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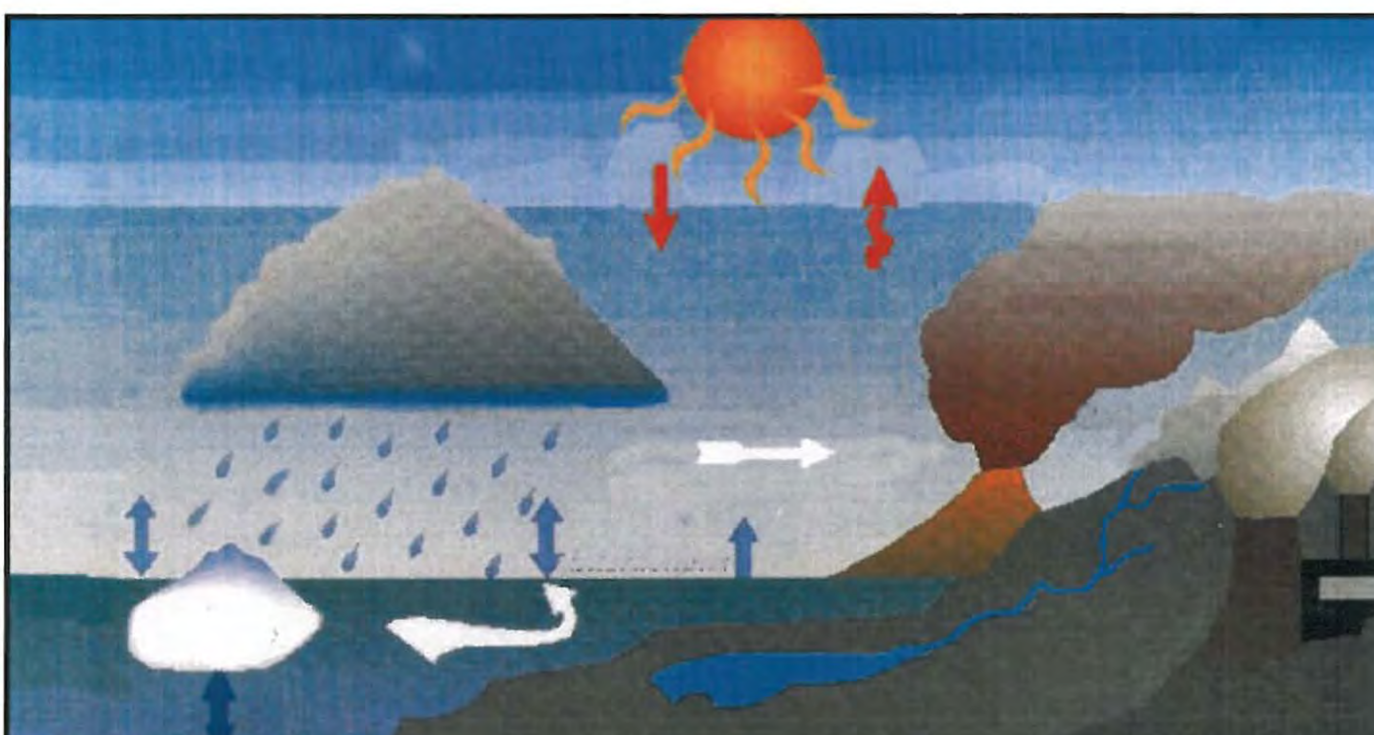

Numéro du 25e anniversaire : Changement climatique

CMOS Bulletin SCMO

"at the service of its members
au service de ses membres"

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Cover page: To celebrate its 25th anniversary, CMOS Bulletin SCMO is pleased to present this special issue on Climate Change. The figure on the cover page illustrates the major components of the Earth's climate system; and Climate Change will have an effect on all of them. The first article examined the possible mitigating effect of global warming on future and past sea-level variation in Hudson Bay (p.159). The second article presents the point of view of a Climatologist who has to respond to many requests imposed on his work (p.163). The third article presents an interview with Jim Bruce on the "New World Climate Order" (p.165) and finally the last article illustrates the socio-economic impact of a rapid climate change (p.168). We close this first issue on Climate Change by stressing the need for an open scientific debate in Canada on Global warming and Climate change issues (p.176). As the answer to our June call was very positive, we will continue in the next issue to present more articles on this very interesting topic.

Page couverture: Pour célébrer son 25e anniversaire, le CMOS Bulletin SCMO est fier de présenter ce premier numéro sur le Changement climatique. L'illustration graphique en page couverture démontre les composantes principales du système climatique de la planète Terre; les changements climatiques auront un effet sur toutes. Le premier article examine l'effet de l'atténuation possible du réchauffement de la planète sur la variation future et passée du niveau de la mer dans la baie d'Hudson (p.159). Le deuxième article présente le point de vue d'un climatologue qui doit répondre aux nombreuses requêtes que lui impose son travail (p.163). Le troisième article présente une entrevue avec Jim Bruce sur le "New World Climate Order" (p.165) et finalement le dernier article démontre les effets socio-économiques d'un changement rapide du climat (p.168). Nous clôturons ce premier numéro sur le Changement climatique en démontrant le besoin d'un débat ouvert au Canada sur le changement climatique et le réchauffement global et sur leurs enjeux potentiels (p.176). Comme la réponse à notre appel fait en juin a été très favorable, nous continuerons à présenter dans le prochain numéro des articles sur ce très intéressant sujet.

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Adresses électroniques de la SCMO

.....from the President's desk

As I write this, nations are deliberating in Kyoto the actions that will be taken to combat the threat of climate change. Our Canadian climate community deserves recognition for the role they played, both nationally and internationally, in developing the science and explaining the issue.

That recognition should be given not only to those who see and can explain the big picture without having all the pieces in place, but also to the scientists who point out the gaps in understanding and the information that doesn't seem to fit. An example involved showing that models overpredicted warming. Fixing the problem improved understanding of the role of anthropogenic aerosols and of the climate system. Pointing out the gaps is sometimes inconvenient to those who would influence policy, but it's essential to advancing understanding. Politicians, at least those with experience of governing, are surprisingly tolerant of uncertainty that would give a scientist pause. They work naturally from a big picture perspective and do not expect scientists to have all the answers. Incidentally, it's also clear they have little tolerance for politics masquerading as science.

A report, recently issued and based on a series of hearings of the House of Commons Standing Committee on Environment and Sustainable Development, shows how this plays out in practice. What is encouraging is that not only in its main recommendations did the Committee see the big picture and urge action, but it also appreciated the importance of filling in important knowledge gaps. To quote the report:

"It has often been stated that policy-making related to climate change must be based on a solid scientific foundation. At present, there is little doubt that the scientific consensus on the reality of global warming, and on the vital role played by greenhouse gases, does not extend to the use of various mathematical and computer models to predict the consequences. On the other hand, there is also no doubt that the reliability and sophistication of these models have increased greatly in recent years, and that further efforts to improve these models will be well worth the effort."

Mr. Gordon McBean, Assistant Deputy Minister, Atmospheric Environment Service, described the Canadian Climate Centre's global climate model (GCM) as a sophisticated mathematical model involving the atmosphere, the ocean and the ice component. The two oceanographers who appeared before the Committee, Mr. Allyn Clarke, Acting Manager, Ocean Sciences Division, Bedford Institute of Oceanography, and Mr. Roger Pocklington from the Bermuda Biological Station, took exception to the claim that present GCMs adequately incorporate the role of oceans in determining world climate.

Suite à la page 158 ... Continue on page 158....

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INSIDE / EN BREF

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Nos meilleurs voeux pour la nouvelle année!

1998

Our best wishes for the new year!

.....from the President's desk

(Suite de la page précédente) (Continued from previous page)

The ocean is believed to be the principal source of climate variability over time scales of months to decades because it has the ability to store and redistribute heat over these time scales. A small change to the freshwater supply over a small part of the Atlantic can trigger a rapid shift of the climate system into a new equilibrium state. According to Mr. Allyn Clarke, "This is one of those 'surprises' that the IPCC assessments warn about."

It is clear to the Committee that much greater effort must be expended on improving GCMs, particularly by achieving a better scientific understanding of the roles of oceans and ocean currents in climate change. In view of Canada's existing expertise in this area, and the importance of oceans to our climate system, this would appear to be an issue which should receive a high priority.

Recommendation No. 5: The Committee recommends that the Government of Canada recognize ocean climatology as a research priority and encourage greater private and public sector research initiatives through the provision of adequate funding."

You can read the whole report on the web at: http://www.parl.gc.ca/36/1/parlbus/commbus/house/ensu/reports/ensurp02-e.htm

As a result of a parallel set of hearings the House of Commons Committee on Natural Resources recommended "That the federal government, in co-operation with its partners - the provinces, industry, non-governmental organizations and all Canadians - pursue and encourage the necessary research for a better understanding of the climate change phenomenon; its environmental and socio-economic effects; and the costs and benefits of any proposed measures for controlling greenhouse gas emissions."

The Ottawa rumour mill expects to see a modest increase in funding for the granting councils in the next federal budget. Recommendations such as these, and the evidence of the role that university and government science has already played in the climate change issue, give hope that we may see improved support for our sciences in 1998. That would be very appropriate for "The Year of the Oceans".

John Reid,
President / Président

CMOS Archives

A long-time dream has finally come true (almost)! All of the publications of the Society have now been assembled (thanks to Members' collaboration) and bound for posterity. This includes publications from the Canadian Branch of the Royal Meteorological Society and the Canadian Meteorological Society.

Four documents are still missing: namely, the Congress Programs for 1960, 1961, 1963 and 1964. Would any member who might still hold such documents be willing to forward the original or a good photocopy to the usual address?

Archives de la SCMO

Un vieux rêve a finalement été réalisé (enfin presque)! Toutes les publications de la société ont été rassemblées (grâce à la collaboration des membres) et reliées pour la postérité. Ceci inclut les publications du Chapitre canadien de la Royal Meteorological Society et de la Société canadienne de météorologie.

Cependant, il manque encore quatre documents: les programmes du congrès de 1960, 1961, 1963 et 1964. Si un membre possède encore un de ces documents, pourrait-il envoyer l'original ou une bonne photocopie à l'adresse habituelle.

