be sold as offsets.

A good carbon offset should also result in **permanent** reductions in greenhouse gas emissions. This is one reason why some organizations, including the David Suzuki Foundation, recommend against using tree-planting to generate offsets. Although trees have many benefits for the environment, they make risky carbon offsets because they are susceptible to fire, logging and insect infestation – any one of which can release the stored carbon back into the atmosphere and render the offset worthless. Nevertheless, the Province of British Columbia does invest in tree planting for carbon offsets. In this case the provincial government has control over future use of these forests and the project has credibility.

Good carbon offsets should also be **verified** by qualified auditors to ensure that the reductions have actually taken place. At the top end is the Gold Standard. Offsets that carry the Gold Standard label are regarded as the highest quality offsets in the world, and help fund new renewable energy projects. They are independently audited to ensure your purchase has a climate benefit.

Carbon offsets that are real, additional and permanent can have a direct, positive impact on the climate. And they can

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[1] Research Scientist, Institute of Ocean Sciences
Department of Fisheries and Oceans
Sidney, British Columbia.

create some other important benefits. They provide money for much-needed renewable-energy and energy-efficiency projects, which can help move society away from fossil fuels and toward a clean-energy economy. Buying carbon offsets can also help to deal with emissions that aren't currently covered by government regulations, such as international air travel. Carbon offsets can also put a value on carbon, and help to educate businesses and consumers about the climate impact of their daily decisions, and where they should target their own reduction efforts.

Of course, people should do everything they can to reduce their greenhouse gas emissions, but when that isn't possible or feasible, buying high-quality offsets at least ensures that an equivalent amount of reductions is made elsewhere. Carbon offsets alone won't solve climate change. We still need to find ways to make deep reductions in our own emissions. But the problem of climate change is so massive that it requires a whole range of solutions, and offsets can be part of that.

I searched on several Canadian sites to calculate CO_2 emissions for return travel from Victoria BC to Ottawa, via Vancouver, which is my expected route to next year's CMOS Congress. The CO_2 emissions varied a bit, averaging 1,500 kg with offset costs of $55. A return trip from St. John's NL needed half these offset costs. This cost per tonne is higher than a typical offset value for land travel because I included an optional multiplier to cover high-altitude emissions of commercial jets on long flights. Of course, shorter trips by road emit much less CO_2. For example, return travel to next year's Ottawa Congress from Montréal in a Ford Focus is rated at 70 kg of CO_2, for an offset cost of $2.60. If you car pool or use public transport, the emissions will be even less.

For additional help in guiding your decisions about carbon offsets, The David Suzuki Foundation and the Pembina Institute have released a guide, *Purchasing Carbon Offsets,* along with a table of top companies. Both are available at http://www.davidsuzuki.org/Publications/offset_vendors.asp. Both groups encourage you to do your own research on where to invest your dollars. After all, it is your money and you do want to spend it wisely.

Highlights of Recent CMOS Executive Meeting September 11th 2009

■CMOS has submitted a Brief to the House of Commons Standing Committee on Finance, in response to a call for suggestions about how best to distribute available government resources. The Brief is on the CMOS Web site in both English and French, and is reprinted in this issue of the *CMOS Bulletin SCMO* on page 160 in English (163 en français).

■ The executive is searching for its annual CMOS tour speaker. Environment Canada and Fisheries and Oceans Canada take turns sponsoring a scientist to travel across the country giving lectures at our local CMOS Centres. This year Environment Canada will sponsor the speaker. Past president Andy Bush and Executive Director Ian Rutherford are looking for candidates. Last year's speaker was Ken Denman.

■ Executive Director Ian Rutherford will travel to Washington DC this fall to participate in a first-ever Strategic Planning forum of the American Geophysical Union, with expenses paid by AGU. The purpose of the Forum is to **"***create a shared vision for AGU's future within a vibrant, worldwide Earth and space science community***.**"

■ Plans are well under way for the 2010, 2011 and even 2012 CMOS Congresses. The 2010 congress in Ottawa will be a joint meeting with the Canadian Geophysical Union. Organizers have found some innovative ways to recognize sponsors, in addition to providing space for displays. These include having companies sponsor special events, such as the conference ice-breaker.

■ The 2011 congress will be held at the conference centre in Victoria, British Columbia, with accommodation at the Empress, Queen Victoria and Chateau Victoria hotels. The banquet will be held in the Crystal Gardens across the road from the conference centre.

■ The 2012 congress will be held in Montréal, with participation by the American Meteorological Society yet to be confirmed.

■ CMOS is aggressively defending the rights of our Accredited Consultants. Recently, one of our consultants was issued a "Cease and Desist" order by a provincial engineering society, who claimed the consultant was engaged in engineering work. We have responded to this engineering society, noting that CMOS-accredited consultants are entitled to work in the field of geophysical fluid dynamics under the "Natural Sciences" exemption. This response required considerable effort by our Private Sector and Accreditation Committees, our Executive Director, and also coordination with the Canadian Association of Physicists.

■ Please consider submitting your next paper to ATMOSPHERE-OCEAN! The journal has an impact factor of 1.5 and now publishes all pages in colour. ATMOSPHERE-OCEAN is published quarterly, and accepts special issues on major research topics in meteorology, oceanography and related disciplines.

■ We encourage CMOS corporate members to advertise in the *CMOS Bulletin SCMO*. These ads provide excellent exposure to a focussed group of meteorologists and oceanographers.

Sophia Johannessen
Recording Secretary

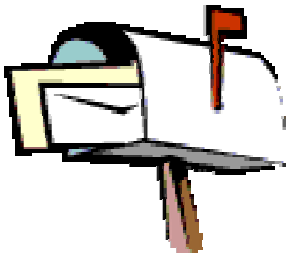
Correspondence / Correspondance

Source: Canadian Ocean Science Newsletter # 44, June 2009

From: Rob W. Macdonald
Chair of CNC/SCOR
Research Scientist
Institute of Ocean Sciences
Department of Fisheries and Oceans
Sidney, British Columbia

To: Canadian Ocean Scientists

Subject: Canadian Ocean Science Newsletter



As you will know from previous newsletters, I've now become the chair of the Canadian National Committee for SCOR (Scientific Committee on Ocean Research), having taken the torch from Gordon McBean at Halifax. The Canadian Committee traditionally does a number of tasks including interfacing with the International SCOR, reviewing Working Group proposals with the intent of getting Canadian scientists involved where appropriate, administering a top-up scholarship for deserving graduate students holding NSERC scholarships and, of course, putting out this Newsletter. We want to ***inform*** the Canadian ocean science community and we want to ***be informed*** by this community. My first request to you is to make this ***your*** Newsletter; contribute your ideas and your news in short articles. My background, interest and passion is ocean science, not bureaucracy. So, my second request is for advice from you. How can we in this CNC-SCOR committee better promote Canadian Ocean Science? Your ideas are welcome. I believe the time has never been more crucial for ocean advocacy based on sound science; we face the challenges of climate change and contaminants, as we all know, but perhaps most of all we face the challenge of communicating these risks coherently and professionally to decision-makers. The SCOR committee (National and International) provides an opportunity to communicate and I depend on you, Canada's ocean scientists, to help with that task.
Rob Macdonald

Prochain numéro du *CMOS Bulletin SCMO*

Le prochain numéro du *CMOS Bulletin SCMO* paraîtra en **décembre 2009.** Prière de nous faire parvenir avant le **13 novembre 2009** vos articles, notes, rapports d'atelier ou nouvelles à l'adresse indiquée à la page 138. Nous avons un besoin URGENT de vos contributions écrites.

Source: Canadian Ocean Science Newsletter # 45, August 2009

From: Dan Kelley
Associate Professor and Graduate Coordinator
Department of Oceanography
Dalhousie University
Halifax, Nova Scotia

To: Rob Macdonald
Chair of CNC/SCOR

Subject: Response to the Chair of the CNC/SCOR

In the CNC/SCOR Newsletter of June, 2009 [http://www.cmos.ca/scor/NLJune2009.pdf], writing as the new chair of CNC/SCOR, you asked "*How can we in this CNC-SCOR committee better promote Canadian Ocean Science?*" Thank you for asking this important question. There are many answers in many categories, and I will focus here on just one: the training of postgraduate students. To my mind, this is a key issue. Canada is on the verge of losing a great deal of expertise through retirement, and it is facing new challenges that will require new approaches. New blood is important. In the interests of promoting discussion, let me lay out four ideas.

1. CNC/SCOR should lobby DFO and similar government agencies to provide increased funding for postgraduate students.

Background: The funding will help to attract more, and stronger, students to Oceanography. That is a sufficient goal in and of itself, but to "sell the idea" to the agencies, CNC/SCOR might argue that (1) funding students is the cheapest way to focus cutting-edge research on areas that interest the agencies, and (2) connections made with students today will be valuable when agencies seek to hire, tomorrow.

Action: Urge the agencies to resurrect the highly regarded "Subvention Grant" program, in which agency funds were used to fund postgraduate students. Likelihood of a successful result: high.

2. Lobby the Canadian government to keep CFCAS alive.

Background: As noted in #4 below, NSERC has only limited funds in its Discovery Grants program. There is funding for business-oriented work, but this does not apply well to environmental science. By contrast, the CFCAS focus areas matched well with those of active university research, and CFCAS moneys were sufficient to actually ***fund*** the work, not just nibble around the edges. CFCAS did everything right, so there is no need to study how to create a new CFCAS. All that's needed is a cheque.

Action: Use the reputation of a National Committee to lobby the federal government to provide new funding for CFCAS. Likelihood of a successful result: moderate to high, depending on political "optics".

3. Take action against foreign-student differential fees for postgraduate students.

Background: Professors typically pay these fees from grants, and so increasing limitations of the grants (see #2 and #4) along with increasing fees, are leading to worrisome limitations on the talent pool. This is bad today, and will be worse tomorrow. Small nations are wise to look outward. Canada needs the best researchers, no matter the source, and it needs the solid international connections that come from foreign students who study here and then return home.

Action: Create a new CNC/SCOR (or third-party) scholarship to offset foreign-student differential fees. Likelihood of a successful result: high.

4. Lobby NSERC to supply more funds to the Discovery Grant program.

Background: The median grant is now about 20K for Panel 9, which covers many oceanographers. (This does not count the 1/3 of applicants who are zero-funded). At many universities, a graduate student costs more than 20K, even before taking into account the costs of their research. NSERC is Canada's flagship funding agency for university science, and something is wrong if it cannot afford to fund postgraduate students.

Action: Use the reputation of CNC/SCOR in the lobbying effort. Highlight the fact that the committee is somewhat arms-length. (The problem with the chorus of comments made by professors is that they are not disinterested parties). Likelihood of a successful result: probably (says a graying professor) quite low.

Dan Kelley

Next Issue *CMOS Bulletin SCMO*

Next issue of the *CMOS Bulletin SCMO* will be published in **December 2009.** Please send your articles, notes, workshop reports or news items before **November 13, 2009** to the address given on page 138. We have an URGENT need for your written contributions.

From: Howard Freeland
Institute of Ocean Sciences
Department of Fisheries and Oceans
Sidney, British Columbia

To: Editor, *CMOS Bulletin SCMO*
Ottawa, Ontario

Subject: New Argo Newsletter

There is a new edition of the Argo Newsletter "*Argonautics*" available online. This issue contains a detailed review of problems experienced with Druck pressure sensors. Systematic failures were taking place in too many floats and the fault was traced to the pressure sensor. Following this discovery the SeaBird Corporation issued a worldwide recall of all CTDs that used the Druck sensors (See *CMOS Bulletin SCMO*, Vol.37, No.3, June 2009, pp. 71-72).

As interest in the global Argo array grows and scientists around the world discover the ease of access to the real-time data that are now available demand for information and training is growing. The Newsletter contains reviews of two outreach meetings that took place during 2009, one in Nigeria to train African scientists and the other in Nadi, Fiji, which was created for the benefit of scientists in the Pacific island nations. The Newsletter also contains reviews of the 10th Argo Steering Team meeting and the Third Argo Science Workshop, both of which took place in Hangzhou, China, and the 9th Argo Data Management team meeting.

The 11th Argo Newsletter can be found at:-

http://www-argo.ucsd.edu/Argonautics11.pdf

Howard Freeland

STOP THE PRESS

The *CMOS Bulletin SCMO* has learned that Dr. Wendy Watson-Wright, ADM Science, Department of Fisheries and Oceans, will be taking over from Patricio Bernal as Executive Secretary of the Intergovernmental Oceanographic Commission of UNESCO in Paris. This nomination will be effective in January 2010.

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.

The First Tropospheric Temperature Profile in Canada

by K.A. Devine[1] and G.S. Strong[2]

While the first published measurement in the free atmosphere was made at Igloolik in 1823 (Devine, 2004), a detailed temperature profile of the troposphere in Canada had to wait another 88 years. John Patterson who had been hired as a physicist by the Meteorological Service of Canada (MSC – that's right, the present 'MSC' is not a new name) in 1910, immediately began these aerological measurements. He started with measurements from *meteorographs* released on hydrogen-filled balloons near the recently constructed headquarters on Bloor Street in Toronto, and with kites at the magnetic observatory in Agincourt, Ontario.

The meteorograph, depicted in Figure 1, was designed by W.H. Dines in the UK and recorded temperature versus pressure on a 1" square silvered copper or glass slide (Dines, 1906). An aneroid (B) moved the slide (R) horizontally to record pressure, while a scribe attached to the temperature sensor marked the slide vertically. The temperature sensor consisted of a nickel silver strip (M) which moved the scribe with respect to an invar rod (H), which has a low coefficient of expansion. The result was a curve of pressure versus temperature as the balloon ascended. Later units incorporated a hair humidity element (X) attached to a separate scribe. Before each flight the meteorograph was calibrated in a gasoline-filled chamber. This calibration produced a series of four isothermal lines with ticks at fixed pressure values directly on the slide. The instrument was mounted on a wire frame surrounded by a thin aluminum cylinder 16 cm high by 7 cm in diameter that acted as a radiation shield (Middleton, 1943). The entire assembly weighed only 60 grams, a reduction from Dines 1906 prototype that had weighed 90 grams. By comparison, the Vaisala RS92 radiosonde with battery and transmitter presently used in Canada weighs 250 grams.

The first regular ascents with this very light meteorograph were conducted by C.J.P. Cave at Pyrton Hill, UK on July 1, 1907 (Dines, 1931). In the next year-and-a-half 133 ascents were made in the UK and 83 were recovered. Earlier, Dines had made kite observations in 1901 in England and from 1902 to 1904 near the western shores of Scotland with a clock driven meteorograph of his own design. With encouragement from Napier Shaw, the Director of the British Meteorological Office, Dines developed a meteorograph which was only one tenth the weight of the clock-driven versions. The initial cost of the production units

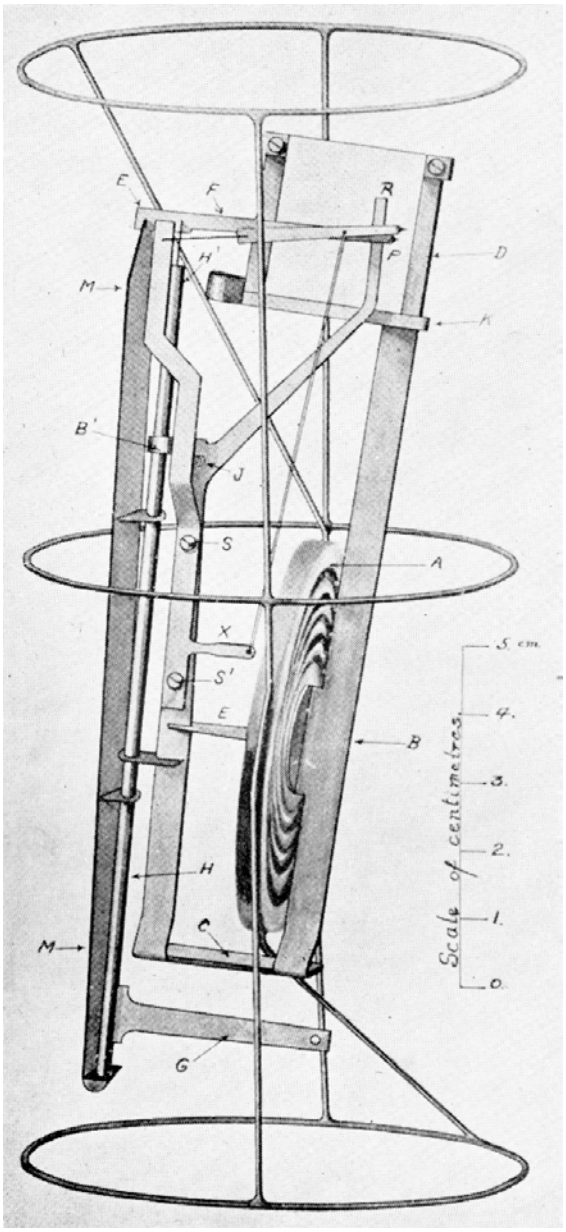


Figure 1: The Dines Meteorograph (BMO, 1956)

[1] Meteorologist Consultant, Aurora, Ontario

[2] Meteorologist Consultant, Ardrossan, Alberta

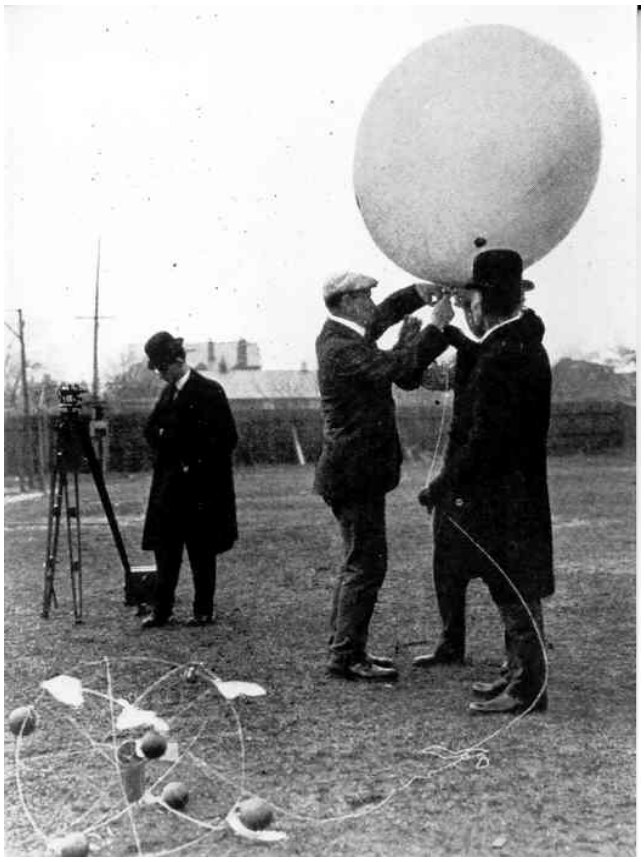


Figure 2: Preparation for a Meteorograph Flight at Toronto in early 1911 with John Patterson in the middle.

was £1, whereas the larger and much heavier instruments produced in other European countries cost £15 to £20. The main reason for the weight of these other meteorographs was due to the clock-driven recorder that the Dines unit did not require. Also, these clocks had difficulty operating in the very cold air of the upper troposphere (Khrgian, 1959). Near the end of its commercial life this unit cost £13 10s from Negretti & Zambra as part number M2261 (N&Z, 1938). The Dines meteorographs were widely used until 1939 as a research instrument.