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Sea-Level Variation in Hudson Bay due to Climate Change

by William A. Gough[1]
Tatiana Allakhverdova and Rizwan Sayed

Résumé

On a examiné l'effet de l'atténuation possible du réchauffement de la planète sur la variation future et passée du niveau de la mer dans la baie d'Hudson. À partir d'un modèle de circulation générale océanique, on a fait une évaluation de l'expansion thermique. Le modèle admet comme hypothèse la propagation des eaux en expansion dans la baie au moyen des ondes de Rossby barotropes. En combinant les estimations de la variation du niveau de la mer occasionnée par l'expansion thermique, la fonte des glaces et le relèvement isostatique ont montré un potentiel pour des baisses grandement atténuées du niveau de la mer et même la possibilité pour une élévation du niveau de la mer. Les données du marégraphe de Churchill au Manitoba montrent une variation de basse fréquence qui approche la tendance temporelle des relevés de température de l'hémisphère Nord, avec un déphasage de cinq à dix ans. Ces résultats sont consistants avec la propagation des ondes de Rossby dans la baie. Par conséquent, nous suggérons que le taux accepté actuellement du relèvement isostatique ne peut être qu'un taux surestimé. Si c'est le cas, il y a des chances encore plus grandes pour une élévation future du niveau de la mer dans la baie d'Hudson.

Abstract

We have examined the possible mitigating effect of global warming on future and past sea-level variation in Hudson Bay. Thermal expansion is estimated using an ocean general circulation model. This assumes the propagation of expanded waters into the Bay via barotropic Rossby waves. Combining estimates of sea-level variation due to thermal expansion, ice melt and isostatic rebound revealed the potential for greatly mitigated sea level falls and even the possibility of sea-level rise. Tide-gauge data from Churchill, Manitoba shows a low frequency variability that resembles the temporal trend of the Northern Hemisphere temperature record with a lag of five to ten years. These results are consistent with the Rossby wave propagation into the Bay. We therefore suggest that the currently accepted rate of isostatic rebound may be an overestimate. If so, there is an even greater likelihood of future sea-level rise in Hudson Bay.

1. Introduction

Worldwide sea-level rise has been identified as a potential impact of a warming climate (Warrick et al., 1996). Tide-gauge data indicates that sea level has been rising at a rate of 1 to 2 mm yr^{-1} during the last century (Gornitz et al., 1982; Peltier, 1990). There are, however, considerable variations in regional behaviour. We explore the impact of potential global warming on the sea-level change rates in the Hudson and James Bay region (hereafter referred to as Hudson Bay). The Hudson Bay bioregion is the largest wetland in North America (Beckmann, 1994). It is therefore of great interest to assess the impact of climate change in this area. Will sea levels continue to drop or will climate change, notably global warming, mitigate or reverse this trend?

Sea-level variation arises from three factors: lithospheric adjustment, land-based ice accumulation or ablation, and thermal expansion or contraction of the oceans. At present it is believed that the first of these processes dominates in the Hudson Bay region. Isostatic rebound resulting from the last glacial episode has been estimated to cause a fall of sea level by as much as 1 cm yr^{-1} (Peltier, 1990; Mitrovica et al., 1994), one of the fastest rates in the world.

Whereas lithospheric processes have the effect of rearranging the ocean water mass, land-based ice accumulation or ablation changes the total mass of the world's oceans. The land-based cryosphere resides in three main reservoirs: the Antarctic Ice Sheet, the Greenland Ice Sheet, and mountain glaciers and icefields. Current estimates of change are ±1.4 mm yr^{-1} for Antarctica and ±0.4 mm yr^{-1} for Greenland (Warrick et al., 1996). The melting of glaciers and small ice caps leads to a net sea-level increase. It has been estimated that this process may account for up to 70% of the sea-level rise in the last century (Warrick et al., 1996).

Thermal expansion provides another source of sea-level rise. Warming seawater expands, thereby increasing the total volume of the world's oceans and thus cause rising sea levels. Current estimates suggest that thermal expansion may account for 30% of the sea-level rise

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experienced in the last century (Warrick et al., 1996). With the potential of accelerated warming and the known lag in atmosphere-ocean interaction, it is likely that thermal expansion could lead to a larger contribution to sea-level rise in the future (Wigley, 1995).

Gough (1998) examines the relative roles of locally and globally expanded seawater on sea level in Hudson Bay. The Bay does not exist in isolation and is connected through Hudson Strait and Labrador Sea to the rest of the world's oceans. The Bay receives an inflow of Labrador Sea water at depth; this water is cold and saline. At the surface warmer, fresher water flows out. Sea-level rise, outside of Hudson Bay can propagate into the Bay. Differential sea-level rise allows for the formation of barotropic Rossby waves which smooth out sea-level differences (except those maintained dynamically by wind stress). A typical propagation speed for these waves is 5 cm s^{-1} (LeBlond and Mysak, 1978). This means a wave takes approximately 5 years to travel from the equator to a pole. Therefore it is not unreasonable to consider input into the Bay from other regions of the world's oceans, particularly regions where expansion is generally greater, e.g. subtropics, due to the local warm and saline seawater.

In the next section we report on recent work that examines using an ocean model to explore the possibility that global warming with its contribution to land-based ice melt and thermal expansion of the world's oceans may offset the isostatic rebound rates in the Hudson Bay region. In the third section, tide-gauge data from Hudson Bay is analyzed and related to the concepts introduced in the modelling analysis.

2. Modelling Analysis

A world ocean circulation model was used to obtain a new temperature and salinity distribution resulting from changes in the surface boundary conditions (i.e. warming by the atmosphere). The model used is the Hamburg Large Scale Geostrophic (LSG) Model (Maier-Reimer et al., 1990; Maier-Reimer et al., 1993). The model has a latitudinal/longitudinal resolution of 2.5° X 5° and has 11 vertical levels. The depth extends to 6000 m in some locations with an average depth of about 4,000 m. The ocean model is coupled to a thermodynamic sea-ice model and uses a fully implicit numerical scheme enabling a 30-d time step. The model is forced at the surface by a seasonally varying cycle on temperature and salinity using restoring boundary conditions (Haney, 1971). The model is integrated for 5,000 years to the current climatology yielding a realistic equilibrium ocean circulation (Mikolajewicz and Maier-Reimer, 1990; Maier-Reimer et al., 1993).

Two additional simulations are performed. First a uniform 3°C warming is imposed on the surface restoring temperatures, thus mimicking an atmospheric warming. This is integrated from rest to an equilibrium circulation and represents a globally warmed climate. To estimate the rate at which this new equilibrium is approached, a transient response simulation is also performed beginning with the flow field and temperature and salinity distribution of the current climate equilibrium simulation. The upper boundary condition on temperature is then changed by a 3°C warming. The temporal evolution to the new equilibrium is subsequently documented.

Temperatures and salinities from the 3°C warming case were averaged horizontally and a one column sea level rise calculation was performed. The results of this are presented in Table 1 and indicate a sea-level rise of 0.977 m. To account for equation of state nonlinearities and nonuniform bathymetry (i.e. decreasing ocean area with depth) sea-level rise was calculated at each grid point and the sea-level rise was then horizontally averaged. This produced a revised estimate of 0.72 m. Gough (1998) reports a 1.4 metre rise in sea-level using a simpler one dimensional, non-dynamic analysis. One assumption in performing a one-dimensional analysis was that the deep ocean would eventually equilibrate at 3°C warmer throughout. As can be seen in Table 1, the surface waters were warmed by less than 3°C and the abyssal waters were warmed only a fraction of a degree. There are two reasons for the mitigated ocean warming. Deep water formation occurred in polar regions at the sea-ice edge. While sea ice remains, the temperature of the seawater at the surface is tied to the freezing point of seawater, -1.9°C. The 3°C warming affected the location of the sea-ice edge but does not affect the freezing point. Thus the deep water that formed in the polar region was not significantly warmer. The second consideration is the change of circulation in a warmed climate. It has been shown that a warmed climate produces an intensified thermohaline circulation as the new equilibrium (Manabe and Bryan, 1985; Gough and Lin, 1992). This results in a more intensive upwelling of cold bottom waters, thus mitigating the oceanic thermal response and thus reducing the amount of sea-level rise.

The new equilibrium temperatures and salinities of the warmed case were achieved after a 5000-yr integration and represents the new climate state but tells us nothing of the approach to the new equilibrium. It is, however, desirable to obtain an estimate of how rapidly the increase in sea level will occur in order to compare with contributions from ice melt and isostatic rebound. The initial conditions were taken from the reference simulation of the current climatology. The surface boundary conditions are adjusted to the 3°C warming case. During the first 100 years the sea level rose 40 cm and thus we assume an average rate of 4 mm yr^{-1} for the first 100 years of a 3°C warming, which is similar to other work (Church et al., 1990; Mikolajewicz et al.,1990).

The contribution from isostatic rebound is independent of the warming and a median value of -8 mm yr^{-1} for the Bay region (Mitrovica et al., 1994) was chosen. Glacier ice melt is estimated at 1.6 ± 1.0 mm yr^{-1} $°C^{-1}$ or 4.8 mm yr^{-1} for a 3°C warming (Warrick et al., 1996). Finally, using the transient response experiment, a value of 4 mm yr^{-1} is used for thermal expansion. Summing these, a marginally positive result of 0.8 mm yr^{-1} was obtained. However, uncertainty exists in the glacier ice melt estimate. By taking extreme values of the rate of ice melt, revised values of -2.2 mm yr^{-1} and 3.8 mm yr^{-1} were obtained for the net sea-level change. Similarly a lower limit of 1.5 mm yr^{-1} can be placed on the thermal expansion by using the results Cubasch et al. (1992). This reduces the net sea-level rise to -1.7 mm yr^{-1} when using the median value for the glacier melt. This analysis shows that sea-level rise from potential global warming cannot be neglected as a factor in assessing the sea-level change in Hudson Bay. All results showed at least a 75% reduction in the current sea-level fall and possibly a complete cancellation or modest sea-level rise.

3. Tide-gauge data analysis

Tide-gauge data was obtained from the Permanent Service for Mean Sea Level (PSMSL) (Spencer and Woodworth, 1993). For the Hudson Bay, there were three available sites, Churchill, Manitoba, Inoucdjouac, Québec and Coral Harbour, Southampton Island. The latter two records had sparsely recorded data and were discarded. Churchill, however, has a record spanning nearly 55 years (1940 - 1994). The temporal trend of sea level was examined by using a time series of annual average values. A five-year running mean was used to suppress high frequency variability and to bridge over data gaps. This time series was compared to the temperature record for the Northern Hemisphere (Gough and Sayed, 1998).