Soundings began in Canada in December 1910 (Patterson's notebooks) and generally reached the stratosphere, some beyond 20 km. When found, the instruments were mailed back to the MSC by the finder for a reward of $2.50 (Patterson, 1915). Flags on the spherical bamboo frame that protected the instrument during landing (Figure 2), were intended to attract attention and aid in their recovery. The bamboo frame with the instrument, red balls, and flags weighed 110 grams. Once retrieved, the temperature profile was abstracted using an 80-power microscope and a stage specifically designed for these slides. The temperature could be read to the nearest ½ degree Celsius and was considered by Dines to be accurate to 1°C. Later studies indicated that the daytime temperatures at 12 km were 2°C warmer than those at night (Lennahan, 1936), deemed an error due to radiation, a problem later duplicated in radiosondes well into the 1960s. Glazebrook (1923) indicated that the temperature error was about 1°C and the pressure error was about 1 millibar. Patterson later modified the Dines to lift the scribe off the plate during descent, since the calibration was not the same as during ascent. Other researchers used this descent information. Occasional turbulence near the tropopause could destroy the trace. Since these meteorographs could be followed visually with an optical theodolite, winds could also be determined, at least until the instrument entered cloud. Most Canadian soundings were carried out during evening (around 0100 GMT) in order to reduce solar heating, and as a result winds were not always determined.

Unlike today's radiosondes, the meteorographs had to be recovered in order to retrieve the data, and the average time to recover the instruments was six months. Hence they were used strictly for research, operational soundings having to wait for the development of the radiosonde. The first Canadian meteorograph flight to be recovered was released close to 315 Bloor Street in Toronto on February 3, 1911, with the meteorograph being retrieved from Norwood, 138 km northeast from its release point. This first sounding, including computed winds, is reproduced in Figure 3. A temperature profile from a radiosonde released at Egbert, ON on 04 February 2009 (98 years later) is superimposed as confirmation that the 1911 data are quite realistic. The 1911 profile indicates a sharp inversion capped around 1500 m MSL, consistent with southeast boundary layer winds veering into southwest above the inversion. This first sounding was tracked by optical theodolite at two-minute intervals, but only for the first 16 minutes (under 3 km), presumably lost in cloud cover (Figure 4).

Meanwhile, the first kite sounding from Agincourt was on February 28th 1911. These kites used a large clock-driven meteorograph. The Dines meteorograph flights were transferred out of Toronto to Woodstock by July 5, 1911 in order to improve the recovery rate (Patterson notebooks). Most instruments were re-used, and one was re-used three times before being lost. Since bottled hydrogen was not available in Canada, Patterson built a hydrogen generator (Devine, 2008). His balloons weighed 250 to 330 grams. The free lift of the balloon was determined before release using a special filler/balance, similar to that used in more recent years for ceiling balloons. There were problems with balloon quality after World War I.

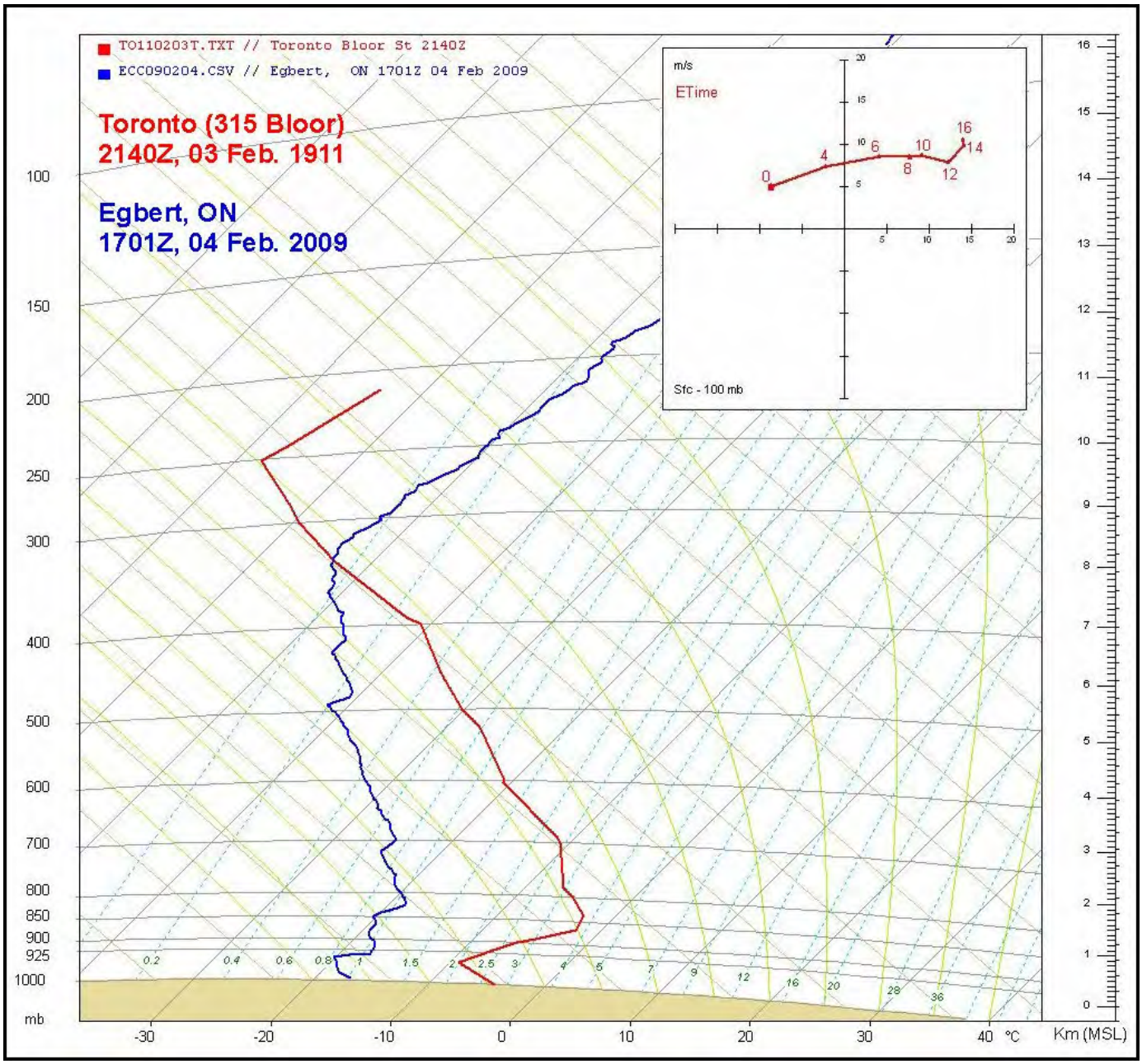


Figure 3: The First Temperature Profile with Winds in Canada, 3 February 1911.
Figure also shown in colour on the cover page.

There were 94 meteorograph releases between 1911 and 1915 but further soundings were terminated in 1917 due to a lack of meteorographs during the war years. Of these 94 earliest soundings, 53 were recovered, and 47 reached the stratosphere, as summarized by Patterson (1915). Balloon sounding operations resumed in 1919 at Queen's University, Kingston, but again were moved to Woodstock since the recovery rate was only one in four (Thomas, 1996). In 1924 they were moved to Goderich, while another station was opened in Calgary in 1922. Patterson also mentioned that there were three flights from Regina about the time operations started in Calgary. During the period from 1922 to the mid-1930s, a total of 40 to 120 meteorographs were released each year from Woodstock, Goderich and Calgary (MSC Annual Reports). The British expedition to Fort Rae, NWT, during the Second Polar Year of 1932-33, released 450 Dines meteorographs but only two were recovered due to the sparse population in the subarctic. Of seventy instruments released at Calgary and Goderich during the Polar Year, fifty-four were recovered. The greatest height reached was 24.5 km and the lowest temperature recorded was –73.6°C (Patterson, 1934). Soundings continued from Calgary and Goderich until after aircraft flights began in 1935.

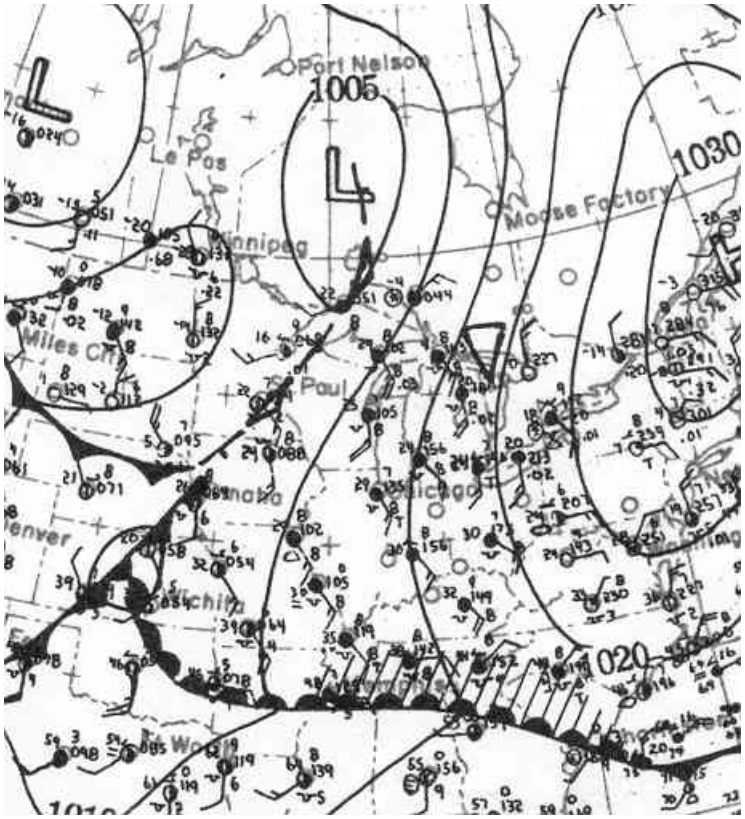


Figure 4: Surface Map for 1300 GMT, 3 February 1911 (United States Weather Bureau)

Of the 585 flights which were reported in the 27-year period ending in 1937, 63% of the instruments were recovered. While a tray of meteorograph slides dated 1926-27 is still held in Downsview, corrosion on the silver coating has unfortunately obliterated the traces for these soundings. No examples of the Dines meteorographs have been located in Canada. Experimental radiosonde flights which had begun under R.C. Jacobsen during the Polar Year at Coppermine using the Russian Moltchanoff instruments, continued at Toronto. Here the MSC experimented with early radiosondes such as the American Blue Hill radiosonde, and probably the German Duckert, and French Bureau sondes. Jacobsen initiated work on the Canadian chronometric radiosonde which became operational at Gander in 1941, providing an extremely important service for the war effort, particularly for wind fields for Allied aircraft being sent to the European theatre.

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John Patterson's notebooks, 1900-1930 (located in his biographical file in the MSC Library, Toronto). These six notebooks cover the period from when he was at Cambridge until he became director of the service. One notebook details 101 station inspections which he conducted starting in 1914. Such a level of involvement by one senior individual would hardly be possible in the bureaucracies of today.

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On the MSC Forecasters Forums and the Future Role of the Human Forecaster

by David M. L. Sills[1]

Résumé: Entre 2003 et 2005, le Service météorologique du Canada a tenu une série de trois forums sur les prévisionnistes dans le but d'obtenir des commentaires de la communauté météorologique en rapport avec les meilleures façons d'implanter une stratégie de restructuration et de développer une vision commune reliée à la production des prévisions du temps. Ces rencontres ont fourni l'occasion d'aller en profondeur dans un nombre de sujets en rapport avec la prévision opérationnelle au Canada et ont fait en sorte que la communauté internationale puisse profiter également de ces discussions.

Au cours de ces trois forums, plusieurs thèmes ont fait surface et révélé beaucoup d'inquiétude. Au tout premier plan de ces thèmes, on mentionne le rôle du prévisionniste en tant qu'humain. La plupart des participants aux forums ont fait savoir que le prévisionniste en tant qu'humain doit être «au centre de la prévision du temps», tout en augmentant l'importance du paradigme analyse/diagnostic/pronostic. À ces trois forums, on a recommandé le développement d'outils de haute technicité nécessaires afin de rendre possible ce rôle.

Suite aux résultats des forums, on a suggéré que le rôle principal du futur prévisionniste était de développer et de maintenir avec une vue d'ensemble une séquence de représentations composites évoluant avec le temps afin de mieux représenter les états courants et futurs de l'atmosphère. Avec l'utilisation d'outils de la prévision numérique du temps comme guide et l'aide méthodique de l'intelligence artificielle, ce rôle devrait s'accomplir par l'utilisation d'un système local d'analyse/prévision exécutable. Le travail du prévisionniste devrait être concentré sur les phénomènes météorologiques ayant un impact important surtout à cout terme mais aussi à long terme lorsque nécessaire. Les produits météo devraient être automatiquement générés à partir de base de données météorologiques, permettant ainsi à l'équipe des prévisionnistes de s'impliquer directement dans la météorologie et de partager, en tout temps, la connaissance de la situation.

In 2003, the Meteorological Service of Canada (MSC) began a significant restructuring of its forecasting operations in response to financial pressures. Senior management proposed that the MSC could be made more cost-effective while continuing to provide quality services by pursuing a more centralized forecasting approach and increasing the automation of forecasts via numerical weather prediction (NWP).

As a result, regional public / marine forecasting centres were reduced in number from 14 to five and renamed 'Storm Prediction Centres', or SPCs. Their locations and areas of responsibility are shown in Fig. 1. Aviation forecasts were centralized to two Canadian Meteorological Aviation Centres in Edmonton and Montréal. A national meteorological operations forecast office remained in the Montréal area. Defence and ice service weather offices were unaffected and are not discussed here.

In addition, a new methodology for operational forecasting was introduced. Specifically, automation of 'routine weather' forecasts would be increased to allow forecasters to concentrate their efforts on 'high-impact weather' (hereafter HIW). There would also be greater emphasis on science in operations, including improved forecaster knowledge, tools incorporating the latest research, and a more scientific forecast process.

Larger areas of responsibility (more than 1,000,000 km^2 at each SPC) effectively decrease the number of days with routine weather since on any given day meteorological conditions are rarely quiescent across the entire domain. Despite these new challenges, the number of operational forecasters assigned to each new SPC was less than that working in the same region before restructuring.

As the transition to the new MSC commenced, a number of important questions began to emerge. How would the role and responsibilities of the human forecaster change in this restructured organization? How would routine weather be discriminated from HIW on a daily basis? What kinds of tools and techniques would allow monitoring of, and forecasting for, such large areas of responsibility?

To help address these questions, three 'Forecasters Forum' meetings were held. The forums (discussed in greater detail in Sills 2008) took place in 2003 at Victoria, British Columbia, in 2004 at Toronto, Ontario, and in 2005 at Montréal, Québec. Each forum was three days in duration and was organized to have themed presentations followed by related 'break-out' sessions. In addition, each meeting was designed so that approximately 50% of participants were MSC operational forecasters from all parts of the country. In fact, over 60% of *all* MSC operational forecasters, including MSC aviation, defence and ice forecasters, attended at least one of the three forums. While MSC managers, researchers, and outreach

[1] Cloud Physics and Severe Weather Research Section
Environment Canada, Toronto, Ontario

officers made up most of the other participants, forecasters, managers and researchers from other organizations such as universities, the US National Oceanic and Atmospheric Administration, and The Weather Network were also present.

Presentation themes for the three forums included: the new MSC structure and forecasting methodology, defining HIW, the future role of the human forecaster at MSC, forecast tools of the future, forecaster training and development, links between operational meteorology and research, the future of NWP, and the communication of uncertainty via probabilistic approaches.

The forums revealed a surprising degree of concurrence. The new MSC forecast methodology - that routine weather forecasts would be automated and forecasters would focus on HIW - was well understood and for the most part accepted by those at the forums. Most participants thought that the human forecaster should be the "heart of weather prediction", meaning the forecast process would be driven by the forecaster rather than automated NWP systems. Furthermore, it was thought that to do an adequate job of predicting HIW, the forecaster must - on a daily basis - go through the analysis / diagnosis / prognosis process (i.e., "hands-on" meteorology) in order to have the opportunity to recognize potential HIW events, maintain skills, and develop expertise. NWP was considered to be a tool offering important guidance and it was agreed that forecasters should have a greater variety of models to interrogate (including long- and short-range ensemble and 'rapid update cycle' systems), as well as sophisticated methods of viewing NWP guidance and comparing it to observational data.

Most participants thought that output from ensemble forecast systems should be used by the forecaster to make deterministic products better, and that additional forecaster training is needed to reach a greater level of comfort with ensemble concepts. However, most participants also thought that more probability information should be included in public forecasts, especially in the longer range. Free-form text was identified as the best way for forecasters to express uncertainty to the public, especially when combined with graphical representations (e.g., the 'cone of uncertainty' commonly used by the US National Hurricane Center).

Three forecast production system paradigms were presented and compared via a panel discussion: a point-based matrix-editing approach (e.g. SCRIBE[2]), an area-based grid-editing approach (e.g. IFPS[3]), and an area-based object-editing approach (e.g. FPA[4]). All three approaches employ an underlying digital weather database. However, most participants thought that an area-based approach would be more intuitive for the forecaster than a point-based approach. They also believed that such an approach would be better suited to forecasting for large areas, and would make it easier to both incorporate local effects and provide graphical and gridded output for internal and external users. In addition, most believed that an approach that incorporates modifiable line, area and gridded field objects, such as that used with FPA, would allow the forecaster to do more "hands-on" analysis, diagnosis and prognosis.

Since the final forum in 2005, the MSC has completed the implementation of its restructuring strategy, and senior management has worked towards addressing a number of the various Forecasters Forum recommendations. However, some important recommendations made at the forums have yet to be acted upon, including committing to area-based, object-oriented forecast production. In addition, considerable uncertainty persists regarding the future role of the human forecaster. To address this lingering uncertainty, the results collected over the course of the three Forecasters Forums will be used below to make recommendations regarding the future role of human forecasters at the MSC and the tools that they should use.

At every forum, it was heard that human forecasters should be the "heart of weather prediction" and that there needs to be a return to "hands-on" meteorology, even if focussed mainly on HIW. The forecasters of the future will not be able to maintain their analysis, diagnosis and prognosis skills if their only role is occasional intervention when automated forecast processes go awry. In addition, the further forecasters get from working with unprocessed meteorological data, the less likely they will be able to recognize the cues and patterns that match conceptual models and lead to appropriate and effective actions.