Fig. 1 is a plot of annual sea-level values using a five-year running mean. For the period of 1945 to 1970 the sea-level falls at a rate of 3 - 4 mm y^{-1}. From 1970 to 1985 the fall increases substantially to approximately 20 - 25 mm y^{-1}. After this the trend flattens to near zero. If we take an average value for the entire time series we get a value of 10 mm y^{-1} which is the rate Mitrovica et al. (1994) and Peltier (1990) attribute to this region as a result of isostatic rebound.

However, in light of the modelling work in the previous section, there may be another explanation for this tide-gauge record. During the period 1940 to 1960, the Northern Hemisphere temperature record is relatively steady with a weak cooling period around 1950. From 1960 to 1975, there was a steady drop of temperature which has reversed since that time. With a shift of about ten years the tide-gauge and temperature records are similar, with the sea-level record lagging.

We therefore speculate the following is happening. The isostatic rebound rate is more properly 3 - 4 mm y^{-1} as indicated in the sea-level record for the years 1945 to 1965. After this the sea level drops much more rapidly. This follows the cooling that began in 1960. The world oceans contract due to thermal contraction and the net formation of land-based ice. This contraction reduces the amount of water flowing into Hudson Bay and thus reduces the sea level. After 1985 the sea-level trend reverses. The Northern Hemisphere temperatures started warming after 1975 and continue to date. The world ocean is expanding due to thermal expansion and the melting of land-based ice. This propagates into the Bay via a barotropic Rossby wave which has a five to ten year time scale to travel from equator to pole. Thus it is possible that current rates of isostatic rebound rates may be overestimated as they may not account for the fluctuating mass of water in the Hudson Bay region.

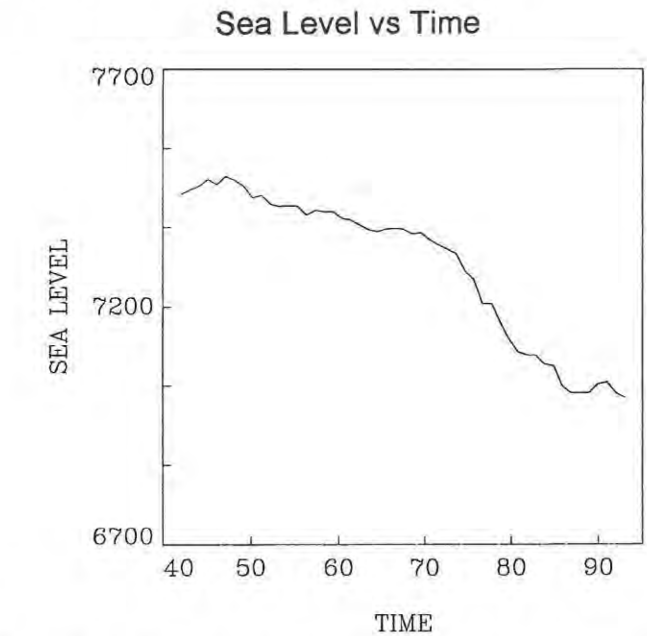

Fig. 1. Annual averages of sea-level height (mm) at Churchill, Manitoba for the period of 1940 to 1994 using a five year running means of data in a).

4. Conclusions

In this article we have examined the possible mitigating effect of global warming on future and past sea-level variation in Hudson Bay. Thermal expansion is estimated using an ocean general circulation model to be 0.72 m for a 3°C warming. This assumes the propagation of expanded waters into the Bay via barotropic Rossby waves. These waves typically have an equator to pole timescale of five to ten years. Combining estimates of sea-level variation due to thermal expansion, ice melt and isostatic rebound revealed the potential for greatly mitigated sea level falls and even the possibility of sea-level rise.

Tide-gauge data from Churchill, Manitoba shows a low frequency variability that resembles the temporal trend of the Northern Hemisphere temperature record with a lag of five to ten years. These results are consistent with the Rossby wave mechanism invoked in the modelling discussion. Based on this we also suggest the currently-accepted rate of 10 mm y^{-1} may be an overestimate of isostatic rebound. If so, there is an even greater likelihood of future sea-level rise in Hudson Bay.

TABLE 1
Horizontally averaged temperatures and salinities from the LSG model

Level in m.	T_i in °C	T_f in °C	ΔT in °C	S_i in ppt	S_f in ppt	Δh in m.
50	16.51	19.25	2.74	34.63	34.65	0.032
112.5	14.50	16.89	2.39	34.89	34.86	0.034
200	12.78	14.81	2.03	34.98	34.92	0.040
350	10.39	11.99	1.60	34.95	34.87	0.052
575	7.91	9.00	1.09	34.89	34.78	0.056
850	5.76	6.46	0.70	34.85	34.72	0.052
1,500	4.02	4.44	0.42	34.82	34.68	0.099
2,500	2.94	3.81	0.24	34.82	34.66	0.146
3,500	2.32	2.44	0.11	34.80	34.63	0.142
4,500	1.88	1.90	0.02	34.76	34.59	0.134
6,000	1.75	1.77	0.02	34.73	34.57	0.190
Total						0.977

where T_i is the intitial temperature; T_f is the final temperature; S_i is the intitial salinity; S_f is the final salinity; Δh is the change in sea-level height. The change in sea-level height is calculated from these averaged values.

Acknowledgments

I wish to thank David Hyndman, a student hired through funding from the Ontario Ministry of Environment's Environmental Youth Corps. Dr. E. Maier-Reimer provided technical advice and Dr. Leonard Tsuji provided stimulating discussions of Hudson Bay issues.

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Dear Climatologist . . .

An inventor of new footwear for walking on water was anxious to test its suitability under various weather conditions over Lake Ontario.

A woman in Lusket, Nova Scotia, wanted to know what the weather had been on February l6 in each of the past seven years to decide whether that date would be favourable as a good one for her wedding.

Officials from the Alberta Fish and Wildlife Department wondered whether the high incidence of chinooks one winter caused a massive die-off of antelope.

The Royal Air Force received Canadian climate data to determine when and where to test the effect of snow on helicopter operations.

Two inmates at Dorchester Penitentiary in New Brunswick who were appealing a second-degree murder sentence requested rainfall data, calling it crucial for their defence.

If there is one thing Canadians have in common, it is an insatiable appetite for information about the weather. One might think we get our fill from television, radio and newspapers, but a quick peek at a climatologist's mail suggests otherwise: Environment Canada weather offices are deluged with more than 200,000 requests for past weather records or climate information annually. Some requests are amusing - like the young student from Newfoundland with a fast-aproaching deadline writing "rush all the information you can get on our weather and weather all across the world, for free", or the Aberta child wanting information on acid rain, "including a sample".

Some requests are somewhat bizarre. Take, for example, the Montréal man who requested information to confirm his suspicion that UFOs had flown over Montréal on the night of November 7, 1991. Meteorologist Jacques Miron recalls that the man wanted all available data, including satellite pictures, air density readings and specific cloud conditions. He paid $150 for the information, which included an observation by a Québec forecaster that cloud conditions created a luminous ring over Montréal that evening.

Other unusual requests were:

A housewife in Cranbrook wanted to know what weather conditions prevent mayonnaise from falling during its making.

Someone was convinced that relative humidity correlated well with the winning numbers in a major lottery.

A manufacturer of fibreglass portable toilets needed data on temperature extremes to calculate the likelihood of the chemical-water solution freezing.

Some requests are trivial, "there's a $l00 bet riding on whether Hurricane Hazel was the same storm that caused the Red River flood". However, most are serious questions concerning health or safety, economics and the environment.

Those requesting historical climate data range from farmers or gardeners worried about unusually dry conditions, to large oil companies concerned with the impact of climate extremes on drilling platforms and tankers. Users can be found in every sector of society, and applications are in nearly everything we do. Requests came from those entrepreneurs starting a business; from individuals preparing to retire, suffering weather-related health problems or planning a dream vacation; from researchers, and from government officials; indeed from all for whom the weather-past is a possible guide to the weather-future.

Few people realize the vast number and variety of uses of past weather data. Most requests received at the Canadian Climate Centre in Downsview, Ont., or at any of the Environment Canada weather offices involve health, litigation, commerce and research.

Physicians, health workers and medical researchers frequently ask for weather information to treat those suffering from asthma, hay fever and migraines. The Institute for the Achievement of Human Potential in Pennsylvania wrote for weather data needed to discover weather conditions causing children's seizures. In October 1991, the Toronto Children's Aid Society asked about the weather occurring on a particular day in Halifax seven years ago. The dossier on one of their recently arrived wards was so thin that any information about the weather on the day the child was born would give them some place to start.

Thousands of health-related requests are received annually from individuals. Typically, "I am 68 years old, have heart disease and rheumatism and suffer migraine attacks. Please, where can I relocate to find clean air, a mild climate and generally a more healthy place to live". A father wrote seeking some place in Canada with dry conditions similar to those in Israel where his son's asthma had improved during a summer visit.

While climatologists cannot field all the countless letters that ask where one should live to improve health and increase life expectancy - those are questions for the medical profession - they can accurately pinpoint Canada's wettest, driest, hottest and coldest regions.

Environment Canada has a wide range of resources to help Canadians answer their climatological queries. Climatologists at regional weather offices have a vast array of publications, computer archives, log sheets, recorder charts and satellite pictures at their fingertips. In addition, Environment Canada's large facility in Downsview, Ont., contains records ranging from handwritten 19th century weather ledgers to sophisticated satellite and radar imagery. Its archives are accumulating observations at more than 40 million a year from a far-flung Canadian network of land, upper-air and over-water stations. Its total archive is estimated to contain in excess of three billion observations from some 8,600 Canadian locations.

Climatologists in Environment Canada's regional climate centres spend much time servicing legal inquiries. Often these involve insurance cases from settling property damage claims to verifying slips and falls. In a Toronto incident, a thunderstorm knocked out power at a fish store and the ensuing smell forced tenants above the store to evacuate. The insurance company refused the claim because no thunderstorm was reported at Toronto Pearson International Airport that evening. When the owner of the building contacted Environment Canada climatologist Bryan Smith, he confirmed that a thunderstorm had occurred at Toronto Island airport, which is closer to the fish store, and the insurance company agreed to pay damages.

In another civil suit the Minnesota North Stars took legal action against the Québec Nordiques in 1980. Minnesota sued Québec for $64,000 for failing to show up for a hockey game. In their successful defence, the Nordiques' lawyers subpoenaed climatologist Gérard Chapleau, who testified that thick fog prevented the team's plane from taking off.

In a more typical litigation case, a law firm representing the owners of a tanker needed weather and sea state information for Canadian waters to help determine responsibility for loss of a ship and some tragic loss of life. In an Edmonton divorce hearing, solicitors wanted to know if the weather on a particular night was hazardous enough to prevent one of the parties in the case from driving home. A young Vancouver couple once requested similar information - but for an entirely different purpose. They asked for the February date in 1991 when a large snowfall occurred; apparently, the woman had become pregnant and the couple traced her condition to the night they stayed home during the snowstorm.

From balloonists to boaters, outdoor enthusiasts recognize the value of historical weather information in planning future activities. Most ski operators from Marble Mountain Nfld., to Whistler, B.C., have written to obtain snowfall data - or the frequency of weather suitable for snowmaking. One call from the Mexican consulate requested information on summer snow skiing and skating opportunities at Blue Mountain Lodge and Horseshoe Valley in southern Ontario. The president of a large United States corporation enquired about the weather he could expect for a planned two-month canoe trip down the Churchill River. The Big Game Committee of the Ontario Federation of Anglers and Hunters requested climate information to support their proposal for an earlier moose season. Marathon swimmer Jocelyn Muir asked for average wind speed and direction to help plan a possible summer swim along the ferry routes to and from Prince Edward Island.

Authors writing about past historical events, braggarts trying to settle certain wagers, or June brides wanting to know whether rain and cloud could spoil their outdoor wedding receptions are some of the many users who find fascinating applications for past weather and climate information.

The research community is a major end user of climate-related data. One PhD student studied tree rings from black spruce in Kouchibouguac National Park in New Brunswick to detect climatic fluctuations. Another graduate student from Wyoming wanted Canadian weather data for his research on how weather influences the body size of North American mammals.

The application for climate information in business and industry ranges from locating, designing and operating thermal or nuclear plants to managing seasonal changes in glues for piano manufacturing. Weather statistics have been used to explain fluctuations in beer sales, develop a new series of chemical de-icers, and schedule advertising campaigns for seasonal products.

One request for low temperature and wind speed data was useful in selecting metal for ship hulls in the Arctic. The same data were useful in assessing the vulnerability of caribou calves to spring storms.

Architects and builders now routinely use snow and ice load values or the probability of severe weather events to design structures capable of withstanding the climate stresses likely to occur in their lifetimes. House builders interested in the feasibility of harnessing wind currents to pump water and solar energy to heat the water would be wise to obtain past climate data. Homeowners can also use climate data for such purposes as planning the best location for a windbreak or a new skylight.

Canadian Tire Corporation used prevailing wind data while designing their large hardware distribution centre in Brampton, Ont. The loading docks were built to take advantage of wind direction, allowing aeolian forces to clear snow, thus reducing snow removal costs and minimizing work disruptions.

Some of the more interesting requests come from authors seeking to add realism to an adventure story or to examine the significance of weather in historic events. Canadian author Scott Young sought March sunrise and sunset times at Spence Bay. N.W.T., to help develop the story line for his latest mystery novel, "The Shaman's Knife". A professor from Columbia University wanted to determine barometric pressure changes caused by the shock wave resulting from the Halifax explosion of December 6, 1917. One researcher's request may lead to a whole new category for baseball statisticians - he asked for Toronto and Montreal barometric data, hoping to correlate air pressure conditions and the effectiveness of certain relief pitchers.

It is obvious that the breadth and scope of the applications of historical weather data are almost limitless. From planning outdoor wedding ceremonies to ideal mating conditions for queen bees, if your question is about past weather, the climatologist probably has the answer.

Dave Phillips,
Senior Climatologist,
AES, Downsview.

Interview with Jim Bruce - Entrevue avec Jim Bruce

"The New World Climate Order"

CMOS Bulletin SCMO is grateful to The Ottawa Citizen[1] for permission to reproduce major extracts from an interview with Jim Bruce by Paul McKay, a Citizen staff writer, which was published under this title earlier in the year. The Society's long and close connection with Jim Bruce, a "Life Member" of CMOS, his prominence in Global Change work, and his recent appointment to the Order of Canada, and election as a Special Fellow of the Academy of Sciences of the Royal Society of Canada, make the inclusion of the interview in this special edition of the *CMOS Bulletin SCMO* very appropriate. We hope that you will enjoy it.

PMcK: Congratulations on your Order of Canada. At the award ceremony you will be honoured along with Buffy Saint Marie. Since your hobby is the piano, and she penned the famous song "Up Where We Belong", is there any chance of a Jim and Buffy duet?

JB: (laughing) She's a far better singer than I am a pianist. So I'm not sure she'd be willing to go along with that. I think I better stick to science.

PMcK: What is the IPCC and what has been your role in it?

JB: The IPCC is a panel of scientists, economists and other specialists from around the world that was established by the U.N. and the World Meteorological Organization in 1988. Governments were beginning to get worried about climate change. They wanted to form an advisory panel that would review and assess all the published literature, and produce reports on the implications of climate change. Originally I was involved in setting up the structure of the IPCC. Since 1992 I have been co-chair of the Working Group which deals with the social and economic impacts of climate change. The IPCC's three-volume report was published by Cambridge University Press in 1996, after it had been thoroughly reviewed by thousands of specialists around the world and governments.

PMcK: Who pays for the IPCC ?

JB: Governments make voluntary contributions to a trust fund. The primary IPCC cost is the cost of getting developing countries representatives to meetings. We don't want the assessments to be biased towards the developed countries - we want a global consensus.

PMcK: What are the annual costs?

JB: Between $1 and $2 million per year. It's one of the world's best bargains.

PMcK: IPCC reports warn that the planet faces an escalating risk of an ecological Armageddon because greenhouse gases are increasing. The fossil fuel lobby, and Provinces like Alberta, argue that cutting greenhouse gases will trigger an economic Armageddon. Is the choice that stark?

JB: No. I think climate change is the most difficult and important environmental issue we have ever faced. I've been involved in a whole range of environmental issues over the past 30 years, from water pollution to acid rain to ozone depletion. If we allow greenhouse gases to continue to increase, we are going to see major changes in the world's ecosystems. All the economic estimates indicate that this will cause quite large economic damage, especially to developing countries. On the other hand, actions to reduce greenhouse gases will require major changes in the energy economy of the world. There are ways of doing this that can not only be done at little cost, but could in the long run be very economically-productive and produce a lot of jobs.

PMcK: Could you give an example ?

JB: In Germany, they think they can reduce greenhouse gases by about 45% with energy efficiency measures and fuel switching - going off coal. About two thirds of this is cost effective, not counting the climate change benefits. If they achieve the 45% reduction that's technically possible, they would create 500,000 net jobs because energy efficiency and alternative fuel measures are more labour-intensive than digging oil out of the ground. These "no regrets" measure have two components: Benefits accrue to a company or hotel or home by reducing fuel costs. You have an upfront investment, then you pay it off over 5 years through reduced fuel costs. The other benefits are social: If you reduce fossil fuel burning, you reduce urban smog, acid rain and particulates - all of which have serious health effects and ecosystem effects. If you quantify those, they offset by 30 - 100 % the costs of greenhouse gas reductions.

PMcK: What is the most convincing evidence the IPCC relies on ?

JB: The evidence is incontrovertible that human activities since the last century have made huge changes in the chemical composition of the earth's atmosphere. We now see CO_2 concentrations about 30% higher than anything that's been seen in the last 160,000 years. We now see methane concentrations double what they were in pre-industrial times. The same is true of nitrous oxide, CFCs and other greenhouse gases. So there is absolutely no question we are changing rapidly the chemical composition of the atmosphere. How that will affect the climate is a very complex issue. The only way to tackle it is through using mathematical models running on large computers. Models are never perfect representations of nature, but they can reproduce very well the changes we have seen in the last decade.

PMcK: Aren't the IPCC conclusions about future climate changes based on a degree of scientific speculation, and a standard of proof which would not be tolerated in other sciences?

JB: No. The biggest uncertainty is how much greenhouse gas emissions we are going to allow in the future. That's a far greater uncertainty than the climate modelling. There is a law in science that says your confidence in a theory can only be as great as its successful resistance to refutation. Among the vast majority of the scientific community , the theory continues to resist attempts to undermine that. Every week new data are consistent with the models and IPCC projections.

PMcK: Isn't there evidence that the greenhouse effect may bring benefits to Canada, such as a longer growing season and extending the boreal forest northwards?

JB: Yes, there is some sign of that, but there will be benefits and disbenefits. One of the benefits will be agricultural, provided there is enough rainwater or water in the rivers for irrigation purposes. But the way most Canadians will experience climate change is not going to be through a long, slow steady warming. It will be a change in the frequency of extreme climatic events: heavy rains, earlier spring floods, higher peaks in the spring flood; more tornadoes, more severe thunderstorms. There's a lot of evidence that's beginning to occur in Canada. Just ask the insurance companies.

PMcK: Is the federal government position on climate change shaped more by science than by politics?

JB: The latter. The scientific evidence is quite clear that climate change will have serious adverse effects on many parts of the Canadian economy. It may have some benefits in some limited sectors. But it will have very serious effects on many developing parts of the world. And we have a responsibility : We are among the biggest greenhouse gas emitters in the world per capita, and every one of us bears a responsibility towards those other countries. The government hasn't taken aboard the independent IPCC economic reports about the ways to achieve reductions that are either economically beneficial, or have little or no cost to society as a whole. There has been enormous pressure from some of the provinces and the fossil fuel industry to take no action. And they're a very powerful voice.

PMcK: Federal reports confirm most of the increases since 1990 are due to Oil Patch production and exports. Is Ottawa subsidizing the very sector that's most responsible for greenhouse gases?

JB: Yes. There are various kinds of exploration write-offs and depletion allowances which are available to the fossil fuel industry, which make it a very unlevel playing field with the renewable energy industry. One of the studies used in the IPCC found that if governments worldwide were to reduce fossil fuel subsidies, there would be a reduction in greenhouse gases estimated at up to 18 %.

PMcK: What kind of federal regulation, if any, is needed to reduce Canada's greenhouse gases by 20%?

JB: We have to go to either a regulatory approach to emissions or a financial one. The economists I work with say that you should try to put a reasonable price on (pollution) costs and make that part of the cost of doing business. Then that price would make the product bear the full cost of production. At the moment, what industry and everybody is doing, is using the air and water as a free good. In the long run, it isn't. The other thing economists suggest is setting up an emissions trading system in which there are certain ceilings set, then companies, and even governments, are allowed to buy rights with someone who has lower emission reduction costs. In this way you reduce the overall cost of reducing emissions. The Europeans are doing that. The are committing themselves collectively to an emission reduction by 2010.