It is often stated that it is becoming increasingly difficult for human forecasters to add value to NWP forecasts, especially beyond the first 12 hours or so, since only occasionally is NWP guidance seriously in error. However, it is at precisely those times when NWP does poorly that the weather is typically of critical importance to the public; that is, in significant HIW situations. Under these circumstances, expert forecasters can increase forecast skill considerably. Therefore, until NWP can better handle these critical situations, the human forecaster will have a crucial role in producing the best possible forecast for HIW.

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[2] SCRIBE is a forecast production tool developed and used operationally by MSC (see Verret et al. 1995).

[3] The Interactive Forecast Preparation System (IFPS) is a forecast production tool developed and used operationally by the US National Weather Service (see Ruth 2002).

[4] The Forecast Production Assistant (FPA) is a forecast production tool developed by MSC and used operationally at a number of commercial and government forecasting offices (see Paterson et al. 1993).

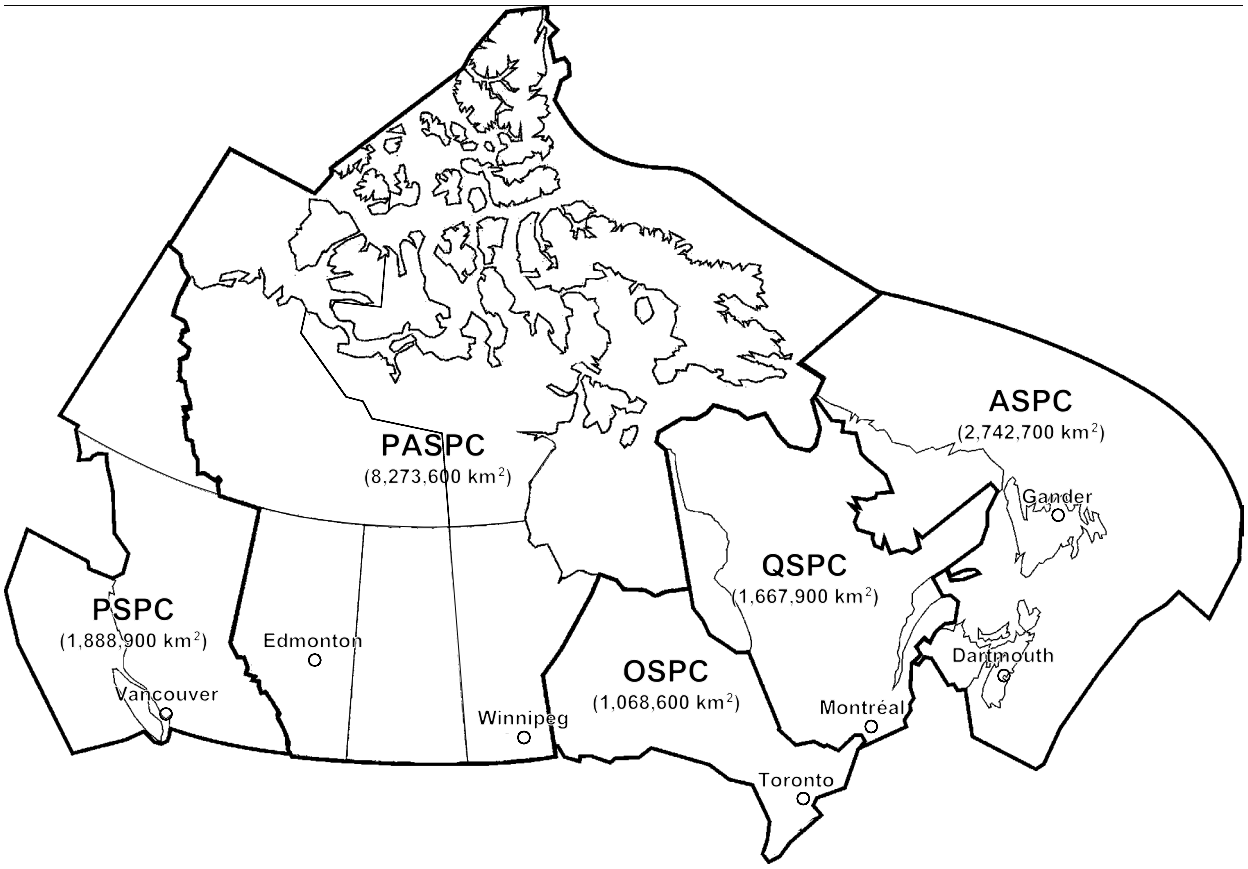

Figure 1: Map of Canada showing MSC SPC areas of responsibility (thick lines) with values in square kilometres (including marine areas). The SPCs are Atlantic (ASPC), Québec (QSPC), Ontario (OSPC), Prairie and Arctic (PASPC), and Pacific (PSPC). SPC office locations are also shown (circles). Note that both ASPC and PASPC split their duties between two office locations. Canadian Meteorological Aviation Centres are collocated with the SPCs in Edmonton and Montréal. The national meteorological operations forecast office is also located in the Montréal area.

Computers are still a long way from doing what humans do best. During the Sydney 2000 nowcasting demonstration project, the relative success of the NCAR Auto-Nowcaster system at nowcasting deep, moist convection compared to other nowcasting systems was based on the ability of the human forecaster to correctly analyze and diagnose low-level convergence boundaries and enter boundary information into the system (Wilson et al. 2004). Also, Project Phoenix has consistently shown that forecasters generate considerably better short-range predictions when NWP is withheld and they are forced to spend more time on analyses and diagnoses, and creating their own prognoses (McCarthy et al. 2007).

Taking all of the above into account, it is suggested here that the primary role of the human forecaster should be to develop and maintain a shared weather-object database that uses a sequence of plan–view composite depictions evolving through time to best represent the current and future states of the atmosphere. This would be accomplished using an area-based, object-oriented analysis / forecast system with an intuitive user interface, plus a toolbox of NWP guidance and carefully designed artificial intelligence (AI) assistants. The emphasis would be on sensible weather near the surface since that region of the atmosphere has the greatest impact on the activities of the public.

This proposed role is illustrated in Figure 2. As shown in the flowchart, the interaction between the human forecaster and the analysis / forecast system would be central to the forecast process, though the forecaster could also influence quality control, observations (e.g., targeted or special observations) and NWP.

In this forecast process, the forecaster would begin with analysis and diagnosis using past and current observational data in order to develop a mental model, or working hypothesis, for the current weather situation. Once a robust understanding of the current weather has been achieved (a critical step for accurate prediction), the forecaster would decide which NWP solution to use as a basis for prognoses. The NWP solution could be output from a deterministic model or an ensemble prediction system. Using the analysis / forecast system, any combination of observational and NWP data layers could be superimposed by the forecaster to assist with this selection.

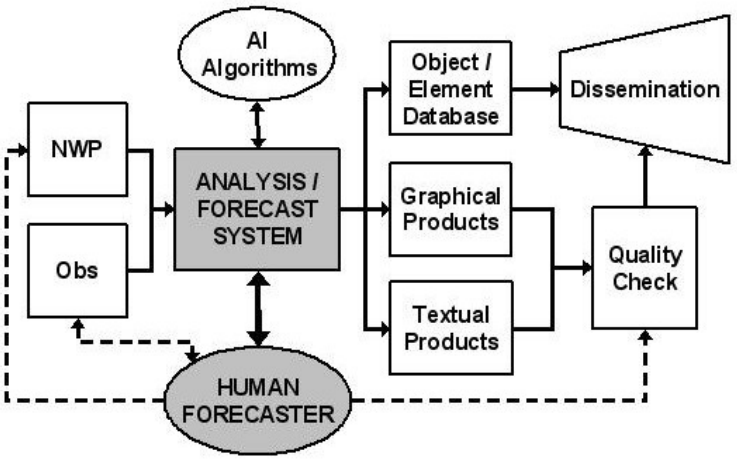

Figure 2: Flowchart (left to right) showing the proposed role of the human forecaster in the forecast production process. White boxes at left represent various inputs while white boxes at right represent various output procedures. Bold arrows indicate that the main interaction is between the human forecaster and the analysis / forecast system. The human forecaster also may influence NWP, observations, and quality checking (all shown as dashed arrows). Public reports of severe weather events are a special type of observation that could go directly to the human forecaster (also shown as a dashed arrow).

Once the analysis / forecast system database has been populated with the selected NWP data, the forecaster would use the NWP guidance, conceptual models, and the forecast data from the previous shift to develop plan-view composite depictions at future times. The depictions would be deterministic in nature, representing the forecaster's best estimate of the evolution of weather features over time. Line and area objects would be used to represent conceptual weather features, such as fronts and jets, and precipitation and cloud areas. Gridded field objects including surface pressure, temperature, relative humidity and wind would be modified as needed at each time interval to match the placement of the line and area objects. For routine weather, only minor adjustments to the depictions developed by the previous shift might be needed. Note that while both observations and NWP output could be *viewed* in three spatial dimensions, any object *editing* would be done in the much simpler two spatial dimensions (i.e., plan view).

Through the above analysis / diagnosis / prognosis process, the forecaster would identify any potential, imminent, or occurring HIW and focus further efforts there. In particular, the forecaster would investigate uncertainty in the timing, location and intensity of the HIW, as well as related impacts. Most modifications to the weather-object database would likely occur during this part of the forecast process. As new data arrive throughout the day, the forecaster would produce detailed analyses, compare observations with NWP / AI output, evaluate 'what if' scenarios, and test and refine hypotheses related to HIW made earlier in the day, leading to revised prognoses – all within the analysis / forecast system.

For convective nowcasting, the forecaster would use radar and satellite imagery, lightning data, and surface observations in conjunction with conceptual models, convective-scale model output, and AI algorithms to forecast the future track and intensity of storms, and/or the development of new convection. Uncertainty would be expressed in watch/warning products using a combination of probability graphics and free-form text. More sophisticated users requiring specific uncertainty information for decision-making could have direct access to ensemble NWP output.

The resulting weather-object database would be shared digitally with other forecasters in the same office or in neighbouring offices, and would be disseminated to interested users. Weather element matrix data at pre-selected point locations and gridded weather element data could also be generated from this database. The main idea is that the daily activity of the forecast team would be focussed on meteorology, not the details of generating products, thereby maintaining shared situational awareness at all times.

The forecaster workstation required to facilitate this role should make best use of human strengths (pattern recognition; using conceptual models and formulating mental models; judgment and decision-making when dealing with complex, incomplete or conflicting data; applying adaptive strategies in rapidly changing situations) and machine strengths (dealing with large volumes of data; handling complex calculations and complicated parameter interactions; automating product generation) while also enhancing forecaster expertise. As has been seen in the past, it is tools that – to a great extent – determine the role of the forecaster.

In addition to the primary prediction role, a significant proportion of the forecaster's annual schedule should be devoted to training / skills development and applied research such as case studies, techniques development, and verification projects. This proportion might justifiably be as high as 50%, though currently at the MSC it is a nominal 20%. Effective communication of the forecast to users would be a separate role handled by another class of meteorologists skilled at forecast interpretation and understanding user-related impacts. Within the MSC, such a class of meteorologists already exists and is known as the Warning Preparedness Meteorologist (WPM). However, the WPM of the future may need to become more integrated into the forecast team than is currently the case (e.g., work shifts alongside the forecasters) in order to be more aware of the forecast issues of the day and the uncertainty associated with HIW prognoses.

To conclude, the human forecaster currently plays a vital role at MSC weather offices, and could continue to contribute toward significant improvements in HIW forecasting if supported by tools that achieve an optimal human-machine mix. An exciting, fulfilling future is possible for the human forecaster, but depends on decisions that

senior managers at meteorological services, like the MSC, will make in the coming years. It is hoped that the results from the forums, and the discussion in this article, will help to guide such decisions.

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Tenure-Track Faculty Position in Satellite Remote Sensing

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

Candidates whose research interests are in the global or regional scales will be considered. They should also have a strong disciplinary expertise in physical meteorology and/or dynamics.

A Ph. D. in atmospheric or oceanic sciences or a closely-related field is required.

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

Qualified candidates are invited to submit an application, including a curriculum vitae, a research proposal, and a teaching statement to: Dr. John R. Gyakum, Chair, Department of Atmospheric and Oceanic Sciences, McGill University, 805 Sherbrooke Street West, Montreal, QC H3A 2K6, Canada (Telephone: 514-398-3719; fax: 514-398-6115), or by e-mail with pdf format application to: satellite@meteo.mcgill.ca.

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

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

Review of the applications will begin on October 15, 2009, and continue until the position is filled.

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

PAGSE Annual Activity Report 2008-2009

The Partnership Group for Science and Engineering (PAGSE; www.pagse.org) is a cooperative association of more than twenty-five national organizations in Science and Engineering. It was formed in June 1995 at the invitation of the Academy of Science of the Royal Society of Canada. The national organizations that comprise PAGSE represent approximately 50,000 individual members from industry, academia, and government sectors. They work collectively to represent the Canadian science and engineering community to the Government of Canada, and to advance research and innovation for the benefit of Canadians. PAGSE is ***not*** a lobby group. It does not seek an audience in order to advance the cause of specific science and engineering initiatives: rather, its intent is to address the broader issues of science and engineering policy at the national level.

To be truly representative of the science and engineering community in Canada, PAGSE must ensure that individual members of member societies and associations are aware of the activities that are undertaken in their name. While details may be found on the PAGSE website (www.pagse.org), PAGSE also provides a periodic summary of activities.

Bacon & Eggheads

PAGSE, in partnership with the Natural Sciences and Engineering Research Council (NSERC), sponsors a monthly breakfast meeting held on Parliament Hill, and known as *"Bacon and Eggheads"*. Speakers at the meetings inform parliamentarians about recent advances in science and engineering. No Bacon & Eggheads talks were held in Fall 2008 due to the federal election. Since the return of parliament in January 2009, PAGSE has organized the following presentations:

- "*Are Batteries and Fuel Cells Ready for All-Electric Vehicles?*", by Jeffery Dahn, Dalhousie University**,** Thursday, January 29, 2009;
- "*Life, Climate and Vanishing Ice at the Top of Canada*", by Warwick Vincent, Université Laval, Thursday, March 5, 2009;
- "*When the canary dies*", by Bridget Stutchbury, York University, Thursday, April 2, 2009;
- "*Hot prospects in the cold: the new Geological Map of the Arctic*" by Marc St-Onge, Natural Resources Canada, Thursday, May 7, 2009
- "*The Violent High Energy Universe*", by Victoria Kaspi, McGill University, Thursday, June 4, 2009

PAGSE Monthly Meetings

Guests, representing science and engineering in the government and industry sectors, are invited to monthly PAGSE meetings to present their perspectives on science and engineering in Canada, on the activities of their organizations, as well as the potential issues and challenges that they would like to see PAGSE address. Members also consider federal activities and reports and how best to promote and sustain Canada's scientific base. The meetings are held at the University of Ottawa. During the last year PAGSE has welcomed the following guests:

- October 7th 2008: Dr. Chad Gaffield, President, Social Sciences and Humanities Research Council
- February 17th 2009: Eliot Phillipson, President, Canada Foundation for Innovation
- March 17th 2009: Dr. Suzanne Fortier, President, Natural Sciences & Engineering Research Council

On July 1 2009, Rees Kassen, University of Ottawa, took over as Chair of PAGSE from Dawn Conway. PAGSE thanks Dawn for her invaluable contributions and leadership.

Submissions to Parliamentary Committees

PAGSE submits a brief each year to the House of Commons Standing Committee on Finance (HCFC). In August 2008, it submitted a brief on the theme "*Investments in Big Science Initiatives and International Science Partnerships".* The theme was governed by the stated priorities for briefs to the Finance Committee for 2008.

Summary of the Submission:

Canada is one of the largest countries in the world, yet historically it has been a minor player in international science projects, including those of strategic importance to the country. Collaboration on international science not only exposes Canadian scientists to breaking discoveries, it provides the critical mass required for certain major research initiatives, as well as access to scientific talent and intellectual property, representing huge leverage of the country's investment. It also allows Canadians to benchmark against other countries and to influence international programming while enhancing Canada's reputation as a serious international partner, which can influence leading international scientists to consider working here. Greater involvement and investment in selected major international initiatives will help change the perception of Canada from that of a small player who must join with other small players for access to a scientific programme, to that of a key partner.

International science is defined as initiatives and Secretariats requiring the coordinated financial, logistical or intellectual resources of several countries and sectors. Big Science is defined as initiatives of a significant magnitude

that require resources beyond the capacity of any single institution, funding agency or country to operate, and which are expected to yield very significant results. Big Science includes all levels of initiatives from consortia at facilities such as CERN (European Organization for Nuclear Research); the world acclaimed Sudbury Neutrino Observatory Laboratory; or the Ocean Drilling Programme, to major research networks such as the Polar Environment Research Laboratory on Ellesmere Island; and NEPTUNE, which will be the world's largest cable-linked seafloor observatory.

Canada subscribes to a number of international science programmes and hosts the international secretariats for a few. It can ratchet up its reputation, contributions and most importantly, its benefits, by coordinating funding sources, supporting infrastructure and operational costs; hosting international science secretariats, and removing strictures affecting the environment for innovation and economic development. These measures will enhance the reputation of Canadian science and scientists in the international sphere, increase awareness by industry of the roles played by Canadians, and will encourage the retention of research and innovation in Canada.

The Partnership Group recommended:

- *That the federal government adopt a strategic approach to investments in big science initiatives and international science partnerships. The approach must incorporate financial support to ensure full benefits to Canadians and their economy.*

For further information on activities, please visit the PAGSE website www.pagse.org

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Rapport annuel d'activités du PFST pour 2008-2009

Le Partenariat en faveur des sciences et de la technologie (PFST; www.pagse.org) est une association coopérative de plus de vingt-cinq organisations nationales en sciences et en génie et constituée en juin 1995 à l'invitation de l'Académie des sciences de la Société royale du Canada. Les organisations nationales membres du PFST regroupent plus de 50 000 membres provenant de l'industrie, du milieu universitaire et des gouvernements. Elles œuvrent ensemble pour représenter le milieu canadien des sciences et du génie auprès du gouvernement du Canada et faire progresser la recherche et l'innovation, à l'avantage des Canadiens et des Canadiennes. Le PFST n'est *pas* un groupe de pression; il ne cherche pas à mobiliser un public pour défendre des initiatives particulières en sciences ou en génie, mais il s'intéresse plutôt aux grandes politiques nationales dans ces domaines.

Pour que le PFST soit vraiment représentatif de la communauté canadienne des sciences et du génie, nous devons nous assurer que les personnes composant les diverses sociétés et associations membres soient renseignées sur les activités entreprises en leur nom. On peut en trouver les détails sur le site Web du PFST (www.pagse.org), mais nous présentons également ces résumés périodiques aux organisations membres.