PmcK: Given that some of today's greenhouse gases will remain suspended in the atmosphere for up to 150 years, will a 20% cut be enough ?

JB: No. Not to solve the problem The ultimate aim is to stabilize greenhouse gas concentrations that will not cause dangerous interference with the climate system. If you want to achieve that you have to reduce emissions by at least 50%. The sooner you reduce emissions, the sooner you stabilize the concentrations. The timing of that is very much a political judgement.

PMcK: Doesn't that mean that we will be experiencing a sharply escalating concentration level far later than we will have a chance to stop it ?

JB: Yes, there is a fly-wheel effect. What's really important is the cumulative emissions over a decade or several decades. In the next century we will put about five times as much cumulative CO_2 into the atmosphere as we did in the last century.

PMcK: Are you optimistic about the outcome of the forthcoming climate conference in Japan in December?

JB: I think a great deal depends on how the Americans go. *[Note that the interview took place before this was known.]* The Europeans have their act together reasonably well. If they can reduce the emissions from Europe by 10-15%, we ought to be grateful for that and be trying some of the same measures here. There are a host of measures in the IPCC report that are likely to allow significant reductions at little or no cost to the economy. If that view prevails, then I think we have a chance at a good outcome. On the other hand, if the view prevails that it is too risky an experiment on the economy, then we will go on performing the even more risky experiment on Planet Earth. We are out on a limb now. The concentrations of greenhouse gases in the atmosphere are now much higher than anything we have experienced in the last 160,000 years.

Note from the Editor: Interview prepared for the *CMOS Bulletin SCMO* by Uri Schwarz.

1: Ottawa Citizen, August 11, 1997, p.A-11.

Socio-Economic Impacts of the Warm Winter of 1952-53 in New Brunswick

by W. G. Richards and M. P. Russell[1]

Résumé

Le changement climatique est un des enjeux primaires de l'environnement de la planète qui a reçu une attention particulière au cours des dernières années. La Terre possède un effet de serre naturel qui la maintient approximativement 30 degrés Celsius plus chaude qu'elle ne devrait l'être. Les petites concentrations des gaz qui agissent sur le rayonnement (incluant la vapeur d'eau) sont responsables pour cet effet de serre naturel. L'activité humaine augmente la concentration de ces gaz dans l'atmosphère et en conséquence, on a prévu que les températures moyennes du globe augmenteront à un taux d'environ 0,3 °C par décennie au cours du prochain siècle.

Les enjeux scientifiques entourant le changement climatique ont fait l'objet d'études et on continuera de le faire de façon intensive. D'autres groupes ont aussi tenté d'évaluer les impacts d'un climat en évolution et d'examiner des stratégies appropriées afin de réagir à ce changement. D'excellents résumés sur ce sujet ont été préparés par le Groupe intergouvernemental d'experts sur l'évolution du climat (GIEC).

Pendant que les rapports du GIEC renferment de l'information pertinente à l'échelle globale, quelques études ont été initiées afin d'évaluer les impacts d'un climat plus chaud au Canada. Dans ces études, on a pris, comme approche, l'hypothèse de quelques climats futurs plus chauds, comme en doublant le gaz carbonique dans l'atmosphère et voir à l'évaluation de l'impact socio-économique de ce scénario.

Dans l'étude suivante, nous avons identifié et documenté plusieurs impacts de l'hiver doux exceptionnel de 1952-1953, en examinant l'information provenant de sources historiques. Les impacts ont été documentés dans les secteurs économiques de l'agriculture, la foresterie, le transport et la récréation. Tandis que des températures d'un hiver doux peuvent avoir un effet bénéfique sur quelques activités comme sur les coûts de déneigement, d'autres effets peuvent annuler ces économies.

L'étendue de ce rapport n'a pas été assez vaste pour attribuer des coûts-avantages à ces impacts, ni même pour déterminer s'ils étaient hors de la portée des événements attendus. Cependant, le rapport a fourni une indication des effets d'un hiver qui peut être typique d'un climat plus chaud que celui que les Néo-Brunswickois subissent actuellement.

Introduction

Climate change is one of the primary global environmental issues which has received considerable attention in recent years. The earth has a natural greenhouse effect which keeps it approximately 30 degrees Celsius warmer than it would otherwise be. Small concentrations of radiatively active gases (including water vapour) are responsible for this natural greenhouse effect. Human activity is increasing the concentration of these gases in the atmosphere and as a result it has been predicted that global mean temperatures will rise at a rate of about 0.3°C per decade during the next century[11].

The scientific issues surrounding climate change have and are being studied intensively. As well, other groups have attempted to assess the impacts of a changed climate and to examine appropriate strategies to respond to this change. Excellent summaries of this material have been prepared by the Intergovernmental Panel on Climate Change[9,10,11] (IPCC).

While the IPCC reports contain information pertinent to the global scale, a number of studies have been conducted to estimate the impacts of a warmer climate in Canada. See for example Jackson[12], IBI Group[8], or Nuttle[22]. Examples of studies of the potential impacts of climate change in the Atlantic Region of Canada can be found in Lane[16], Martec[18], and Stokoe[23]. In these studies the approach was to assume some warmer future climate, usually the result of a doubling of carbon dioxide in the atmosphere, and then estimate the socio-economic impact of that scenario.

The purpose of this study is to try to gain some appreciation of the potential impacts of climate change in the province of New Brunswick. The approach taken is to examine what actually happened during an anomalously warm period. We have selected a period of time when the climate was abnormally warm, and as well researched historical sources, such as newspapers, to identify the socio-economic impacts of the warmer climate.

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Climate Trends

Several authors have studied trends in climate elucidated by historical instrumental records. Jones et al[13] and Hansen and Lebedeff[7] have published data on global trends. Gullett and Skinner[6] have documented trends in Canadian data. Nickerson et al[21] studied instrumental records at several locations in Atlantic Canada.

Nickerson et al[21] have shown that, taken as a whole, there is a positive trend in mean annual temperature at all 10 Atlantic Region stations that were analyzed. Furthermore, when these data are broken down into seasonal averages, Nickerson et al[21] showed that the greatest increase was noted in the winter temperatures and the least amount of change was in the summer months. Spring and autumn both showed moderate increases.

As an example we have plotted the mean annual and seasonal temperatures for Fredericton from 1872-1994 along with 11-year running means in Figure 1. The methods used by Nickerson et al[21] to compute seasonal and monthly averages, estimate missing data, and splice data sets were applied to these data. The change in winter temperatures at Fredericton is typical of that shown at other locations as documented in Nickerson et al[21].

The trend in temperature is not linear and it is apparent that the decade of the 1950's was, on average, the warmest decade in the past 120 years in the Atlantic Provinces. Within that decade the winter of 1952-53 was the warmest winter on record, not only at Fredericton but at other locations in New Brunswick as well. Because warming trends seem to be more apparent in winter we chose to investigate the winter of 1952-53 in order to get an idea of what impacts a warm winter could have on New Brunswick.

The Winter of 1952-53

The winter of 1952-53 was especially mild with a far greater proportion of rainfall to snowfall than usual. Much bare ground was exposed during the winter[20]. We analyzed historical meteorological data for four New Brunswick locations and the graphical summaries are presented in Figures 2 - 9. The four locations studied were Fredericton Airport (45° 52'N, 66° 32'W), Saint John Airport (45° 19'N, 65° 53'W), Moncton Airport (46° 07'N, 64° 11'W) and Chatham Airport (47° 01'N, 65° 27'W).

To place weather conditions during the winter of 1952-53 into perspective we extracted temperature and precipitation data for that winter from Environment Canada archives[4,5]. These actual conditions were compared with 1951-80 normal values[1,2,3]. In all four locations mean monthly temperatures for December through March were warmer than the normals by at least 1°C and by as much as 4°C (Figure 5). Heating degree days were below normal (Figure 6). Mean daily temperatures for Fredericton, Saint John and Moncton were plotted with smoothed daily normals in Figures 2-4. The majority of the days were warmer than normal which again illustrates the mild conditions of the winter.

Although total monthly and seasonal precipitation was near normal (Figure 9), the winter of 1952-53 was very wet. December had a below-average rainfall, but rainfall in January through March more than made up for it (Figure 7). On the other hand snowfall was below average for all of the locations in December and January and, with the exception of Chatham, also in February and March (Figure 8). Even though snow did fall throughout the season, there was rarely a measurable amount actually covering the ground. The mild temperatures and greater-than-average rainfall melted the snow almost as quickly as it landed[24(b)].

Impacts of the Anomalous Winter

The weather conditions of the winter of 1952-53 affected many aspects of life in New Brunswick. To determine what socio-economic impacts occurred due to these conditions, historical sources such as daily and weekly newspapers, agricultural annual reports and some other sources of anecdotal information that came to our attention, were researched. The impacts which were identified were grouped under the headings hydrology, agriculture, forestry, transportation, and recreation.

Hydrological Events

From February 8-11 mild temperatures and heavy rains led to flooding in various areas of the province. The highway from Moncton to Amherst was inundated with 3-4 feet of water between Woodstock and Frosty Hollow. All traffic was stopped[24(e)].

In Sussex the mild temperatures and rain drew the frost from the surface of the gravel highways making the roads very soft in some places. An ice jam in the Kennebecasis river near Norton caused water to flow over the roads in some places but no serious washouts[15].

On March 26, 1953 spring break-up began. The break-up, caused by mild temperatures and heavy rains, was the earliest and heaviest since 1936. Ice jams and flooding affected many regions of the province[14].

Highways and branch roads were flooded all along the St. John river. In Madawaska and Victoria counties the St. John, Quisbis, and Green rivers overflowed[24(e)]. Route 2 was washed out at Bristol and Victoria[17(e)]. In Restigouche county Routes 11 and 17 flooded in several places and were impassable. In Albert county Route 14 was impassable from Mechanic Settlement to Fundy National Park[14].

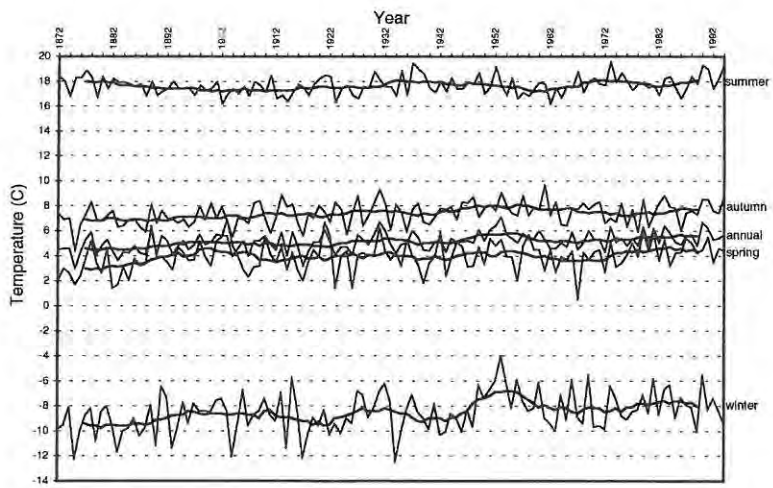

Figure 1: Annual and Seasonal Temperatures for Fredericton, N.B. (1872-1994)