Petits-déjeuners avec des têtes à Papineau

Le PFST, en collaboration avec le Conseil de recherches en sciences naturelles et en génie du Canada (CRSNG), propose chaque mois un petit-déjeuner-causerie présenté sur la colline du Parlement, et intitulé "Petit-déjeuner avec des têtes à Papineau". Les conférenciers invités y renseignent les parlementaires sur les derniers progrès scientifiques et technologiques. En raison de la tenue d'élections, les petits-déjeuners de l'automne 2008 ont été annulés. Depuis le retour du parlement en janvier 2009, le PFST a organisé les événements suivants:

- "*Les batteries et les piles à combustible sont-elles prêtes pour les véhicules tout électriques?*", par Jeffery Dahn, Université Dalhousie**,** Jeudi, 29 janvier 2009;

- "*La vie, le climat et la disparition des glaces au «Sommet du Canada»*", par Warwick Vincent, Université Laval, Jeudi, 5 mars 2009;

- "*Lorsque les oiseaux se taisent à jamais*", by Bridget Stutchbury, Université York, Jeudi, 2 avril 2009;

- "*De chaudes perspectives dans le froid: la nouvelle carte géologique de l'Arctique*", par Marc St-Onge, Ressources naturelles du Canada, Jeudi, 7 mai 2009;

- "*L'univers violent de la haute énergie*", par Victoria Kaspi, Université McGill, Jeudi, 4 juin 2009.

Les réunions mensuelles du PFST

Des personnes, dans le domaine des sciences et de la technologie provenant du gouvernement et de l'industrie, sont invités aux réunions mensuelles du PFST à présenter leurs points de vue sur les sciences et la technologie au Canada, sur les activités de leur organisme et également sur toutes questions et défis pertinents que le PFST devrait aborder. Les membres sont appelés à considérer les activités et les rapports du gouvernement fédéral et à comment faire mieux pour promouvoir et appuyer les fondements scientifiques canadiens. Les réunions ont lieu à l'Université d'Ottawa. Durant la dernière année, le PFST a reçu les invités suivants:

- 7 octobre 2008: Dr Chad Gaffield, Président, Conseil des Sciences sociales et humanitaires;

■ 17 février 2009: Eliot Phillipson, Président, Fondation canadienne pour l'innovation;

■ 17 mars 2009: Dre Suzanne Fortier, Présidente, Conseil en sciences naturelles et génie.

Le 1er juillet 2009, Rees Kassen, de l'université d'Ottawa, a remplacé Dawn Conway comme président. Le PFST remercie Mme Conway pour sa contribution remarquable et son leadership.

Soumission aux comités du Parlement
Le PFST soumet chaque année un mémoire au Comité permanent des finances de la Chambre de communes . En août 2008, un mémoire fut présenté sous le thème *"Investir dans les grandes initiatives scientifiques et dans les partenariats internationaux*". Ce thème a été dirigé par les priorités indiquées pour les mémoires devant être présentés au Comité des finances pour 2008.

Sommaire de la soumission
Le Canada est l'un des plus grands pays et pourtant il a toujours été un joueur de peu d'importance dans les projets scientifiques internationaux, y compris les projets qui revêtent une importance stratégique pour le pays. La collaboration à des projets scientifiques internationaux expose les scientifiques canadiens à d'éventuelles découvertes et elle fournit la masse critique nécessaire à la réalisation de grands travaux de recherche et donne accès à des talents scientifiques et à la propriété intellectuelle, qui décuplent le pouvoir des ressources investies par le pays. La collaboration internationale permet également aux Canadiens de se comparer à d'autres pays et à peser sur la programmation internationale tout en rehaussant la réputation du Canada en tant que partenaire international sérieux, facteur qui peut amener certains scientifiques de pointe à envisager de travailler au Canada. En participant et en investissant davantage dans certaines grandes initiatives internationales, on aidera à changer la perception du Canada; de petit joueur forcé de s'associer à d'autres petits joueurs pour accéder à un programme scientifique, il deviendra un partenaire incontournable.

Les travaux scientifiques internationaux sont des initiatives et des secrétariats qui nécessitent les ressources financières, logistiques ou intellectuelles coordonnées de plusieurs pays et secteurs. Les grands travaux scientifiques sont des initiatives de grande ampleur qui nécessitent des ressources débordant de la capacité d'un établissement, d'un organisme de financement ou d'un pays et qui sont censées produire des résultats considérables. Les grands travaux scientifiques englobent des initiatives de tous les niveaux, des consortiums travaillant dans des installations comme le CERN (l'Organisation européenne pour la recherche nucléaire), l'Observatoire de neutrinos de Sudbury, salué mondialement, le Programme de sondage des fonds marins ou encore de grands réseaux de recherche comme le *Polar Environment Research Laboratory* sur l'île Ellesmere et le projet NEPTUNE[1], le plus grand observatoire câblé des fonds marins.

Le Canada souscrit à un certain nombre de programmes internationaux et héberge quelques secrétariats internationaux. Il a la possibilité d'améliorer sa réputation, ses contributions et surtout ses avantages en coordonnant des sources de financement, en soutenant l'infrastructure et les coûts opérationnels, en hébergeant des secrétariats scientifiques internationaux et en éliminant les restrictions environnementales qui entravent l'innovation et le développement économique. De telles mesures permettront d'améliorer la réputation des milieux scientifiques canadiens et des scientifiques canadiens à l'échelon international, sensibiliseront l'industrie aux rôles joués par les Canadiens et favoriseront le maintien de la recherche et de l'innovation au Canada.

Le Partenariat recommande :

● *que le gouvernement fédéral adopte une démarche stratégique à l'égard des investissements dans les grandes initiatives scientifiques et dans les partenariats internationaux en sciences; cette démarche doit comporter un soutien financier pour maximiser les avantages pour les Canadiens et leur économie.*

Pour plus d'information sur les activités du PFST, prière de visiter le site web à www.pagse.org

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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.

RAPPEL - RAPPEL - RAPPEL

La SCMO a négocié des tarifs intéressants pour ses membres qui désirent devenir membre de la Société royale de météorologie (RMetS) et de l'Union géophysique canadienne (CGU). Un rabais de 25% est appliqué lorsque vous devenez membre associé de ces deux sociétés savantes. Les membres de ces deux sociétés ont également le privilège de devenir membre associé de la SCMO; dites-le à vos collègues et encouragez-les à joindre la SCMO.

[1] North-East Pacific Time-series Undersea Network Experiments

17th International Northern Research Basins Symposium and Workshop

Theme: Managing hydrological uncertainty in high-latitude environments

by Kathy L. Young[1]

Canada was honoured to host the 17th International Northern Research Basins Symposium and Workshop. Full details of the meeting, its sponsors, proceedings (419 pp., edited by K. L. Young and W. Quinton) and outreach activities can be found at: http://www.northernresearchbasins.com/nrb17.html.

We are grateful to CMOS for being one of the sponsors of this symposium/workshop which gathered more than 69 northern hydrologists, arctic physical oceanographers and participants from across the Circumpolar North (Russia, Denmark (Greenland), Sweden, Iceland, Norway, Finland, Canada, USA), together with countries having polar programs (Japan, England) in the Eastern Canadian Arctic for a week long northern hydrology symposium and workshop in August 2009. The group travelled from Iqaluit to Pangnirtung, Nunavut and then to Kuujjuaq, Northern Quebec (Nunavik) via an expedition ship operated by an Inuit owned company.

A variety of sessions were held including: Prediction of Precipitation in Ungauged Northern Basins; Northern Lake Systems; Hydrology & Ocean Interactions; Climate, Cryosphere, Hydrosphere; Modelling Hydrologic Variables & Climate Change and Arctic Hydrology & Uncertainty. A well-attended poster session offered an ideal venue for young career scientists to share their research with more senior scholars.

Recognizing an inadequate understanding of terrestrial-oceanic interactions amongst northern hydrologists from previous NRB meetings, we were delighted to invite a plenary guest speaker: Dr. Robie Macdonald, a Physical Arctic Oceanographer, Department of Fisheries & Oceans, Canada. His talk titled *Rivers and Lakes in the Ocean-the Other Hydrological Cycle* focussed on what happens to freshwater when it moves into northern oceans. He explained how it controls buoyancy and convection and how terrestrial runoff affects the light climate through terrestrial CDOM[1]. It was our added privilege to have another guest speaker, Dr. Larry Hinzman, Director, International Arctic Research Centre, University of Fairbanks Alaska, USA. Larry's talk was titled *The Potential Role of Feedbacks in the Arctic Hydrologic System* and his presentation cautioned that we need to develop better dynamic models which deal with feedbacks and linkages between terrestrial, atmospheric and oceanic systems, if we are ever to achieve realistic simulations of future and past climates.

Ming-ko Woo, Professor Emeritus, McMaster University, Canada provided an overview of the rich history of the NRB working group which has been holding regular meetings for 34 years, while inspiring talks on IPY supported snow research in the Arctic and Antarctic were provided by Dr. Glen Liston (Colorado State University, USA) and Dr. Matthew Sturm (CRREL, Alaska, USA). Mr. Richard Janowicz (Water Manager, Yukon Government, Canada) kindly hosted a Yukon water awareness session which included a slide show, showing past and present water resources and research in the Yukon territory. Field trips, traditional for NRB meetings included a trip to Kekerten Island-a historical whaling station; Auyuittuq National Park, with a view of the Penny Ice cap and zodiac trips to Monumental and Apatok Islands (sitings of polar bears).

Two workshops were held during the meeting. The first, chaired by Dr. Doug Kane, University of Alaska, Fairbanks, USA examined the ongoing problems with precipitation gauges, and highlights of this discussion can be found on the 17th NRB website. The second workshop was chaired by Dr. Terry Prowse, University of Victoria/Environment Canada, Canada. It reviewed the findings of two NRB taskforces: (1) *Temperature Regimes of Northern Lakes* and (2) *Prediction in Ungauged Basins* (PUB) and their full reports can also be found on the NRB website. During the discussion it was decided that the first task force, headed by Dr. Nikolay Filatov, Russia had made much progress with two published papers (*Water Resources Research, Russia and Hydrology Research*). However, it was suggested that the taskforce could be broadened and strengthened with involvement of North American scientists, also doing northern lake research (*e.g.,* Drs. Terry Prowse, Claude Duguay, and Ms. Laura Brown). Dr. Chris Spence, Environment Canada, provided an overview of the PUB accomplishments over the last two years. Citing difficulties in obtaining funding to hold a PUB workshop, it was decided that PUB should continue but that it has a focussed deliverable (*e.g.,* a review paper). Spurred on by discussions during workshop #one, the NRB group decided to form another task force to focus on problems with measuring precipitation in northern basins, and that this

[1] York University, Toronto, Canada

could possibly lead to a summary paper. Dr. Amy Tidwell (University of Alaska, Fairbanks, USA) representing young career scientists (21 in attendance) provided a few summary remarks about the achievements & challenges of the 17th NRB meeting for young scientists. Amy indicated that everyone appreciated the friendliness and mentorship that this type of meeting fostered and the young scientists look forward to attending future meetings. They acknowledged the support of their supervisors and sponsors of this meeting. For future meetings, they would like to see more time set aside for workshops and perhaps a training-type session.

The NRB group collectively felt it important that governments of all circumpolar countries be told that we know that the North is changing due to climate change (*e.g.*, sea ice disappearance, earlier snowmelt, glacier retreat, more episodes of rain-on-snow) and that we know that it is impacting our northern citizens and has far-reaching global ramifications. However, we continue to do a poor job at documenting it because of the inadequate weather and water survey networks existing in northern regions. For instance, the Queen Elizabeth Islands in Canada (an area the size of France) has only three government manned weather stations and no water survey stations. If we are to plan for the future, for example, in terms of adequate infrastructure (bridges, roads), water for northerners and ecosystems (both quantity and quality) and assess changes at the global scale (rising sea levels), it is essential that we be measuring these types of data now (*e.g.,* the climate, water levels, stream discharge). In addition, the NRB group felt strongly that all governments should push for an *Open Data Policy* for private industries (*e.g.,* mining and oil companies) and consulting firms receiving government subsidies. Presently, research studies by these groups are not accessible to the broader scientific community, and their relevancy cannot be peer-reviewed.

It was our deep privilege to meet with local Inuit dignitaries in Iqaluit, Pangnirtung and Kuujjuaq. A special highlight was a community meeting held in Pangnirtung. This hamlet recently experienced some extreme weather (rain on spring snowmelt'08), which resulted in extensive flooding and infrastructure destruction. A panel was made up of all chief delegates from the circumpolar countries, along with Dr. Robie Macdonald, DFO; Richard Janowicz, Yukon Government, and Dr. Carl Bøggild (UNIS & a Greenlander). Dr. Chris Spence, Environment Canada, in association with Dr. Sean Carey, Carleton University, Canada, provided a rolling presentation titled *A Discussion on Improving Knowledge of Northern Water Resources*. Nine elders through a translator talked about the extreme flood in 2008 and other local signs of climate change - glaciers disappearing in Cumberland Sound, high tides, and moss washing into the sea. The NRB group also had lunch with Mr. Simon Watt (Mayor Kuujjuaq) and learned of deep permafrost thaw on the northwest coast of Ungava Bay which is threatening the hamlet of Salluit. He indicated that the whole town may need to be moved in the near future. Locally, changes on land and ice conditions in Ungava Bay and along river systems are impacting their traditional hunting travels.

Overall, the 17th NRB meeting was a great success and the support from CMOS for Dr. Robie Macdonald's travel to this meeting was very much appreciated!

Note 1: CDOM = Colour Dissolved Organic Matter.

Ocean Acidification: A Summary for Policymakers from the second Symposium on the Ocean in a High-CO_2 World

Résumé: L'acidification des océans, due à l'absorption en grande quantité de dioxyde de carbone, s'accélère à un rythme sans précédent et menace les écosystèmes marins et les moyens de subsistance de dizaines de millions de personnes, ont conclu les scientifiques réunis du 6 au 9 octobre 2008 à Monaco, à l'occasion du 2ème Symposium sur l'océan dans un monde trop acide.

The second symposium on the Ocean in a High-CO_2 World was held on 6 – 9 October 2008 at the Oceanography Museum of Monaco under the High Patronage of His Serene Highness Prince Albert II. The meeting brought together 220 scientists from 32 countries to assess what is known about ocean acidification impacts on marine chemistry and ecosystems, and to address the socio-economic and policy perspectives of these impacts. This article summarises new research findings presented at the symposium. The results are synthesised in a scientific report, Research Priorities for Ocean Acidification (2009), available from the following web site:

http://www.ocean-acidifcation.net

The ocean absorbs approximately 25% of the CO_2 added to the atmosphere from human activities each year, greatly reducing the impact of this greenhouse gas on the climate. When CO_2 dissolves in seawater, carbonic acid is formed. This phenomenon, called ocean acidification, is causing seawater to become corrosive to the shells and skeletons of numerous marine organisms. It also affects the reproduction and physiology of some marine organisms.

These impacts have now been detected in living organisms in several regions around the world. Within decades, the chemistry of the tropical oceans will not sustain coral reef growth while large parts of the polar oceans will become corrosive to calcareous marine organisms. These far-reaching changes will impact food webs, biodiversity and fisheries.

The ocean is acidifying rapidly

Ocean acidity has increased by 30% since the beginning of the Industrial Revolution. If the concentration of atmospheric CO_2 continues to increase at the current rate, the ocean will become corrosive to the shells of many marine organisms by the end of this century. How or if marine organisms may adapt is not known.

This increase is 100 times faster than any change in acidity experienced by marine organisms for at least the last 20 million years. Sixty-five million years ago, ocean acidification was linked to mass extinctions of calcareous marine organisms, an integral part of the marine food web. At that time, coral reefs disappeared from the geologic record and it took millions of years for coral reefs to recover.

Today's human-induced acidification represents a rare event in the geological history of our planet. The average concentration of atmospheric CO_2 is currently 385 parts per million (ppm), 38% higher than the pre-industrial level of 280 ppm.

Half of this increase has occurred in the last 30 years. Current CO_2 emissions are greater than projected for the worst-case scenario formulated by the Intergovernmental Panel on Climate Change a decade ago.

Ocean Acidification is a Direct Result of CO_2 Emissions, Not Climate Change

While climate change and its impacts have significant uncertainties, the chemical changes occurring in the ocean as a result of increasing atmospheric CO_2 are observable now and highly predictable into the future.

When CO_2 dissolves in seawater, carbonic acid is formed. It is this chemical reaction that leads to ocean acidification, and it is independent of climate change.

Reduction of global temperatures and the concentration of other greenhouse gases will not reduce ocean acidification. Ocean acidification is not a peripheral climate issue – it is the other CO_2 problem.

Negotiations aimed at reducing greenhouse gas emissions must take ocean acidification into account. Geoengineering approaches to combat climate change by reflecting sunlight, for example, will not solve the ocean acidification problem.

How will marine ecosystems respond?

Most studies show a decrease in calcification, including shell and skeleton formation, with increasing acidification. Marine organisms have different calcification responses at different stages of their life cycle. Some early-life stages are particularly sensitive to acidification.

For marine animals, including invertebrates and some fish, accumulation of CO_2 in the body may also result in disturbances of processes other than calcification, leading to overall changes in the organism's morphology, metabolic state, physical activity and reproduction.

While some groups of phytoplankton, such as coccolithophores, may be adversely affected by ocean acidification, others, including nitrogen-fixing cyanobacteria, may benefit from elevated CO_2 levels. Impacts on phytoplankton and other sensitive species may cause disturbances to marine food webs that will affect fisheries.

By the middle of this century, it is expected that coral calcification rates will decline by about one third, and erosion of corals will outpace new growth. Many reefs may no longer be sustainable.

Experiments have shown that ocean acidification hinders calcification of deep-sea corals. By 2100, 70% of cold-water corals will be exposed to corrosive waters. Cold-water coral ecosystems provide habitat, feeding grounds, and nursery areas for many deep-water organisms, including commercial fish species.

Selective breeding of one species of oyster shows that resistance to acidification can be increased, suggesting that some level of adaptation may be possible for some organisms. However, the adaptability of most organisms to increasing acidity is unknown.

The severity of these impacts is likely to depend in part on the interaction of acidification with other environmental stresses, such as rising ocean temperatures, over-fishing and land-based sources of pollution. In two species of crab, ocean acidification decreases the resistance to temperature extremes, indicating enhanced sensitivity to warming as well as the potential for shrinking areas of species distribution.

Naturally high-CO_2 environments, such as some coastal zones influenced by upwelling or river inputs, or areas receiving volcanic or hydrothermal CO_2 inputs, may provide a glimpse into marine ecosystems of the future. These areas show low biodiversity and a high number of invasive species.

How will ocean acidification affect societies and economies?

Ocean acidification may trigger a chain reaction of impacts through the marine food web that will affect the multi-billion dollar commercial fisheries and shellfish industries, as well as threatening the food security for millions of the world's poorest people. Larval fish and shellfish may be especially vulnerable.

Ocean acidification may render most regions of the ocean inhospitable to coral reefs, affecting tourism, food security, shoreline protection and biodiversity. Coral reefs may be particularly affected because of the combined impact of coral bleaching caused by increased water temperatures and ocean acidification.