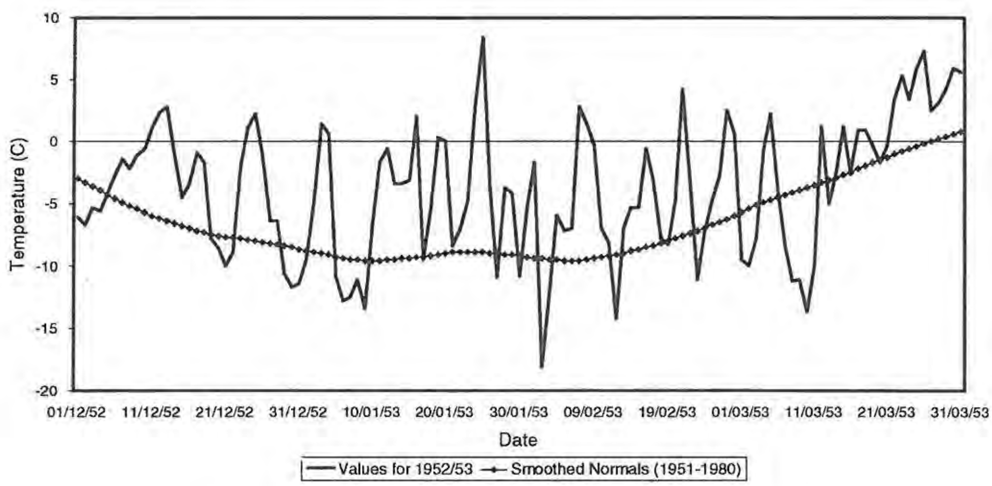

Figure 2: Daily Mean Temperatures - Fredericton Airport

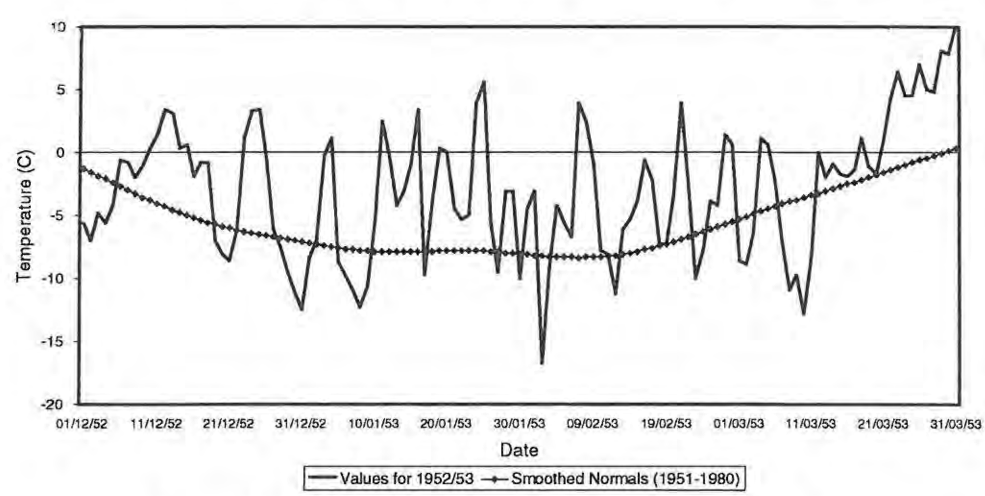

Figure 3: Daily Mean Temperatures - Saint John Airport

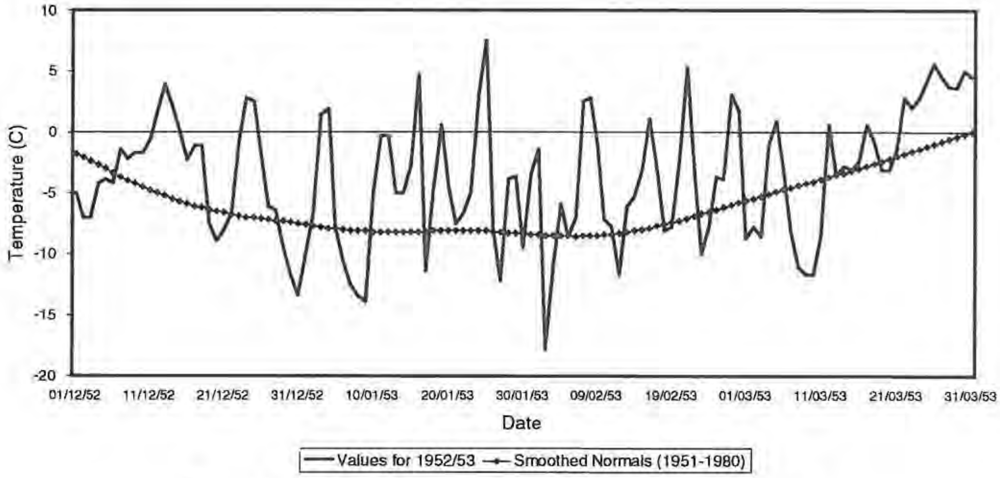

Figure 4: Daily Mean Temperatures - Moncton Airport

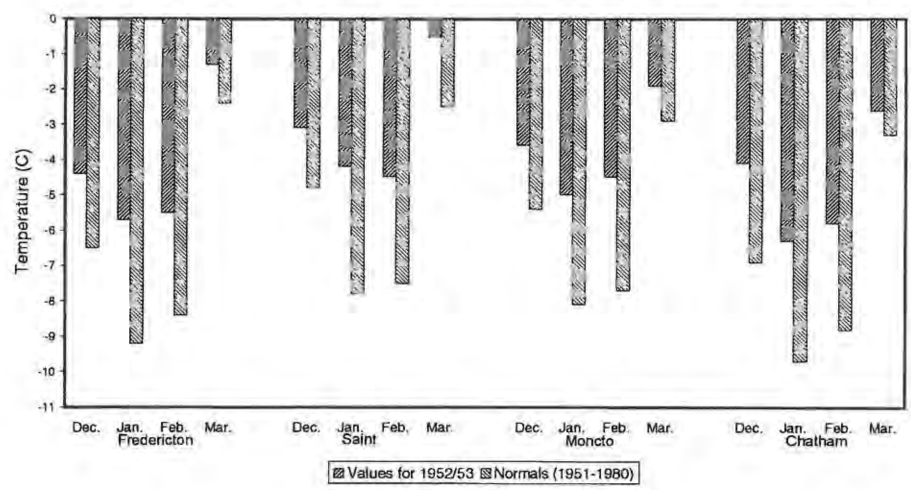

Figure 5: Mean Monthtly Temperatures

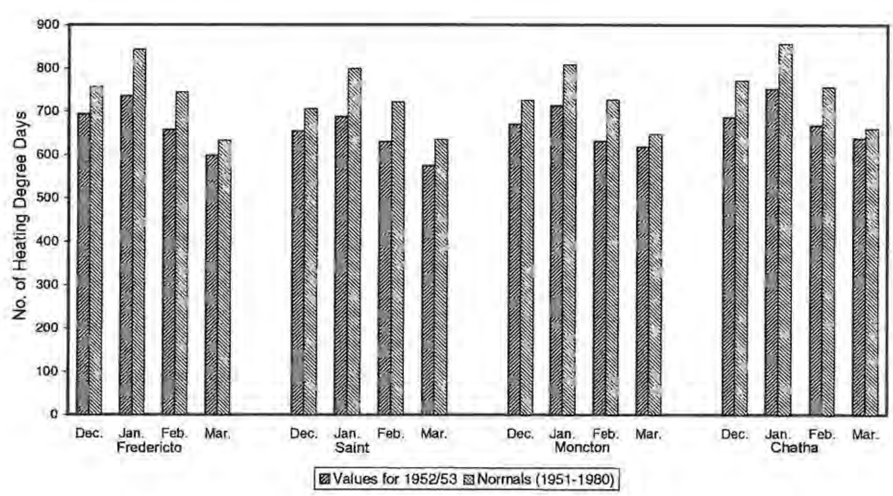

Figure 6: Number of Heating Degree Days

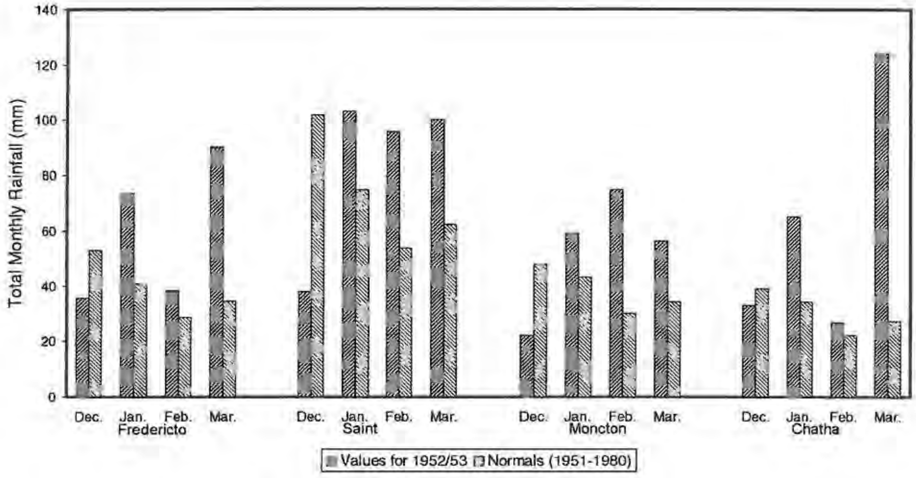

Figure 7: Total Monthly Rainfall

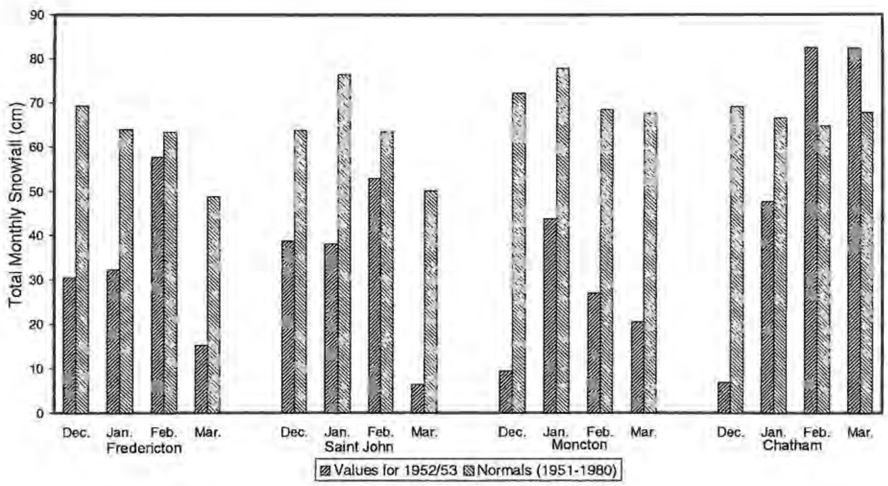

Figure 8: Total Monthly Snowfall

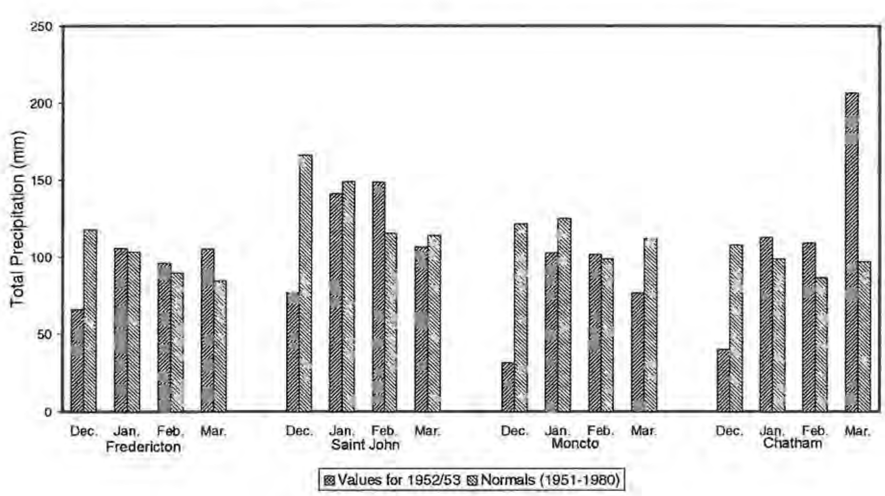

Figure 9: Total Monthly Precipitation

In Fredericton an ice jam occurred at the Dominion Experimental Station. Several waterfront buildings experienced basement flooding and slight ice damage. Cellars were also flooded in Chatham, Newcastle and St. Stephen[14].

In Nashwaak River Valley an ice jam threatening the Durham Bridge broke up before any damage was done. Penniac Bridge and the Railway Bridge at Cross Creek were also endangered by ice jams. When a jam at Stanley broke there was a sudden rise in water. Roads and houses in the Taymouth area were flooded. Power and telephone lines were out[24(f)].

There was extensive flooding at MacLean's Flats. The Canadian National Railway line was under a metre of water over a distance of more than 3 kilometres. More than 50 metres of track collapsed into the river. The ice began to move when the jam was successfully dynamited by CNR[14].

Porter Cove Bridge was carried out at Ludlow, and the main highway bridge at Doaktown was submerged. In Charlotte county the Magaguadavic river was in spring freshet, forcing farmers to move some cattle to higher ground. Flooding continued until April 3, 1953[19(e)].

Agricultural Events

The winter of 1952-53 was exceptionally mild with much more than usual rainfall. It was feared that there might be some apple bud development with resulting damage from freezing. Luckily, fruit trees of all ages wintered well. Fruit tree bud development was promising and well in advance of a normal season. However, cool, cloudy, rainy weather later in the spring retarded development. In the end, these factors balanced each other out and harvesting occurred at the normal time[20].

Snowfall was relatively light during the winter. Much bare ground was exposed and many fields were ice coated at some point throughout the winter months. The raspberry yield for 1953 was below average as a result of snow breakage of cane and winter injury. There was a light hay crop that year due in part to the extensive winter killing of clover[20].

Forestry

It was predicted that the summer of 1953 would be particularly bad for forest fires. It was announced at the end of February that a substantial snowfall was needed or else there would be serious danger of forest fires. In order to provide enough moisture, the snow would have to remain until spring thaw when it could soak into the ground. Several heavy rainfalls could not provide the same benefit. Because the ground was frozen, rain would run off quickly[19(c)].

In 1952 the forestry industry was worth $165,000,000 to New Brunswick. At that time forest fires cost the province almost a million dollars each year[17(c)]. Throughout the spring many precautions were taken to prevent forest fires. Weather stations were set up in the fire towers in April to keep a close watch on the climatic factors. The most dangerous time in the forest fire season is usually the first couple of weeks of July. In 1953 the danger of forest fires was expected to be more acute and start earlier than in previous years[19(c)]. There were many articles about fire prevention in the newspapers throughout the Spring in an attempt to raise public awareness and hopefully cut down on forest fires due to carelessness.

Fire occurrence and area burned were above average for 1953; however, the fire season was not severe. In 1953 there were 369 forest fires burning a total of 5,415 acres. In the ten year period from 1943-1952 the province fought an average of 245 fires per year, losing approximately 3,473 acres each year. In 1953 the greatest losses due to forest fires occurred in the May and June period when 192 fires burned over 3,500 acres. Rainfall was above normal and well distributed during most of the spring. This was, perhaps, the reason why the fire season was not as severe as had previously been feared.

Transportation

The mild weather meant large savings in snow removal costs across the province. In Saint John, snow plows ran for only two hours over the entire season. This resulted in a savings of more than $21,000 over 1951-52. However, the weather conditions allowed for particularly icy roads. A record amount of salt and sand was used by the City of Saint John[24(d)].

Often a snowfall would be closely followed by rain. This resulted in a lot of slush which would clog the catch basins and create small lakes at intersections. The flooding of the highways and branch roads caused a lot of damage to the roads in the way of frost bumps and potholes. Therefore, the savings in snow removal costs were used to make up for the increased cost of damage repair and extra salt and sand used.[24(d)].

At the beginning of the season the Atlantic Region of CN rail was benefitting from the weather conditions to a high degree. At the end of the first week in January snow removal costs for CNR had been practically nothing. The cost at the same time in 1952 had amounted to almost 1.5 million dollars[19(a)].

The end of the season was not so advantageous to the railway. Much expense was incurred when fifty metres of track fell into the river in late March. Repairs took more than a week and therefore service was disrupted. CNR express was forced to use trucks between Fredericton and Newcastle while repairs were being made[24(c)]. Water along the tracks caused train delays other times through late winter and early spring[14].

The unusually mild conditions brought only good news for those who meant to travel by water. The shipping season for Restigouche river remained open until January 6, 1953. This was the latest closing date on record up to that time[24(g)]. Some St. John river ferries were able to operate every day[24(d)].

Recreation

The lack of snow ruled out many winter activities. Sledding, skiing, and snowshoeing were not feasible for most of the winter. However, it was a record season for outdoor skating rinks. Rinks in Moncton were open for 47 days, five days more than the previous record. One day denotes that the rink was open for at least six hours. Often, the rink would be open in the morning but by mid-afternoon the sun would have weakened the ice and the rinks would have to close[19(d)].

Skiing is now a very popular winter sport and also a large money-making business. A winter season with little snow could mean financial difficulty for the numerous ski resorts across the country.

Conclusion

In this report we have identified and documented various impacts of the unusually mild winter of 1952-53 through examination of historical sources of information.

Impacts have been documented in the agricultural, forestry, transportation and recreation sectors of the economy. While mild winter temperatures may have a beneficial effect on some things such as snow clearing costs, other effects can negate these savings.

The scope of this report is not broad enough to assign costs/benefits to these impacts nor to determine if they were outside of the range of expected events. However, it does provide an indication of the effects of a winter that may be typical of a warmer climate than that which New Brunswickers presently experience.

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d) March 30, 1953: NB Winter Getting Milder?---Maybe, says Weatherman, But Don't Bank On It
e) April 2-3, 1953: Three Rivers Rampaging in the Madawaska Area
f) April 10, 1953: River Ice Melts, Expect Ship Soon
g) April 10, 1953: Cloudy Weather, Rain Handicap Maple Sugar Season
h) April 11, 1953: Roads Still Showing Frost Bumps, Holes
i) May 11, 1953: Four Forest Fires Roaring in Separate Areas of New Brunswick
j) July 4, 1953: Forestry Men Quell Fifth Mystery Blaze
k) July 14, 1953: Two Northumberland Fires Under Control

Research Assistant (RA) Positions Available for M.Sc. or Ph.D. students

Students wishing to pursue an M.Sc. or Ph.D. in Atmospheric Science, and having an interest and background in numerical weather forecasting, are invited to apply to the graduate program at UBC. We have 2 RA positions available, starting September 1998 (or could start in summer 1998 if student is available).

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Examples of pure research projects include ensemble initialization methods, boundary-layer parameterizations, modification of initialization fields to incorporate valley measurements, and Kalman filtering of model output. Examples of applied projects include forecasting and verification of: precipitation in dam watersheds, snow forecasts for avalanche prediction, local wind driven ocean currents, floods and blizzards in BC, forest-fire prediction, and air pollutant transport.

For more information, contact Prof. Roland Stull, Chairman, Atmospheric Science Programme, UBC, 1984 West Mall, Vancouver, BC V6T 1Z2. (rstull@geog.ubc.ca) Tel.: (604) 822-5901, Fax: (604) 822-6150. Some info about the Atmospheric Science Programme is on the web: http://www.geog.ubc.ca/atmos/

Global Warming and Climate Change in Canada: Need for an Open Scientific Debate

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Résumé

L'émission de gaz à effet de serre et le réchauffement de la planète sont des enjeux qui sont de plus en plus discutés aujourd'hui dans les médias canadiens d'information ; toutefois, il y a très peu de débat scientifique sur ce sujet au Canada. Dans cet article, on discute de quelques enjeux scientifiques importants en relation avec le réchauffement de la planète et le changement climatique, et on en fait un cas pour un débat scientifique ouvert.