The ocean's capacity to absorb CO_2 from the atmosphere is being degraded by ocean acidification, which will make it more difficult to stabilise atmospheric CO_2 concentrations.

The cost of stabilising atmospheric CO_2 at a level that will avoid most of the negative impacts is lower than the cost of inaction, and stabilisation is achievable with technology that can be deployed now and in the near future.

When they die, the hard shells of small ocean organisms sink to the ocean floor, locking away carbon for a long time. This is part of the ocean's carbon pump and lighter shells will transfer less carbon to the deep ocean. The cost of the ecosystem service provided by the ocean's carbon pump can be estimated by applying current prices in carbon credit markets. With the carbon market price range of US $20 to $200 per tonne of carbon, ocean uptake of CO_2 represents an annual subsidy to the global economy of US$40 - 400 billion, or 0.1–1% of the Gross World Product. The projected decrease in efficiency of the ocean carbon pump could represent an annual loss of billions of dollars.

International negotiations to keep atmospheric CO_2 levels below 550 ppm, or even 450 ppm, may fail to prevent much of the polar oceans from becoming corrosive to the shells of key marine species. Even at these CO_2 levels, projections indicate net reef growth in tropical areas can't keep pace with reef erosion and dissolution.

Ocean acidification research is in its infancy

Ocean acidification is a relatively new field of study, with 62% of the research papers on the subject published since 2004.

Despite advances in understanding the impacts of elevated CO_2 concentrations on a wide range of marine organisms, we are still unable to make meaningful projections of impacts on marine ecosystems and fisheries as a whole, or to identify thresholds beyond which marine ecosystems may not recover.

Globally, there are relatively few sites with multi-decadal measurements of the chemical and ecosystem variables needed to provide a baseline for the timely assessment of ocean acidification impacts. A global early warning and forecast network coordinated across nations is required for research, management and verification of stabilization actions.

Most studies on marine organisms have only examined the responses of single species to one environmental factor, such as an increase in acidity, CO_2, or temperature. Methods must be developed to examine the full ecosystem response to multiple environmental factors, using scenarios for expected conditions in the next few decades.

Long-term studies and selective breeding experiments are required to understand adaptation and evolution pathways. Identifying genes involved in calcification and acid-base balance and means to measure the expression of these genes will be important for understanding the adaptability of marine organisms to changes in acidity.

The global scale of the acidification suggests that options for mitigation are likely to be very limited, especially on short time scales. Research is needed to understand whether addition of alkaline substances to the ocean could counter acidification in specific areas, the degree to which acidification impacts can be offset by reducing other environmental stresses, such as eutrophication, and the optimal management of marine ecosystems to counter these and other combined threats.

User groups to guide research should include policy experts with interests that span the relevant environmental, industry and conservation sectors.

Symposium sponsors

1) The non-governmental Scientific Committee on Oceanic Research (www.scor-int.org) which was established in 1957 by the International Council of Scientific Union to promote international cooperation in all areas of ocean science.

2) The Intergovernmental Oceanographic Commission (http://ioc-unesco.org) which was established by the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 1960 to provide Member States of the United Nations with an essential mechanism for global cooperation in the study of the ocean.

3) The International Geosphere-Bioshpere Programme (www.igbp.net) is an international scientific research programme that studies the interaction between biological, chemical and physical processes and human systems, to develop and impart the understanding necessary to respond to global change.

4) The Marine Environmental Laboratories (MEL) of the International Atomic Energy Agency (www-naweb.iaea.org/naml) promotes UN inter-agency efforts to protect the seas and carries out research on ocean acidification by combining isotopes with manipulative experiments and by using numerical models to better understand and project how acidification may alter marine resources during the 21st century.

Financial and in-kind support

The scientific sponsors and the organizing committees of the symposium gratefully acknowledge the financial and in-kind support received from the following organisations and funding agencies:

- U.S.National Science Foundation
- PrinceAlbert II of Monaco Foundation
- Scientific Committee on Oceanic Research
- Intergovernmental Oceanographic Commission of UNESCO
- International Atomic Energy Agency
- International Geosphere-Biosphere Programme
- Musée Océanographique de Monaco
- Centre Scientifique de Monaco
- The International Council for Exploration of the Sea
- The North Pacific Marine Science Organization

Note from the Editor: The results outlined here are synthesized in the scientific report Orr *et al.* (2009) Research Priorities for Ocean Acidification available from www.ocean-acidification.net

This Summary for Policymakers is available on the web at the same location. It was edited by Maria Hood, Wendy Broadgate, Ed Urban and Owen Gaffney. It is reproduced here with the written authorization of the editors.

Brief to the House of Commons Standing Committee on Finance by the Canadian Meteorological and Oceanographic Society (CMOS)

Executive Summary of Recommendations

1. CMOS recommends the introduction of financial incentives to reduce net greenhouse gas emissions rapidly. These measures will complement the present incentives to reduce emissions by 2020 and 2050, and will encourage other nations to rapidly limit their own emissions.

2. CMOS recommends that the Federal Government invest funds in the provision of science-based climate information, in order to ensure prosperity and a sustainable future for Canadians from an economic, social and environmental perspective.

3. CMOS recommends the renewal of financial support for research into meteorology, oceanography, climate and ice science, especially in Canada's North, through independent, peer-reviewed projects.

Recommendation 1 – Financial Incentives to Reduce Emissions

The scientific evidence today indicates overwhelmingly that allowing the emission of greenhouse gases from human activities to continue unchecked constitutes a significant threat to the well-being and continued development of society. Since the signing of the Kyoto Protocol, global emissions have increased. In Canada, they are now 33% higher than our Kyoto target.

The Synthesis Report from the Climate Change Conference that took place in Copenhagen in March 2009 states that a temperature rise of 2°C will be difficult for contemporary societies to cope with and is likely to cause major societal and environmental disruptions through the rest of this century and beyond. Considerable support has developed, including by the G8 nations, for containing the rise in global temperature to a maximum of 2°C above pre-industrial levels. Beyond the 2°C limit, often referred to as the "2°C guardrail", impacts will become very severe and many impacts will be irreversible.

The Intergovernmental Panel on Climate Change (IPCC) 2007 Report predicts a likely increase of global average temperature of about 1.2°C in years 2090 to 2100 compared to the year 1900, even if greenhouse gas emissions are zero after the year 2000. Global temperatures would be about 0.5°C higher without the human-generated aerosols and dust that presently cool the planet. The rate of future injection of dust and aerosols is expected to decrease as we move to a low-carbon world. Removing the cooling of aerosol and dust leaves the world very close to the 2°C guardrail. These numbers show that rapid reductions of greenhouse gas emissions are needed for this guardrail to be respected.

Though Canadian emissions represent only a small fraction of global emissions, it is important for a rich and developed nation such as Canada to lead by example. Only by showing leadership in addressing the problem at home will we be able to secure the engagements of developing countries such as India and China. In addition, restrictions on our trade with other nations are a likely outcome if we do not respect international goals to reduce greenhouse gas emissions. We commend the federal government for its commitment to a "20% reduction in greenhouse gas emissions from 2006 levels by 2020, and a 60 to 70% reduction from the 2006 level by 2050[1]"; however, more immediate actions are required.

Many of the greenhouse-gas-reducing projects are cost-effective and will provide a needed springboard for Canadian industry to lead the way to new climate-related global ventures generating new Canadian wealth and jobs. These greenhouse-gas reducing projects will help Canada achieve the objectives proposed in the 2007 federal document: *Mobilizing Science and Technology to Canada's Advantage.*

> **CMOS recommends the introduction of financial incentives to reduce net greenhouse gas emissions rapidly. These measures will complement the present incentives to reduce emissions by 2020 and 2050, and will encourage other nations to rapidly limit their own emissions.**

Recommendation 2 – Invest in Science-Based Climate Information

In order to ensure prosperity and a sustainable future for Canadians from an economic, social and environmental perspective, CMOS recommends that the Federal Government invest funds in the provision of science-based climate information. Canadians require such information to understand, anticipate and respond to climate, climate change, and climate variability.

Changes in climate affect important sectors of our economy, including agriculture, fisheries, forestry, energy, transport and tourism:

- Climate is a key parameter in growing food. It controls the soil moisture level, the amount of

[1] A Climate Change Plan for the Purpose of the Kyoto Protocol Implementation Act 2009, page 3.

sunlight plants receive and the conditions to which plants are subjected on a daily basis.

○ Ocean acidification threatens our marine resources. Acidification is progressing most rapidly in Canadian Arctic waters.

○ For the oil and gas sector, climate variability and change threaten key infrastructures. In the Arctic, higher temperatures melt permafrost, thus threatening the foundations of roads, pipelines and electrical transmission towers. In coastal regions, storms can endanger offshore oil and gas rigs and related infrastructure. Likewise, climate conditions affect the amount of water available to hydroelectric power.

○ The *mountain pine beetle* has expanded its range in Canada, destroying millions of acres of forests. It is recognized that climate warming has played a determining role in the infestation.

Climate also plays a role in the social well-being of Canadians:

○ Studies indicate that climate warming will impact severely Canadians living in the North, where temperature rise is expected to be most rapid.

○ Fundamental determinants of health, such as air quality, water availability, food and disease, are affected by climate.

○ Weather extremes, such as droughts, wildfires and floods, are exacerbated by climate change and are very likely to increase in frequency and intensity.

The provision of climate information will enable Canadian citizens and Canadian industry not only to adapt so that negative impacts can be reduced, but also to recognize new opportunities:

○ Knowledge of climate change helps farmers plan their crops. If water is projected to be scarce, for example, they can choose drought-resistant plants.

○ Climate change impacts fisheries rapidly, and often mysteriously, through global changes in the ocean and wind patterns. Coordinated research among these disciplines will provide new insight.

○ Understanding how climate is changing now, how it will change in the future and the consequences of those changes on energy demand will benefit a large sector of our economy.

○ Climate change may soon open the Arctic to shipping, impacting Canadian sovereignty.

Weather and climate information, including prediction, have many similarities: both provide information on the way the atmosphere is behaving. But where weather information focusses on the short-term (minutes to months), climate focusses on long-term conditions (seasons to decades). Climate prediction requires an understanding of the interactions among atmosphere, ocean, ice and snow cover, and the land surface.

The last few decades have seen a remarkable progress in understanding the climate system. Continuing advances in **inter-seasonal** to **multi-decadal** prediction make possible the provision of pertinent, tailored climate information to the user communities.

Investing in the provision of climate information will require the Federal Government to enhance the development and sustainability of

○ Atmospheric and oceanographic observation and monitoring,

○ Research and modelling, and

○ Adaptation and application programs.

The first two elements, observation and monitoring, research and modelling, already exist in Canada, but concerns have been raised. For example, Canada's climate monitoring north of the 56th parallel is sparse and does not meet the minimal guidelines set by the World Meteorological Organization. In addition, research and modelling activities, particularly in the academic sector, are at risk of being compromised severely by a lack of funding.

It is of primary importance that the federal budget include measures to ensure the integrity of the observing network, its expansion in the North, and an increased support to ocean, atmospheric and terrestrial climate research in federal laboratories and universities. Core government department programs in oceanography, meteorology, climate and ice sciences must be synchronized with academic research programs. This ensures that government-funded research is used to carry out government of Canada mandates.

The establishment of climate adaptation and application programs would require new investments and impetus. It will bridge the gap between the climate information developed by scientists and the practical needs of the public and of users in climate-sensitive sectors. It will also provide the public with much needed scientific education on climate issues. Several provincial governments and the private sector have already invested in programs of this nature (e.g., Ouranos in Québec, and the Pacific Institute for Climate Solutions in British Columbia). The involvement of the federal government will bring synergy and completeness to these efforts.

CMOS recommends that the Federal Government invest additional funds in the provision of science-based climate information, in order to ensure prosperity and a sustainable future for Canadians from an economic, social and environmental perspective.

Recommendation 3 - Renew Financial Support for Research

Recent federal stimulus measures have targeted investment in infrastructure. CMOS believes such measures to be ineffective in the long term if not coupled with corresponding investment in the education of people, in knowledge and innovation. The long-term prosperity of our country depends on our ability to develop into a knowledge-based society and it is important to look beyond the customary approach to innovation that focusses solely on technology-based solutions.

Previous economic crises have demonstrated that companies and nations that maintain and increase their investments in research and development during bad times emerge stronger and more competitive when the recovery begins. Canada must seize this opportunity to transform its economy.

The soundest basis for ensuring that research money is well spent is to provide continuing funds to the granting councils who can assess research proposals on their scientific merit as judged by anonymous peers in the research community. Proposals are ranked by relevance to Canadian and international society, as well as by excellence of the proponents and the innovation of the research. These criteria provide a proper balance to maximize benefit.

Three Canadian funding agencies offer examples of how these projects could be funded. The **Canadian Foundation for Climate and Atmospheric Sciences (CFCAS)** and the **Natural Science and Engineering Research Council (NSERC)** support research into oceanography, meteorology, ice and climate change. The Canadian program within the **International Polar Year Program (IPY)** provided scientists from all sectors with the funding they needed to achieve the goals of this intensive study year. IPY also connected academics with northern communities. These programs also provide funds that educate the next generation of Canadian scientists.

CFCAS, since its establishment in 2000-2001, has supported more than 150 projects, as well as two major initiatives and 24 networks of research among Canadian academics. The main themes of CFCAS are air quality, Arctic, northern and cryospheric science, climate change and its impacts on the physical environment such as water resources, and finally weather prediction and severe weather. One project is presently developing new techniques to determine the future of glaciers in western Canada. Other projects are concentrating on urban weather, ocean currents, Arctic and Atlantic storms, ice, marine life in the Arctic, impacts of aerosols on climate and improved weather prediction. CFCAS funding is especially needed to support coordinated, large-scale networks across many universities. Unless renewed, funding for CFCAS will end in 2010.

International Polar Year (IPY) 2007-2008 was the largest-ever international program of scientific research focussed on the Arctic and Antarctic regions. Thousands of scientists and researchers from more than 60 nations around the globe participated in IPY during the 24-month period beginning March 2007. The Government of Canada provided specific funding for this program, mainly through grants to Canadian researchers. IPY developed a more complete scientific understanding of the Canadian North, which can be applied to address issues related to our environment and the well-being of our communities. IPY is a good example of a peer-reviewed, independent funding program for scientists in the private sector, government and universities.

The Natural Science and Engineering Research Council (NSERC) provides research funds to university scientists and engineers for innovative science in all disciplines. The Council has a reputation of funding excellent projects that yield significant benefit for Canadians. This Council requires continuing strong funding to continue its mandate.

CMOS recommends the renewal of financial support for research into meteorology, oceanography, climate and ice science, especially in Canada's North, through independent, peer-reviewed projects.

About CMOS

The Canadian Meteorological and Oceanographic Society (CMOS) is the national society of individuals and organizations dedicated to advancing atmospheric and oceanic sciences and related environmental disciplines in Canada. The Society is the main non-governmental organization serving the interests of meteorologists, climatologists, oceanographers, limnologists, hydrologists and cryospheric scientists in Canada. The Society comprises some 1000 members, including scientists, academics, students, corporations, institutions and others who are involved in education, communications, the private sector and government. Membership is open to all who share an interest in atmospheric and oceanic sciences, their related sciences and applications. CMOS executive and members are available to provide additional insight on any of these recommendations.

William Crawford, President, CMOS
email president@cmos.ca

Other contact information at
CMOS Web site: http://www.cmos.ca/

Mémoire au Comité permanent des finances de la Chambre des communes par la Société canadienne de météorologie et d'océanographie (SCMO)

Sommaire des recommandations

1. La SCMO recommande l'introduction d'incitations financières pour réduire rapidement les émissions nettes de gaz à effet de serre. Ces mesures accompagneront les incitations présentes visant à réduire les émissions d'ici 2020 et 2050, et elles encourageront d'autres nations à limiter rapidement leurs propres émissions.

2. La SCMO recommande au Gouvernement fédéral d'investir des fonds dans la fourniture de renseignements climatiques fondés sur la science afin d'assurer la prospérité et un futur durable aux Canadiens d'un point de vue économique, social et environnemental.

3. La SCMO recommande le renouvellement du soutien financier pour la recherche en météorologie, en océanographie, en climatologie et en glaciologie, particulièrement dans le nord du Canada, par l'intermédiaire de projets indépendants examinés par des pairs.

Recommandation 1 – Incitations financières pour réduire les émissions

Aujourd'hui, les preuves scientifiques indiquent de façon accablante que de permettre la poursuite incontrôlée d'émissions de gaz à effet de serre provenant d'activités humaines constitue une menace au bien-être et au développement continu de la société. Depuis la signature du Protocole de Kyoto, les émissions mondiales ont augmenté. Au Canada, elles sont maintenant 33 % supérieures à notre objectif de Kyoto.

Le Rapport de synthèse de la Conférence sur les changements climatiques qui s'est tenue à Copenhague en mars 2009 indique qu'une augmentation de la température de 2°C sera difficilement supportée par les sociétés contemporaines et que cela provoquera probablement des bouleversements sociétaux et environnementaux majeurs jusqu'à la fin de notre siècle et au-delà. Un soutien considérable s'est développé, y compris de la part des nations du G8, pour contenir l'accroissement de la température mondiale à un maximum de 2°C au-dessus des niveaux préindustriels. Au-delà de la limite de 2°C, souvent appelée la « barrière de sécurité de 2°C », les répercussions deviendront très graves et plusieurs d'entre elles seront irréversibles.

Le Rapport de 2007 du Groupe d'experts intergouvernemental sur l'évolution du climat (GIEC) prévoit une augmentation probable de la température moyenne mondiale d'environ 1,2 °C dans les années 2090 à 2100 par rapport à l'année 1900, même si les émissions de gaz à effet de serre sont nulles après l'année 2000. Les températures mondiales augmenteraient d'environ 0,5°C sans les aérosols et les poussières générés par les êtres humains qui refroidissent actuellement la planète. On prévoit que le taux d'injection future de poussières et d'aérosols va diminuer à mesure que nous progressons vers un monde faible en carbone. La suppression de l'effet refroidisseur des poussières et des aérosols laisse le monde très près de la barrière de sécurité de 2°C. Ces chiffres montrent que de rapides réductions des émissions de gaz à effet de serre sont requises afin de respecter cette barrière de sécurité.

Bien que les émissions canadiennes ne représentent qu'une faible fraction des émissions mondiales, il est important, pour une nation riche et développée comme le Canada, de montrer l'exemple. C'est uniquement en montrant un leadership pour la résolution du problème chez nous que nous serons capables de garantir l'engagement des pays en développement comme l'Inde et la Chine. En outre, des restrictions sur notre commerce avec d'autres nations sont un résultat probable si nous ne respectons pas les objectifs internationaux de réduction des émissions de gaz à effet de serre. Nous félicitons le gouvernement fédéral pour son engagement à « réduire les émissions de gaz à effet de serre de 20 p. 100 par rapport aux niveaux de 2006 d'ici 2020, et de 60 p. 100 à 70 p. 100 par rapport aux niveaux de 2006 d'ici 2050[2] », cependant, des mesures plus immédiates sont requises.

De nombreux projets visant à la réduction des gaz à effet de serre sont rentables et offriraient un tremplin nécessaire à l'industrie canadienne pour montrer la voie à de nouvelles entreprises mondiales liées au climat qui généreraient de nouvelles richesses et de nouveaux emplois au Canada. Ces projets visant à la réduction des gaz à effet de serre aideront le Canada à atteindre les objectifs proposés dans le document fédéral de 2007 : *Réaliser le potentiel des sciences et de la technologie au profit du Canada.*

> **La SCMO recommande l'introduction d'incitations financières pour réduire rapidement les émissions nettes de gaz à effet de serre. Ces mesures accompagneront les incitations présentes visant à réduire les émissions d'ici 2020 et 2050, et elles encourageront d'autres nations à limiter rapidement leurs propres émissions.**

Recommandation 2 – Investir dans les renseignements climatiques fondés sur la science

Afin d'assurer la prospérité et un futur durable pour les Canadiens d'un point de vue économique, social et environnemental, la SCMO recommande que le gouvernement fédéral investisse des fonds pour la

[2] Plan sur les changements climatiques aux fins de la *Loi de mise en œuvre du Protocole de Kyoto* – 2009, page 4.

fourniture de renseignements climatiques fondés sur la science. Les Canadiens requièrent de tels renseignements pour comprendre, anticiper et répondre au climat, aux changements climatiques et à la variabilité du climat.

Les changements climatiques ont des répercussions sur d'importants secteurs de notre économie, y compris l'agriculture, les pêches, la foresterie, l'énergie, le transport et le tourisme :

- Le climat est un paramètre clé de la culture des aliments. Il contrôle le niveau d'humidité du sol, la quantité de lumière solaire reçue par les plantes et les conditions auxquelles les plantes sont soumises de façon quotidienne.

- L'acidification des océans menace nos ressources marines. L'acidification progresse le plus rapidement dans les eaux arctiques canadiennes.

- Pour le secteur du pétrole et du gaz naturel, la variabilité et les changements climatiques menacent les infrastructures essentielles. En Arctique, les températures plus élevées font fondre le pergélisol, menaçant ainsi les fondations des routes, les pipelines et les tours de transmission de l'électricité. Dans les régions côtières, les tempêtes peuvent endommager les installations de forage en mer pour le pétrole et le gaz naturel ainsi que l'infrastructure associée. De même, les conditions climatiques ont des répercussions sur la quantité d'eau disponible pour l'énergie hydroélectrique.

- Le dendroctone du pin ponderosa a élargi son aire de répartition au Canada, détruisant des millions d'acres de forêts. Il est reconnu que le réchauffement climatique a joué un rôle déterminant dans cette infestation.

Le climat joue également un rôle dans le bien-être social des Canadiens :

- Des études indiquent que le réchauffement climatique aura des répercussions graves sur les Canadiens vivant dans le Nord, où l'on prévoit un accroissement de la température plus rapide.

- Les déterminants fondamentaux de la santé, comme la qualité de l'air, la disponibilité de l'eau, la nourriture et les maladies, sont affectés par le climat.

- Les extrêmes climatiques, comme la sècheresse, les incendies de forêt et les inondations, sont exacerbés par les changements climatiques et leur fréquence et leur intensité vont probablement augmenter.

La fourniture de renseignements climatiques permettra aux citoyens canadiens et à l'industrie canadienne non seulement de s'adapter afin de réduire les impacts négatifs, mais également de reconnaître de nouvelles possibilités :

- La connaissance des changements climatiques aide les agriculteurs à planifier leurs récoltes. Si l'on prévoit que l'eau va manquer, par exemple, ils peuvent choisir des plantes résistantes à la sècheresse.

- Les changements climatiques ont des répercussions rapides, et souvent mystérieuses, sur les pêches par l'intermédiaire de changements globaux dans les océans et la direction des vents. Des recherches coordonnées dans ces disciplines fourniraient de nouvelles idées.

- La compréhension de la façon dont le climat change actuellement, dont il va changer dans le futur et les conséquences de ces changements sur la demande énergétique, profitera à un large secteur de notre économie.

- Les changements climatiques vont probablement ouvrir bientôt l'Arctique au trafic maritime, ce qui aura des répercussions sur la souveraineté canadienne.

Les renseignements météorologiques et climatiques, y compris les prédictions, ont de nombreux points communs : ils fournissent tous les deux des renseignements sur la façon dont l'atmosphère se comporte. Mais, alors que les renseignements météorologiques se concentrent sur le court terme (de minutes à plusieurs mois), les renseignements climatiques se concentrent sur les conditions à long terme (des saisons aux décennies). Les prédictions climatiques requièrent une compréhension des interactions entre l'atmosphère, les océans, la couverture de glace et de neige ainsi que la surface des terres.

Les quelques dernières décennies ont vu un progrès remarquable dans la compréhension du système climatique. Les avancées continues dans les prédictions **inter-saisonnières** à **pluri-décennales** rendent possible la fourniture de renseignements climatiques pertinents, sur mesure, aux communautés d'utilisateurs.

Des investissements dans la fourniture de renseignements climatiques demanderont au gouvernement fédéral d'améliorer le développement et la durabilité :

- de l'observation et de la surveillance atmosphériques et océanographiques,

- de la recherche et de la modélisation,

- de programmes d'adaptation et d'application.

Les deux premiers éléments, l'observation et la surveillance, la recherche et la modélisation, existent déjà au Canada, mais des préoccupations ont été soulevées. Par exemple, la surveillance climatique du Canada au nord du 56e parallèle est éparse et ne répond pas aux lignes directrices minimales établies par l'Organisation météorologique mondiale. En outre, les activités de recherche et de modélisation, particulièrement dans le secteur universitaire, risquent d'être gravement compromises par un manque de financement.

Il est de la première importance que le budget fédéral inclut des mesures afin d'assurer l'intégrité du réseau d'observation, son expansion dans le Nord et un soutien accru aux recherches sur le climat océanographique, atmosphérique et terrestre dans les laboratoires fédéraux et les universités. Les programmes essentiels des ministères gouvernementaux en océanographie, météorologie, climatologie et glaciologie doivent être synchronisés avec des programmes de recherche universitaires. Cela assurera que la recherche financée par le gouvernement est utilisée pour remplir les mandats du gouvernement du Canada.

L'établissement de programmes d'adaptation et d'application requerrait de nouveaux investissements et un nouvel élan. Cela comblerait l'écart entre les renseignements climatiques développés par les scientifiques et les besoins pratiques du public et des utilisateurs des secteurs sensibles au climat. Cela fournira également au public une éducation scientifique plus que nécessaire sur les enjeux climatiques. Plusieurs gouvernements provinciaux et le secteur privé ont déjà investi dans des programmes de cette nature (par exemple, Ouranos au Québec et le Pacific Institute for Climate Solutions en Colombie-Britannique). La participation du gouvernement fédéral apportera synergie et exhaustivité à ces efforts.

> **La SCMO recommande au Gouvernement fédéral d'investir des fonds dans la fourniture de renseignements climatiques fondés sur la science afin d'assurer la prospérité et un futur durable aux Canadiens d'un point de vue économique, social et environnemental.**

Recommandation 3 – Renouvellement du soutien financier pour la recherche

Les mesures de stimulation fédérales récentes ont ciblé les investissements dans l'infrastructure. La SCMO croit que de telles mesures sont inefficaces à long terme si elles ne sont pas accompagnées des investissements correspondants en éducation du public, en connaissances et en innovation. La prospérité à long terme de notre pays dépend de notre capacité à nous développer en une société basée sur les connaissances et il est important de regarder au-delà de l'approche habituelle pour l'innovation qui se concentre uniquement sur des solutions basées sur la technologie.

Les crises économiques précédentes ont démontré que les entreprises et les nations, qui maintiennent et qui augmentent leurs investissements en recherche et développement pendant des temps difficiles, émergent plus fortes et plus concurrentielles lorsque la reprise commence. Le Canada doit saisir cette occasion pour transformer son économie.

La base la plus saine, pour s'assurer que l'argent de la recherche est bien dépensé, est de fournir un financement continu aux conseils subventionnaires qui peuvent évaluer les propositions de recherche sur leurs mérites scientifiques, car elles sont jugées anonymement par des pairs de la communauté de la recherche. Les propositions sont classées par pertinence pour la société canadienne et internationale, ainsi que par l'excellence des promoteurs et l'aspect innovateur de la recherche. Ces critères fournissent un équilibre approprié afin de maximiser les bénéfices.

Trois organismes canadiens de financement offrent des exemples de la façon dont ces projets pourraient être financés. La **Fondation canadienne pour les sciences du climat et de l'atmosphère (FCSCA)** et le **Conseil de recherches en sciences naturelles et en génie (CRSNG)** soutiennent la recherche en océanographie, en météorologie, en glaciologie et en changement climatique. Dans le cadre de l'**Année polaire internationale (API)**, le programme canadien fournit à des scientifiques de tous les secteurs le financement dont ils ont besoin pour atteindre les objectifs de cette année d'études intensive. L'API a également relié des universitaires aux communautés du Nord. Ces programmes fournissent également des fonds pour l'éducation de la prochaine génération de scientifiques canadiens.

Depuis sa fondation en 2000-2001, la FCSCA a appuyé plus de 150 projets, ainsi que deux initiatives majeures et 24 réseaux de recherche au sein des universitaires canadiens. Les thèmes principaux de la FCSCA sont : la qualité de l'air, l'Arctique, le Nord et les sciences cryosphériques, les changements climatiques et leurs répercussions sur l'environnement physique comme les ressources hydriques, et finalement les prévisions météorologiques et les phénomènes météorologiques violents. L'un des projets actuels vise à développer de nouvelles techniques permettant de déterminer l'avenir des glaciers dans l'ouest du Canada. D'autres projets se concentrent sur le climat urbain, les courants océaniques, l'Arctique et les tempêtes atlantiques, la glace, la vie marine dans l'Arctique, les répercussions des aérosols sur le climat et l'amélioration des prévisions météorologiques. Les fonds de la FCSCA sont particulièrement requis pour le soutien de réseaux à grande échelle, coordonnés, entre de nombreuses universités. À moins qu'il ne soit renouvelé, le financement pour la FCSCA se terminera en 2010.

L'Année polaire internationale (API) 2007-2008 a été le plus important programme international de recherche scientifique jamais mis en œuvre concernant les régions de l'Arctique et de l'Antarctique. Des milliers de scientifiques et

de chercheurs de plus de 60 nations dans le monde ont participé à l'API pendant la période de 24 mois qui a commencé en mars 2007. Le gouvernement du Canada a fourni des fonds particuliers pour ce programme, principalement par l'intermédiaire de subventions aux chercheurs canadiens. L'API a développé une compréhension scientifique plus complète du Nord canadien, qui peut s'appliquer pour répondre aux enjeux liés à notre environnement et au bien-être de nos communautés. L'API est un bon exemple de programme de financement indépendant, examiné par des pairs, pour des scientifiques du secteur privé, du gouvernement et des universités.

Le Conseil de recherches en sciences naturelles et en génie (CRSNG) fournit des fonds pour la recherche à des scientifiques et des ingénieurs des universités pour l'innovation scientifique dans toutes les disciplines. Le Conseil a la réputation de financer d'excellents projets qui produisent des bénéfices importants pour les Canadiens. Ce Conseil requiert un financement continu important pour poursuivre son mandat.

La SCMO recommande le renouvellement du soutien financier pour la recherche en météorologie, en océanographie, en climatologie et en glaciologie, particulièrement dans le nord du Canada, par l'intermédiaire de projets indépendants examinés par des pairs.

À propos de la SCMO

La Société canadienne de météorologie et d'océanographie (SCMO) est une société nationale de personnes et d'organisations vouées à l'avancement des sciences atmosphériques et météorologiques liées aux disciplines environnementales au Canada. La société est l'un des principaux organismes non gouvernementaux à servir les intérêts des météorologues, océanographes, limnologues, hydrologues et scientifiques cryosphériques au Canada. La Société compte environ 1 000 membres, y compris des scientifiques, des universitaires, des étudiants, de grandes entreprises, des institutions et d'autres groupes engagés dans l'éducation, les communications, le secteur privé et le gouvernement. Peut devenir membre de la SCMO toute personne qui a un intérêt dans les sciences atmosphériques et océaniques, ainsi que dans les disciplines connexes et leurs applications. La direction et les membres de la SCMO sont disponibles pour fournir des renseignements supplémentaires sur chacune de ces recommandations.

William Crawford, Président de la SCMO
courriel: president@scmo.ca

Autre point de contact:
Le site Web de la SCMO: http://www.scmo.ca/

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Snow Cover Validation and Sensitivity to CO_2 in the UVic ESCM

by ANDREY SKVORTSOV, MICHAEL EBY and ANDREW WEAVER

Abstract
The University of Victoria's (UVic) Earth System Climate model is used to conduct equilibrium atmospheric CO_2 sensitivity experiments over the range 200-1600 ppm in order to explore changes in northern hemisphere snow cover and feedbacks on terrestrial surface air temperature (SAT). Simulations of warmer climates predict a retreat of snow cover over northern continents, in a northeasterly direction. The decline in northern hemisphere global snow mass is estimated to reach 33% at 600 ppm and 54% at 1200 ppm. In the most northerly regions, annual mean snow depth increases for simulations with CO_2 levels higher than present day. The shift in the latitude of maximum snowfall is estimated to be inversely proportional to the CO_2 concentration. The northern hemisphere net shortwave radiation changes are found to be greater over land than over the ocean, suggesting a stronger albedo feedback from changes in terrestrial snow cover than from changes in sea ice. Results also reveal high sensitivity of the snow mass balance under low CO_2 conditions. The amplification feedback (defined as the zonal SAT anomaly caused by doubling CO_2 divided by the equatorial anomaly) is greatest for scenarios with less than 300 ppm, reaching 1.9 at the pole for 250 ppm. The stronger feedback is attributed to the significant albedo changes over land areas. The simulation with 200 ppm triggers continuous accumulation of snow ('glaciation') in regions which, according to paleo-reconstructions, were covered by ice during the last glacial cycle (the Canadian Arctic, Scandinavia, and the Taymir Peninsula).

Résumé [traduit par la rédaction]
Nous utilisons le *modèle climatique du système terrestre* de l'Université de Victoria (UVic) pour mener des expériences sur la sensibilité au CO_2 atmosphérique à l'équilibre, dans l'intervalle de 200 à 1600 ppm afin d'explorer les changements dans la couverture de neige dans l'hémisphère Nord et les rétroactions sur la température de l'air à la surface (TAS) de la terre. Des simulations de climats plus chauds prévoient un retrait de la couverture de neige dans le nord des continents, dans une direction nord-est. On estime que la diminution de la masse de neige

totale dans l'hémisphère Nord atteindrait 33 % à 600 ppm et 54 % à 1200 ppm. Dans les régions les plus septentrionales, l'épaisseur moyenne annuelle de la neige augmente dans les simulations faisant intervenir des niveaux de CO_2 plus élevés qu'actuellement. On estime que le déplacement de la latitude des chutes de neige maximales est inversement proportionnel à la concentration de CO_2. Les changements dans le rayonnement net de courtes longueurs d'onde dans l'hémisphère Nord apparaissent plus importants au-dessus des continents qu'au-dessus des océans, ce qui suggère que les changements dans la couverture de neige des continents entraînent une plus forte rétroaction de l'albédo que les changements dans la glace de mer. Les résultats révèlent aussi une grande sensibilité du bilan de la masse de neige dans des conditions de faible teneur en CO_2. La rétroaction amplificatrice (définie comme l'anomalie zonale de la TAS résultant du doublement du CO_2 divisée par l'anomalie équatoriale) est plus grande dans les scénarios où la concentration est inférieure à 300 ppm, atteignant 1,9 au pôle pour 250 ppm. La plus forte rétroaction est attribuée aux importants changements dans l'albédo au-dessus des régions terrestres. La simulation avec 200 ppm déclenche une accumulation continue de neige (« glaciation ») dans les régions qui, selon les paléoreconstitutions, étaient couvertes de glace au cours de la dernière période glaciaire (l'Arctique canadien, la Scandinavie et la péninsule de Taïmyr).

Atmosphere-Ocean 47-3 Paper Order

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Large-scale Disasters
Prediction, Control and Mitigation

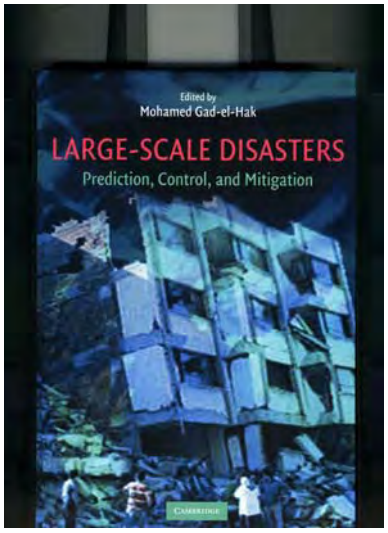
Ed: Mohamed Gad-el-Hak

Cambridge University Press, New York, 2008,
ISBN 978-0-521-87293-5, 576pp., Hard Cover, $US 200

Book reviewed by Charles Schafer[1]

The philosophy that seems to underlie the production of this book is taken from a Hindu fable that the editor included on page vi. It states that [1] "*We start life with a bag of luck and an empty bag of experience.* [The] *Aim of life is to fill the bag of experience before the bag of luck runs out*". In keeping to that proposition, the book's 21 review-style and well-referenced chapters seek to assemble and consolidate a broad range of disaster prediction, control and mitigation experiences that have been solicited from 32 internationally-distributed contributing authors from both university institutions and government departments. Collectively, the 21 chapters comprise the result of the editor's aim "*to establish a common framework for predicting, controlling and managing manmade and natural disasters ,...*" Technological, scientific, medical, logistical, sociological, economical, and political aspects of both natural and manmade disasters are examined for a broad variety of disasters and their related underlying causal factors.

The book's preface offers a detailed rationale for its completion and scope. Its core chapters derive from the *U.S.-Egypt Workshop on Predictive Methodologies for Global Weather-related Disasters* that was held on March 13-15, 2006 in Cairo, Egypt. The meeting hosted 30 formal presentations and two panel discussions (see: Gad-el-Hak, 2006). In traversing the book's various chapters, the reader can expect to encounter disaster-related information on subjects such as multi-scale modelling for large-scale disasters, the root causes of large-scale disasters, disaster relief logistics, medical response issues, health care capacity, global warming, the energy crisis, seawater irrigation, anthropogenic aerosol-related hazards, tsunamis, the troposphere and stratosphere, coupled weather-chemistry modelling, climate prediction, climate change, impact on precipitation, arid land issues, the history and present status of numerical weather predictions, and, last but not least, an introduction to the International Charter and weather satellite measurements. The International Charter outlines a strategy to exploit space technology in disaster management through cooperation among space agencies



and space system operators. In the *Introduction*, Mohamed Gad-el-Hak (Virginia Commonwealth University) presents the reader with a classification of disasters that ranges from *Scope I* to *Scope V.* Scope I is defined as a small disaster involving < 10 persons or < 1 km^2. At the Scope V scale, we have *gargantuan* disasters that include between 1000 - 10^4 persons or >1000 km^2. The scope level of a disaster can be classified if at least one of the two criteria is met. However, he goes on to point out that, in addition to a disaster's scope, there are also considerations regarding the rapidity of the calamity (e.g., earthquakes versus eustatic sea level rise). Near the end of the introduction, Gad-el-Hak mentions a number of useful internet sites that can be consulted for further detailed information e.g.:

www.disastercenter.com and www.disaster.net

I elected to do an in-depth review of three of the chapters that I felt would: (i) provide an example of what the reader can expect to find in the other 18 chapters and (ii) that I felt might be of particular interest to the CMOS Journal readership. I selected chapters 2 (*The Art and Science of Large-scale Disasters*), 4 (*Addressing the Root Causes of Large-scale Disasters*) and 8 (*Energy, Climate Change and How to Avoid a Manmade Disaster*).

Chapter 2 is a 68 page mix of theory and recent disaster examples with numerous references that was written by the book's editor. It begins with several sections that feature topics such as disaster *scope*, the facets of large-scale disasters, the science of disaster prediction and control, modelling disaster dynamics, the fundamental transport equations, the butterfly effect, the Global Earth Observation System of Systems (GEOSS), the art of disaster management, and a suite of important disaster case histories. The author emphasizes that the power of modern numerical modelling, while becoming increasingly critical to accurate weather forecasting, is limited by our incomplete knowledge of the applicable laws of nature so that prediction [in regard to disasters] remains *more or less a black art.* In the section dealing with the art of disaster management, he reminds the reader that the organizational skills and resources needed to mitigate the adverse effects of various types of disasters (e.g., hurricanes versus

[1] Emeritus Research Scientist
Bedford Institute of Oceanography
Dartmouth, Nova Scotia, Canada

earthquakes) are almost the same, but that responses to disasters are also a function of their dynamics (e.g., global warming versus earthquakes) so that their effective management will call for distinctive skills, appropriate response times and political will. One of the more interesting sections of Chapter 2 considers aspects of social behaviour in disaster situations. Gad-el-Hak argues that, from an evolutionary point of view, disasters bring out the best in society. In a state of extreme calamity, communities tend to be resourceful and cooperative except when there is a profound sense of injustice. For example, he notes that the bright side of the 17th century bird flu pandemic, which wiped out a large portion of Europe's population, was the reconstruction phase that followed. I found the section of the chapter devoted to case studies to be quite comprehensive in regard to disasters that have occurred over the past century or so, but that the author failed to mention an important climate-related disaster that occurred in 1816 (the year without a summer). In addition, the numerous spectacular photographs that he used to illustrate his points have not been referenced.

Chapter 4 was written by Ilan Kalman (Center for Capacity Building, National Center for Atmospheric Research, Boulder, Colorado). It covers a range of arguments about the root causes of large-scale disasters and how they might be addressed to reduce disaster risk. Several case studies are used to illustrate how *vulnerability* (i.e., the human input to disasters) is a key root cause of large-scale disasters. The chapter also incorporates several related sections that speak to this topic (e.g., *Defining Disasters* and *Do Natural Disasters Exist?*). Within the definition of disaster are those resulting from rapid onset events (e.g., earthquakes) to those that are more diffuse in space and time (e.g., droughts). Those with less clear start and end points are also incorporated (e.g., glaciation, coastal subsidence). As such, some practitioners distinguish between catastrophic disasters and chronic disasters. Kalman stresses that incompetence, ignorance or corruption in failing to implement disaster risk reduction could, in itself, be considered to be the disaster as opposed to the event in which lives are lost. In addressing the question of whether or not *natural* disasters exist, many of the arguments put forward by Kalman centre on the human factor i.e., on the idea that the growing vulnerability of the population to extreme physical events, and not to changes in nature, can account for the observed increase in disasters (e.g., high density development in coastal zones). Human decisions are seen as having put people and property in harm's way without adequate mitigating measures. As such, the author argues that they constitute the real root causes of disasters as opposed to the natural events themselves. In one example, Kalman describes a community in which structural flood defences were built along an adjacent but non-flooding river. The barriers accentuated flooding from an extreme rainfall event by preventing the water from draining into the river's channel until the barriers were deliberately breached.

In his evaluation of vulnerability as a root cause, Kalman reminds us that low probability/high consequence events are treated very differently from high probability/low consequence events. For example, hydrological engineering initiatives have frequently sought to control river flow during the spring freshet or the annual dry season. As a result, river edge inhabitants tend to become accustomed to the absence of regular flood and drought cycles. At the end of the day, vulnerability is not only about the present state, but also reflects what society has done to itself over the long term. Strategies for overcoming this trend are illustrated by an excellent example of flood plain management initiated by the city of Toronto following Hurricane Hazel in 1954. That approach prevented new development in river valleys that now serve as both floodways and a network of recreational greenways. In another section of Chapter 4, the author discusses the societal aspects of vulnerability and argues that women are more inherently vulnerable than men in coastal flooding situations. He suggests that the root cause, in this instance, is the vulnerable role that women are placed in some societies which inhibits their swimming ability and their physical strength through factors such as restrictive clothing and less acceptance of women appearing in the water in public. At the community level, a case is made that an effective disaster warning system must incorporate continual community-based education awareness and training as opposed to one that relies only on top down impositions from governments or from scientists relying on technology.

Chapter 8 was contributed by Professor A.F. Ghoniem of MIT. It treats the ways and means of avoiding manmade disasters in regard to energy conservation and climate change. The author's analysis explores a number of important issues that will determine how societies can plan successfully for climate change and the depletion of carbon-based fuels. The first several sections of this chapter include headings such as *Energy consumption now and then*, *How much we will use?* and *Energy and how we live*. In the later sections of this chapter, Ghoniem explores several critical climate change issues (e.g., carbon dioxide, climate modelling, global warming and climate change, sea level rise, CO_2 mitigation techniques, and implementing multiple solutions. His multiple solutions idea is couched in what he describes as a *wedges* model that is essentially an incremental strategy which draws upon a series of options (e.g., improvements in energy conversion, CO_2 capture and nuclear energy etc.) that are listed in Table 8.1. In the remaining parts of the chapter, he offers his analysis of a range of energy options that covers everything from electrochemical separation (i.e., high temperature fuel cells for converting chemical energy to electricity) to biomass energy sources. The *Conclusions* section includes a recommendation to practitioners that a portfolio of approaches must be applied simultaneously in order to achieve energy sustainability and that solutions must be endorsed at the global scale.

The remaining 18 chapters of the book offer a number of interesting disaster-linked ideas for just about everyone. For example, Chapter 3 (written by R.M. Pidaparti, Virginia Commonwealth University) explores multi-scale modelling

for large-scale disaster applications. In chapters 6 and 7, J. Elkholy and Mostsafa Gad-el-Hak (Cairo University) and A. Radwan (Zagazig University) offer perspectives on medical response and the augmentation of health care capacity in large-scale disasters. Seawater agriculture for energy, natural and anthropogenic aerosol-related hazards affecting megacities, tsunamis, and a host of weather-related information, accounts for another 12 chapters. Chapter 20 (prepared by A. Mahmood, Canadian Space Agency and M. Shokr, Environment Canada) provides a comprehensive treatment on the application of measurements from space that are relevant to disaster response. Within this chapter, the reader will find an excellent summary of remote sensing technologies and a section on space-based initiatives for disaster management.

Although this book is relatively expensive, its content offers value as a reference source to a wide range of science, engineering and disaster management practitioners whose efforts are aimed at disaster avoidance, mitigation and public education. Almost all of the book's chapters make ample use of colour illustrations to help explain the concepts that are presented. As such, the compilation brings a comprehensive, timely and carefully crafted perspective to the field of disaster research that makes for an exceptional reference text for both personal and institutional libraries.

[1] Gad-el-Hak, M., 2006. Proceedings of the U.S. – Egypt Workshop on Predictive Methodologies for Global Weather-related Disasters, Cairo, Egypt, 13-15 March, 2006, CD Publication, Virginia Commonwealth University, Richmond, Virginia, 23284-3015.

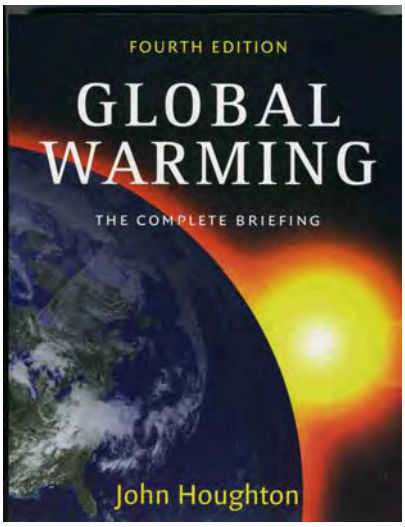
Global Warming: The Complete Briefing

John Houghton

Cambridge University Press, 2009, Hardback: US$120; Paperback: US$59 ISBN 978-0-521-70916-3

Book reviewed by John Stone[2]

Just how many books, magazine articles, television documentaries and other popularizations is it going to take before we see real action to address the threat of climate change. The Intergovernmental Panel on Climate Change (IPCC) in its Fourth Assessment Report (AR4), completed in 2007, essentially drew a line under the scientific debate on the question of human-induced climate change with its clear conclusions that: "*Warming of the climate system is unequivocal*" and "*Most of the observed increase in global average temperatures since the mid-20th century is very **likely** due to the observed increase in anthropogenic greenhouse gas concentrations*". Sir John Houghton, in this Fourth Edition of his book: "Global Warming: The Complete Briefing", has written what should be the last word in this magisterial presentation of the latest science based very much on the IPCC Assessments. Coming as it does when the Conference of the Parties under the UN Framework Convention on Climate Change will meet in Copenhagen in December this year, this easily accessible book should leave no government negotiator in any doubt of the reality of the threat and the need to respond now. My fear is that we are running out of time.



The author is singularly well qualified to help the concerned individual understand the science of climate change having been a professor of atmospheric physics at Oxford University before heading the United Kingdom Meteorological Office (UKMO) and having been the chair or co-chair of the IPCC's scientific contributions (Working Group I) to the first three Assessment Reports in 1990, 1995 and 2001. He was also one of a small group of scientists that were invited to brief Margaret Thatcher on the issue in 1990 – the first time an overhead projector was introduced into the Cabinet Office. This briefing, incidentally, led to the decision to establish the Hadley Centre for Climate Prediction and Research.

The book, almost seductively, leads the reader through the essential science behind the issue of climate change. There is nothing of the author's earlier, more alarmist statements such as that contained in his letter to the Guardian newspaper in which he had no hesitation in describing [climate change] as a "weapon of mass destruction". Rather, this book treats the science in a balanced, understandable and rigorous manner. It also demands quite a bit of the reader, whether scientist or non-scientist, with challenging exercises at the end of each chapter. This would make the book an excellent text for a seminar class to senior undergraduates or masters students. The science is up-to-date with references to papers published since the IPCC AR4 although this does lead occasionally to the odd discrepancy in the text. The text is enhanced by many useful diagrams, most of which have been taken from IPCC Reports. One of the few grumbles I have with the book is that all references for the diagrams are placed at the end of the book in an appendix.

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[2] Retired Meteorologist and Adjunct Research Professor in the Department of Geography and Environmental Studies at Carleton University, Ottawa, Ontario, Canada

Sir John begins his story by recalling the seeming increase in the frequency and intensity of extreme events during the last 30 years, some of which occurred during his tenure at the UKMO such as the storm of 1987 in which over 15 million trees were blown down in southeast England (and which the forecasts missed!). He is cautious in attributing all these events to climate change noting that weather and climate extremes are nothing new and that our communities and infrastructure have become more vulnerable. Nevertheless, despite the greater confidence that the chance of occurrence of these events has increased as a result of climate change, the sense of denial continues.

While our climate models and projections of future climate change have improved significantly there are two areas of science where uncertainties remain: the sensitivity of the climate, which is principally a problem of some of the physical feedbacks in the climate system such as cloud radiative forcing; and the carbon cycle, which is more related to biological feedbacks and is crucial in translating emissions into atmospheric concentrations. As the author notes, a 2% release of the carbon stored in the oceans could lead to a doubling of atmospheric carbon dioxide. Climate sensitivity is dealt with in chapter 2 and the carbon cycle in chapter 3. These two uncertainties are important in determining action to avoid “dangerous” climate change.

The book contains an elegant description of changes in the climate over the past one hundred, thousand and million years (chapter 4) and then launches into an explanation of modern weather and climate models (chapter 5) before introducing projections for the 20th century and beyond (chapter 6). The modelling chapter picks up the discussion in chapter 2 on the important feedbacks in the climate system which the author lists as those related to water vapour, clouds, ocean circulation and ice-albedo and of which that related to clouds is the main contribution to climate sensitivity. Surprisingly, the author does not discuss here carbon-cycle feedbacks even though these are now being incorporated into models. In the climate projections chapter he returns to the uncertainties resulting from future emission scenarios and the climate sensitivity although not mentioning that current emissions are greater than any of the IPCC scenarios and that the climate sensitivity could be much larger than the quoted 3^{o} C “best estimate.

The author discusses the potential impacts of climate change in chapter 7 in a fairly balanced manner focussing on sea-level rise, water availability, food supply, health and ecosystems (in which he deals with Arctic sea-ice but somehow misses the dramatic decline in 1977). The real disappointment in this chapter is the sketchy attention paid to adaptation. Estimates of the costs rely heavily on the Stern Report but, as with this Report, my sense is that the estimates are possibly exaggerated. Having treated climate change so far in a dispassionate manner, chapter 8 comes as something of a bombshell. In this chapter, which interestingly comes in the middle of the book, Sir John gives his personal view of the issue. This is the viewpoint of someone who is a deeply committed Christian (brought up as a Calvinistic Methodist in Wales). In this chapter he deals with questions of values such as our responsibility for being good stewards of the Earth and for the poor and disadvantaged. I would hope this chapter was not skipped over in any seminar course.

The rest of the book deals mainly with how we might respond to the threat and avoid “dangerous” climate change. It includes a chapter on the role of the IPCC (chapter 9) and another of the UN Framework Convention on Climate Change (chapter 10). Solutions to reduce emissions, mainly in energy and transportation, are given in chapter11 and the book ends with an exploration of how climate change is situated within the context of other major global problems faced by mankind. While the author discusses some of the reductions in emissions that will be required, he somewhat under plays the magnitude and urgency of the action required.

There is a growing consensus that we should strive to limit global warming to 2^{o}C above pre-industrial levels. It is estimated that this could be achieved with a continual 3% year-on-year emissions reduction. If this were begun now emissions would peak around the middle of the next decade and could lead to a 50% reduction in emissions by 2050 (which is another often-stated target). Temperatures would probably peak around 2065 at just above 2^{o}C, but with about a 20% chance of exceeding 2.5^{o}C. Delaying action by ten years more certainly would raise peak temperatures over 2.5^{o}C; delaying by a further ten years would mean a rise of about 3^{o}C, with a much longer recovery. With this we could be in the region of irreversible changes.

However, there is a reasonable chance that we will overshoot the desired temperature target of 2^{o} C for a period of time. The two significant factors that we have to consider and that are well explained in this book are: first that the climate system adjusts slowly and when a desired concentration is reached the temperature will continue to rise for several decades; and second that the CO_2 will stay in the atmosphere for hundreds to thousands of years after the stabilization target has been reached. According to a recent paper by Andrew Weaver and colleagues at the University of Victoria, 15-30% of emissions remain in the atmosphere for at least 10,000 years.

Experience has shown us that while solid science is a necessary foundation, it has not yet been a sufficient one to guarantee real action by governments. Scientists have responsibly put the issue of climate change on the public policy agenda; they have warned of the dangers. What seems to be lacking is the will to take collective action. There is an urgency to begin taking action now; to wait and see any longer is an irresponsible response.

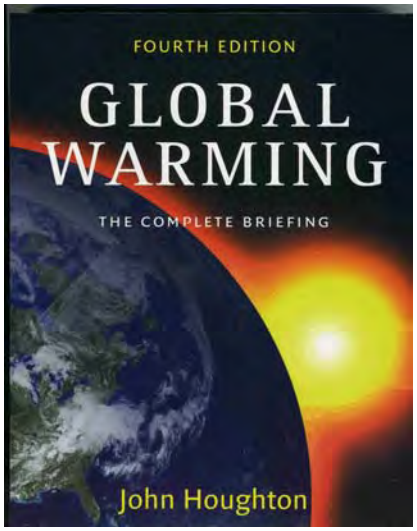
Global Warming: The Complete Briefing

John Houghton

Cambridge University Press, 2009, Hardback: US$120;
Paperback: US$59 ISBN 978-0-521-70916-3

Book reviewed by Dov Richard Bensimon[3]

This comprehensive text on the topic of climate change is comprised of 12 chapters. The first four present the basic science of the atmosphere and introduce important concepts in climatology (e.g. the greenhouse effect, reconstruction of past climate from isotope data, etc.). The next chapter is devoted to modelling the climate and explains both weather and ocean models. This chapter also addresses the important issue of feedback in climate models, which is the source of some uncertainty, but which is of paramount importance in the actual evolution of the climate. Chapter 6 continues the theme of the future by examining possible scenarios of future climates.



The second half of the book deals with the impacts and consequences of climate change. The author discusses some of the most plausible impacts of global warming on human health, the economy and food supply, to name but a few. It is made abundantly clear in the text that although uncertainty does still exist in depictions of future scenarios (an entire chapter is actually devoted to the topic of uncertainty), there is ample information that already allows us to conclude that future climates will require significant changes in societal behaviour if the environment is to continue to be hospitable to human development. Chapter 10 reviews past international conventions on climate change (e.g. the Montréal and Kyoto protocols), while the following chapter presents energy and transport strategies for the future that may alleviate the pressure that current forms of energy use put on existing resources. The author concludes the text with a reminder that this is a *global* topic which will need contributions from all humankind to solve.

While many books dealing with global warming or climate change cover the basic science in a fashion similar to how it is done in this text, the inclusion of chapters dealing with detailed solutions in terms of renewable energy source and chapters which pose the question “Why should we be concerned?” make this book one that takes a more holistic approach to the topic. This is an important angle in terms of education of the public with respect to the topic of climate change, since it emphasizes that there is an impact on all of us now, as well as on future generations.

The book is intended as a general text for students. As the author explains in the preface, the target audience can be students from high-school level up to university graduates. It is also meant to appeal to both scientists and non-scientists. The book is generally written in qualitative terms as a result. The questions at the end of each chapter promote both scientific reasoning (e.g. asking students to calculate the surface temperature of the Earth in the absence of carbon dioxide in the atmosphere) as well as stimulating key discussions on topics related to climate change (e.g. “How far can science be involved in the generation and application of environmental values?”).The book is superbly illustrated, with many graphs quantifying points made in the text and with several photos showing “before/after” shots of areas having undergone desertification or deforestation. Each chapter is followed by an extensive bibliography, both in the form of sections entitled “Further Reading and Reference” as well as detailed notes, which often point to other references.

The author emphasizes that scientists not only have a role in trying to describe climate change as accurately as possible, but to participate in the goal of finding solutions as well. Communicating the urgency and importance of this topic to the public is one of the many challenges faced by the scientific community. To his credit, the author has provided an excellent example of how to do this in writing this book.

Although I am a meteorologist, I appreciated the general scope to the book, since my area of specialty is not climate change. When writing a book destined for a wide audience, there is always a danger that it may appeal to no-one. The author succeeds in avoiding falling into this trap by keeping the book easy to read and well illustrated, even if it remains general. For specialists in the field of climate change, this book may not be technical enough, yet for all other audiences, the text has a great deal of knowledge to offer.

[3] Meteorologist, Environment Canada
2121, route Transcanadienne
Dorval, Québec, Canada

Science Adopts A New Definition of Seawater

The world's peak ocean science body has adopted a new definition of seawater developed by Australian, German and US scientists to make climate projections more accurate.

In Paris, in June 2009, the General Assembly of UNESCO's Intergovernmental Oceanographic Commission (IOC) accepted the case for the introduction of a new international thermodynamic description of seawater, cast in terms of a new salinity variable called Absolute Salinity.

Hobart-based CSIRO Wealth from Oceans Flagship scientist, Dr Trevor McDougall, made the case during his presentation of the Bruun Memorial Lecture to the Paris meeting.

"Scientists will now have an accurate measure of the heat content of seawater for inclusion in ocean models and climate projections," Dr McDougall says.

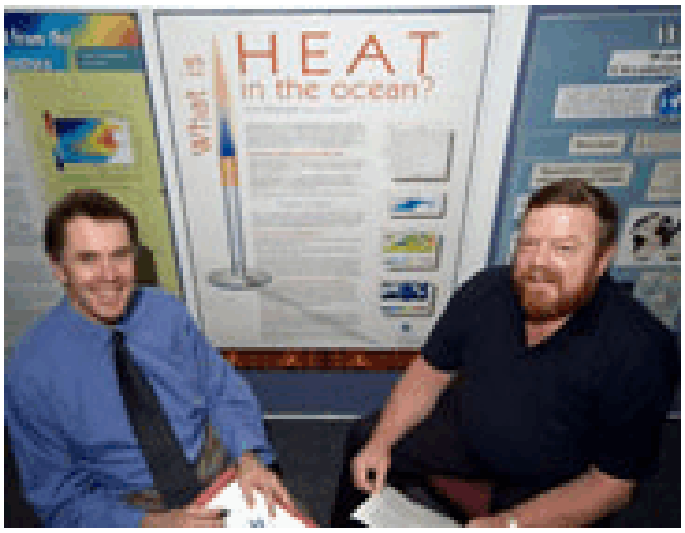
"Variations in salinity and heat influence ocean currents and measuring those variations are central to quantifying the ocean's role in climate change. The new values for salinity, density and heat content should be in widespread use within 18 months."

Marine scientists have been searching for the 'magic formula' for measuring salinity – which varies from ocean to ocean and between tropical, temperate and polar regions – for more than 150 years.

"These variations in salinity and temperature are responsible for driving deep ocean currents and the major vertical overturning circulations of the world's oceans, which transfer ocean heat towards the Arctic and Antarctic regions," Dr McDougall says.

Unchanged since the last assessment 30 years ago, the case to review ocean thermodynamic measurements began in 2005 when the Scientific Committee on Oceanic Research (SCOR) established a working group, chaired by Dr McDougall. Supporting him were Dr Rainer Feistel from the Leibniz-Institut für Ostseeforschung in Warnemünde (Germany), Dr Frank Millero, from the Rosenstiel School of Marine and Atmospheric Science at the University of Miami in Florida, Dr Dan Wright of the Bedford Institute of Oceanography, Canada and Dr David Jackett of CSIRO.

Salinity, comprising the salts washed from rocks, is measured using the conductivity of seawater – a technique which assumes that the composition of salt in seawater is the same in all the world's oceans.



CSIRO's Drs Trevor McDougall and David Jackett, who's work has been influential in the new definition of seawater. Photo credit: CSIRO website.

"The new approach, involving Absolute Salinity, takes into account the changes in the composition of seasalt between different ocean basins which, while small, are a factor of about 10 larger than the accuracy with which scientists can measure salinity at sea," Dr McDougall says.

"Scientists will now have an accurate measure of the heat content of seawater for inclusion in ocean models and climate predictions" — Dr. Trevor McDougall

Until the new description of seawater is widely adopted, ocean models will continue to assume that the heat content of seawater is proportional to a particular temperature variable called "potential temperature".

"The new description allows scientists to calculate the errors involved by using this approximation while also presenting a much more accurate measure of the heat content of seawater, namely Conservative Temperature," Dr McDougall says.

"The difference is mostly less than 1ºC at the sea surface, but it is important to correct for these biases in ocean models."

Reference: http://www.csiro.au/news/Science-adopts-new-seawater-definition.html

Further reference: *Improved seawater thermodynamics: How should the proposed change in salinity be implemented?* SCOR/IAPSO Working Group 127, February 2008, CMOS Bulletin SCMO, Vol.36, No.3, pp.103-106.

Les organisations environnementales font équipe afin de poser les jalons pour une certification professionnelle en météorologie

Calgary, le 25 mai 2009 - ECO Canada, en partenariat avec la Société canadienne de météorologie et d'océanographie (SCMO) et Environnement Canada, développent les fondations d'un programme de certification professionnelle dans le domaine de la météorologie.

L'objectif de ce projet est de documenter les Normes professionnelles nationales (NPN) pour les spécialistes en environnement et mieux définir les professions environnementales en météorologie.

Les NPN documentées seront offertes aux partenaires pour le développement de nouveaux programmes de formation et de mises à jour de programmes. Elles seront aussi offertes aux spécialistes pour leur perfectionnement professionnel, et aux employeurs pour le développement des ressources humaines.

Les objectifs à long terme du projet comprennent:

■ Promouvoir la reconnaissance des qualifications des spécialistes en météorologie;

■ Faciliter la mobilité de la main-d'oeuvre à travers le Canada;

■ Guider le développement des programmes de formation liés à la météorologie;

■ Augmenter la sensibilisation aux carrières et les possibilités pour les spécialistes en météorologie.

Contexte:
Comme par le passé, ECO Canada développera des normes professionnelles nationales avec la pleine participation des établissements d'enseignement, des employeurs et des spécialistes afin d'assurer l'appui des partenaires universitaires et de l'industrie. Ce projet est financé par le Gouvernement du Canada par l'entremise du Programme des conseils sectoriels. Pour de plus amples renseignements, visitez le www.eco.ca/meteorology ou envoyez vos questions à meteorology@eco.ca

Note from the Editor: This news item was already published in English in the June issue of the *CMOS Bulletin SCMO* (Vol.37, No.3) but is reproduced here in French for the benefit of our French language readers.

SOS Ocean Acid

From: Alaska Marine Conservation Council

September 6, 2009, Homer, Alaska — More than 100 fishing boats, sail boats, skiffs and kayaks took to the waters of Homer Alaska today as commercial fishermen, mariners and others from coastal communities spelled out an urgent message to protect jobs and fisheries from the threat of ocean acidification. The boats arranged themselves in the ocean to spell out "**Ocean Acid SOS**" as part of a 'Voices for the Ocean' event hosted by the Alaska Marine Conservation Council (AMCC) and Sustainable Fisheries Partnership (SFP) with International Aerial Artist John Quigley (www.SpectralQ.com).

Timed to spell out the message "**Ocean Acid SOS**" in the tight window that tides permitted, this Labor Day weekend event marked a rare collaboration between commercial fishermen and the conservation community in the region. Participants hope the '**SOS**' will be heard by the US Congress and international leaders participating in the upcoming United Nations climate negotiations in Copenhagen, and that their call for help will result in definitive action to curb ocean acidification, referred to by scientists as the '**evil twin**' of climate change.

"Fishermen and others who depend on Alaska's rich marine resources are coming together as one voice in support of reducing fossil fuel consumption and moving to a renewable energy future. This is the only real solution to ocean acidification and the time to act is right now," said Alan Parks, a small-scale family fisherman from Homer whose primary source of income is commercial fishing in Alaska. Parks helped organize fishermen for the event with Alaska Marine Conservation Council.

"Alaska's senators know that ocean acidification is a looming danger to our fisheries," said Parks. "This message from fishermen is to support our leaders in taking the necessary action now to reduce carbon emissions. Time is of the essence".

Parks and others are asking leaders to follow science and not politics, and with this 'SOS' are calling on state, national and international leaders to protect the ocean from the acidifying, oxygen-depleting and climate-altering impacts of uncontrolled fossil fuel emissions.

"This is the first significant show of numbers, vessels and determination from the north pacific fishing industry, but it is not the last," said Brad Warren of the Sustainable Fisheries Partnership". Some 3 billion people get their food from the

sea and there are a lot of a people who want to keep it that way. We expect to see people from the seafood industry around the world taking up this same issue of ocean acidification with the same intent — to get a strong international carbon policy that protects oceans, fisheries and fishing industry jobs".

Aerial artist John Quigley, who has done similar actions on land and ice, but never before at sea, said, "This message from the sea is a call for people around the world to join in a visual declaration to urge leaders to immediately adopt a treaty that reduces greenhouse gas emissions, stabilizes the climate, and protects the oceans."

Recent research confirms that acidification is caused by billions of tons of carbon dioxide that rise from smokestacks and tailpipes every year and mix into the sea. In seawater, the gas forms an acid that attacks the foundation of marine food webs. The same pollution that drives climate change also undercuts fisheries around the world, especially in the vulnerable North Pacific off Alaska and the Pacific Northwest, which produce more than two thirds of the U.S. seafood harvest. The North Pacific is a global repository for carbon dioxide in the oceans.

Supporters of the Homer event included the Alaska Marine Conservation Council (AMCC), the National Fisheries Conservation Center, the Sustainable Fisheries Partnership (SFP), and many participants from the fishing industry, Alaska coastal communities and conservation groups.

The 2008 Barbara Hoglund Citation of Excellence

Citation of Excellence 2008 Environment Canada's Citation of Excellence recognizes the extraordinary achievements by individuals or teams, which benefit the Department, its clients or employees. The Citation also recognizes employees and teams that represent the Department in a positive way through activities that foster and improve teamwork, morale and the work environment. The Barbara Hoglund Citation of Excellence is awarded to an employee who:

- Initiated positive, far reaching actions that have contributed to the wellness of Environment Canada employees;

- Performed duties under extraordinary circumstances while respecting the human element;

- Managed work in a way that eliminated excessive workload and related stress;

- Encouraged and supported employees' aspirations to achieve a work-life balance; or,

- Led by example in establishing a balance between work and personal life.

For 2008, the Citation is awarded to Peter Bowyer, Canadian Hurricane Centre, Meteorological Service of Canada.

Peter Bowyer at the Hurricane Museum of the Atlantic giving a talk on the history of recent hurricanes that hit Atlantic Canada. This public lecture was presented during the last CMOS Congress held in Halifax, the night of June 2nd, 2009. Photo credit: CMOS Historical Photos Archives.

When Peter Bowyer noticed that morale at work was low, he did not feed the vicious cycle by complaining. Instead, he did something about it. He approached management with an intriguing proposal to deliver lunch-hour sessions on the Art and Science of Balancing Life. This 12-part health and wellness series included topics like a common-sense approach to diet and exercise. Based on his own experiences and advice he had gleaned from self-help gurus, Peter packaged practical information in palatable portions, ideal for a lunch-hour break. An entertaining and energetic speaker, his sessions were well attended, not due just to their content, but also to Peter's delivery style and good nature. His talks had an impact on his co-workers, many of whom supported Peter's nomination with personal letters. The role of morale booster is not new to Peter. In 2005, he took on the full-time role of Executive Coordinator

for the Government of Canada's Workplace Charitable Campaign (GCWCC), of which Environment Canada was the lead. He proved to be an inspiration not only to Environment Canada but throughout the federal public service in Nova Scotia. It was one of the most successful campaigns in the province's history, in no small part due to Pete's energy and his message about the impact of giving. Peter has always demonstrated incredible passion for his work on marine weather and hurricanes, and provided national and international leadership in this area. At the same time, he has personified a deeply-rooted respect and love for family and non-work activities that others have consistently admired and used as a model for work-life balance. For his exceptional support, example and initiatives which have contributed to the overall wellness of Environment Canada employees, Peter Bowyer is honoured with the Barbara Hoglund Citation of Excellence.

2009 A.G. Huntsman Award

November 12, 2009

Bedford Institute of Oceanography

The 2009 A.G. Huntsman Award recipient is Professor James P.M. Syvitski in recognition of his contributions to marine geoscience. The award ceremony will take place at the Bedford Institute of Oceanography on Thursday, November 12, 2009.

Professor James Syvitski

Professor Syvitski's scientific interests are broad and include fjords, rivers, deltas, estuaries, particle dynamics, simulation of sediment transport and stratigraphy, continental margin sedimentation, gravity flows and animal–sediment interactions.

Professor Syvitski received his Ph.D. from the University of British Columbia in 1978 and was a member of the Geological Survey of Canada (Atlantic) from 1981 to 1995. In 1995 he became Director of the Institute of Alpine and Arctic Research at the University of Colorado. Professor Syvitski has held various academic appointments at the University of Colorado and since 2007 has been Executive Director of the Community Surface Dynamics Modelling System (CSDMS).

IN MEMORIAM

Dr. David Esson Slauenwhite

Dartmouth, N.S. It is with sadness that we announce the passing of Dr. David Slauenwhite while in the arms of his mother, and his wife on August 21, 2009, in Dartmouth General Hospital. Born in Bridgewater. David was raised in Dayspring, attended Centre Consolidated School and graduated from Park View Education Centre. He then went to Dalhousie University where he received his B.Sc. in Chemistry with honours. He continued his education to finish with his Ph.D. in Chemical Oceanography. He was employed with Dalhousie and St. Mary's Universities and most recently with Bedford Institute of Oceanography. David loved to read books about history and wars and enjoyed playing chess. He also enjoyed the cottage and his many camping adventures. He has taken many Caribbean cruises in the Panama Canal and in March, cruised to Belize and Guatemala. He traveled extensively to Europe and most recently to Scandinavia, Russia, Belarus and Poland. During his brief illness with cancer, he kept his dry sense of humour and when asked how he was doing, he always answered "Doing Good." He was gentle and compassionate and had a heart of gold.

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Chemical Oceanography,
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211-100 High Park Avenue
Toronto, Ontario M6P 2S2 Canada
Tel: 416-516-8941 (Home)
Email; omer86@can.rogers.com

Douw G. Steyn

Air Pollution Meteorology
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4064 West 19th Avenue
Vancouver, British Columbia,
V6S 1E3 Canada
Tel: 604-822-6407; Home: 604-222-1266

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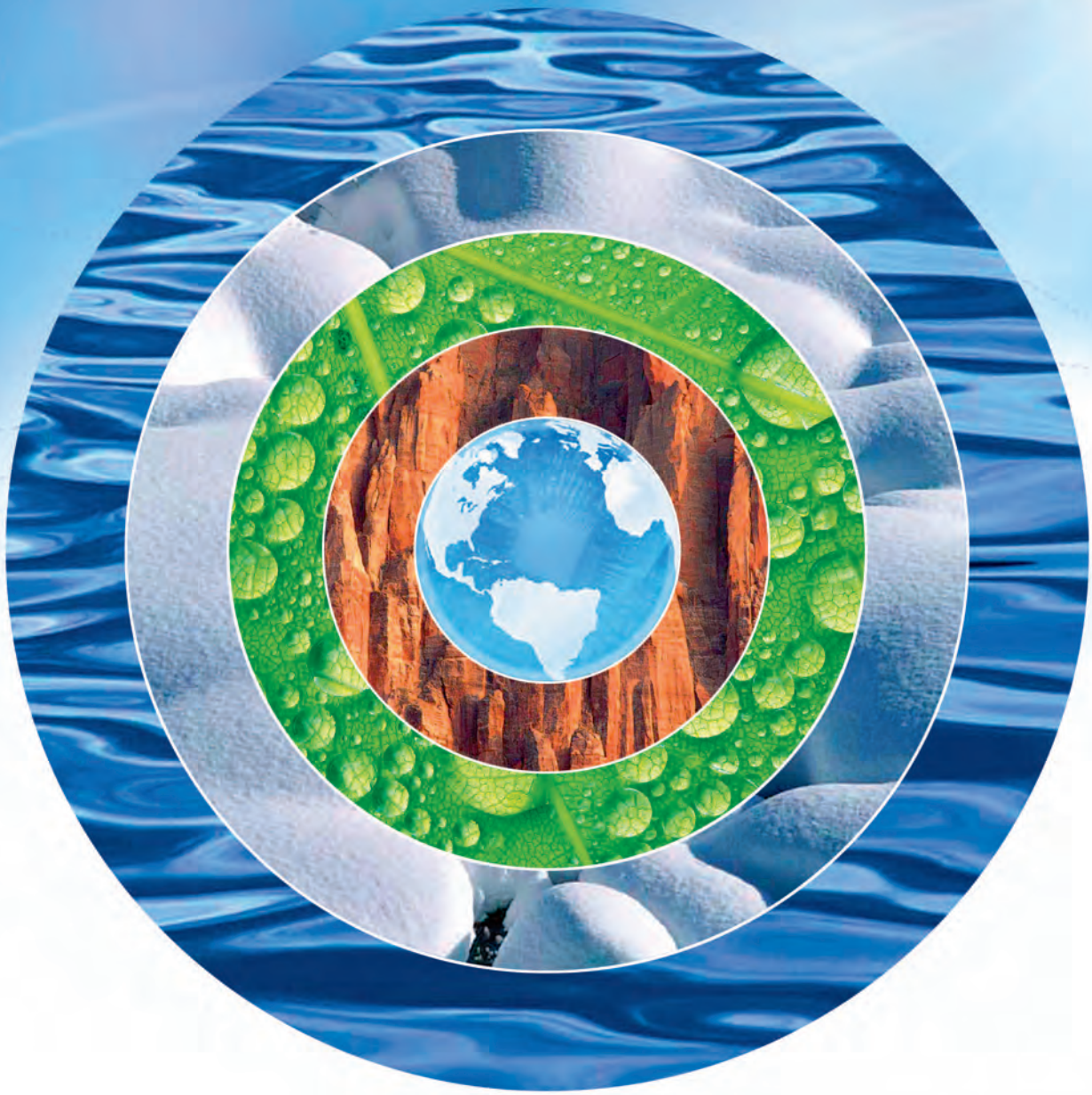

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