Abstract

The issue of greenhouse gas emission and global warming is being increasingly discussed in the Canadian news media at present; however, there is very little scientific debate on this issue in Canada. In this article, some of the important scientific issues relating global warming and climate change are discussed and a case for an open scientific debate is made.

Introduction

The Intergovernmental Panel on Climate Change (IPCC) was jointly established by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) in 1988. The IPCC is now recognized as the prime source of scientific and technical information on climate change and its environmental and socioeconomic impact. The first assessment report on climate change was completed by the IPCC in 1990; the second assessment report on climate change was prepared by the three Working Groups I, II and III of the IPCC, leading to the publication of three reports in 1996. Of these three reports, the first report (IPCC,1996a) on the science of climate change examines observed mean temperature variation of the Earth as a whole for the last several hundred years and also examines the impact of greenhouse gases(carbon dioxide, methane and nitrous oxide) on the mean temperature of the Earth as simulated by coupled atmosphere-ocean models. Among the important findings of the report were: "The mean global temperature has increased by between about 0.3 to 0.6 deg (C) since the late 19th century and the 20th century global mean temperature is at least as warm as any other century since 1400 AD.(Data prior to 1400 are too sparse to allow reliable estimate of global mean temperature)". The report further concludes that *the balance of evidence suggests that there is a discernible human influence on global climate.* This sacramental phrase of the IPCC report has generated a lot of controversy among atmospheric scientists, environmentalists and policymakers and has led to several 'write-ups' by way of scientific correspondences and letters to editors (Avery et al. 1996; Masood,1996; Seitz,1996; Singer et al.1997; Kondratyev,1997). These scientific exchanges point out to a strong dissenting view expressed by several prominent atmospheric scientists in the USA and in Europe about the IPCC conclusion and its possible impact on national and international policies re: greenhouse gas emission and control. Unfortunately in Canada, there is no discernible debate on this issue in the scientific community as evidenced by an almost total lack of documents (or reports) in Canadian scientific publications; instead there appears to be an emerging view that the global warming and associated climate change in Canada is a 'fait accompli' and it is now time to take action on regulating greenhouse gas emissions! This, in my opinion, is an unhealthy attitude and does not serve the interest of many Canadians who would like to know the 'real truth' about greenhouse warming and its possible impact on the Canadian climate. In the following section some of the scientific issues relating greenhouse gas warming and climate change are briefly discussed.

Scientific Issues

1. An increasing number of prominent atmospheric scientists and meteorologists (in USA and Europe) believe strongly that the sacramental phrase appearing in the IPCC report which links global warming to human activity was not thoroughly substantiated by scientific studies (see for ex. Singer et al.1997; Kondratyev,1997). According to Singer et al.(1997), three key clauses which categorically state that "none of the studies have shown clear evidence of observed temperature increase linked to increasing greenhouse gases" were removed in the final version of the IPCC report. These key clauses which were included in the earlier 'draft' version of the IPCC report (see Masood,1996) would have provided a suitable caveat if they were to be included in the final version of the report. Without an appropriate caveat, the sacramental conclusion of the IPCC report has been used (and misused) by proponents and opponents of the ' global warming scenario' to advance

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each other's view point. As Kondratyev (1997) states, he felt disappointed that the highly important statement namely "the balance of evidence suggests that there is a discernible human influence on global climate" was included in the IPCC report without being thoroughly substantiated. These and other scientific exchanges (for ex. Lindzen,1990) suggest that the link between the observed increase in the mean global surface temperature and the increase in greenhouse gases has not been thoroughly established yet.

2. The observed mean temperature of the Earth (see Figure 1) and its variation over the last 100 years or more has been documented and discussed in several recent studies. As can be seen from Figure 1, the Earth's mean temperature shows a steady increase of almost 0.5 deg C from about 1910 to 1940, a steady decline of about 0.2 deg. from 1950 to 1975 and a relatively steep increase of about 0.25 deg from 1980 to 1995. If the steep increase of 0.25 deg between 1980 and 1995 is to be attributed to the recent build up of greenhouse gases, how does one explain the increase in mean surface temperature of 0.5 deg which occurred between 1910 to 1940, well before the present build up of greenhouse gases?

3. The spatial distribution of mean surface temperature trend over northern hemisphere (Jones et al. 1985) during the winter season (December-February) for the period 1961-1990 shows an increase of about 1 deg over western Canada and parts of northern Ontario. The spatial distribution also shows a cooling of about a degree C or so over the northwest Atlantic and over regions of eastern Canada extending from Baffin Bay to Nova Scotia. A similar cooling of 0.5 to 1.0 deg. is found over northwest and north central Pacific. The coupled atmosphere-ocean model (of the Canadian Climate Centre, Victoria) can reproduce the positive temperature anomaly over western Canada with reasonable success, however the model does not adequately reproduce the cooling over the northwest Atlantic and eastern Canada while it (the model) barely reproduces the cooling over the northwest and north central Pacific. Other coupled climate models also appear to have a similar deficiency in adequately reproducing the cooling; for example, the UK Meteorological Office climate model predicts 'warming of 2 to 4 deg. in the Baffin Bay and Davis Strait area which have been the centres of recent regional cooling' (see Marko et al.1994). Consequently, any estimate of the future global warming projected by the Canadian climate model (or by any other model) could be subject to considerable uncertainty.

4. Recent studies on decadal and longer-term oscillations in atmospheric flow patterns have attempted to provide a mechanism for the cooling over eastern Canada and the warming over western Canada. A recent study by Wallace et al. (1996) provides a possible mechanism for the warming of western North America (including western Canada) and the cooling of north central Pacific. Another study by Shabbar et al. (1997) has attempted to explain the surface cooling of eastern Canada by analyzing the decadal variability in the atmospheric circulation pattern over north-eastern North America. These and other related studies appear to provide a partial answer to the variation in the mean surface temperature trend over northern hemisphere, without invoking the 'greenhouse gas increase' hypothesis. The question whether these decadal (and longer-term) atmospheric oscillations are induced by increasing greenhouse gas concentration or are governed primarily by atmospheric dynamics remains to be investigated further.

5. The greenhouse gas-induced impact on the Canadian climate in terms of increased heat waves, floods and droughts as claimed by proponents of 'global warming scenario' (see for ex. McBean,1997) is by no means certain. The second assessment report of the IPCC entitled 'Impacts, Adaptation and Mitigation of Climate Change' (IPCC, 1996b) states categorically that 'unambiguous detection of these climate-induced changes will prove extremely difficult in the coming decades because of the complexity of various physical and ecological systems and their many nonlinear feedbacks'. While reviewing this report for the CMOS Bulletin (Khandekar,1997), I have concluded that the issue of detection and timing of occurrence of climate-induced changes (in Canada) is likely to remain unresolved in the foreseeable future. It is instructive to consider here some of the recent studies on climate change in Canada (and elsewhere) based on observed data. According to Gray et al (1994) and Khandekar (1996), there is no significant increase in the number of hurricanes or the number of storm (hurricane) days in the Atlantic over the last 25 years or more. A study by Von Storch (1993) concludes that there was no observational evidence of systematic change in either the frequency or the severity of extratropical storms in the northern Atlantic over the past one hundred years. A study by Balling Jr. (1996) concludes that over one hundred years of excellent drought records in the U.S.A. over a period of substantial buildup of greenhouse gases shows no evidence of a drying trend (in the U.S.A.). A study on drought in Canada (Maybank et al 1995) finds that the 'Palmer Drought Severity Index' (a commonly used drought index) shows no significant trend during the last 80 years over the Canadian prairies, the most drought-prone region in Canada. A study on variability and trends in total precipitation and snowfall (Groisman and Easterling,1994) finds a 20% increase in annual snowfall and rainfall during the last four decades in Canada north of 55 N. A recent comprehensive analysis of Canadian precipitation data (Hogg and Swail,1997) shows no increase in extreme rainfall events (rainfall exceeding 25mm in one rainfall event) over any region of Canada between 1910 and the present. In view of these (and other) observational studies, the greenhouse gas -induced climate changes as projected by coupled atmosphere-ocean models need to be carefully examined and the uncertainties associated with these projected climate changes must be adequately assessed. Furthermore, the question of detection and timing of occurrence of these greenhouse gas-induced climate changes must be critically examined and assessed. Are the

greenhouse gas-induced climate changes expected to occur in the next 10 years, in the next 25 years or in the next 50 years ? If so, how do we detect these changes?

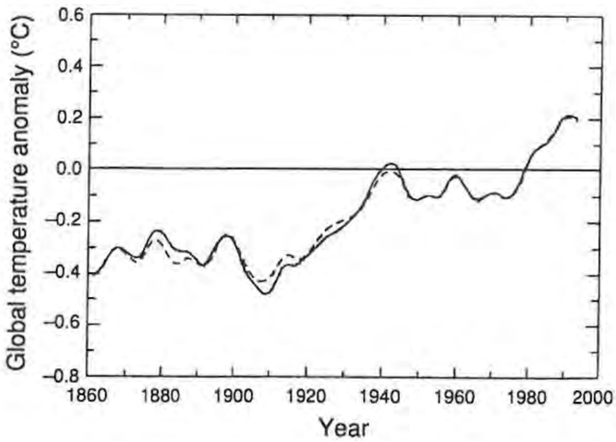

Figure 1: Combined land-surface air and sea surface temperatures (oC) 1861 to 1994, relative to 1961 to 1990. The solid curve represents smoothing of the annual values shown by the bars to suppress sub-decadal time-scale variations. The dashed smoothed curve is the corresponding result from IPCC (1992). Ref: page 26, Climate Change 1995: The Science of Climate Change, Cambridge University Press.

6. An important consequence of global warming, according to the IPCC (1996a), would be the melting of glaciers and ice-sheets leading to a rise in the mean sea level. The current rate of mean sea level rise is estimated to be about 1.8 ± 0.3 mm/yr (Douglas,1991). A recent article appearing in EOS (see Baltuck et al 1996) has summarized the findings of several recent studies which raise questions about future sea level changes. According to Baltuck et al., only about 1.0 mm/yr rise is assessed to have a reasonable certainty; the remaining 0.8 mm/yr rise has a considerable uncertainty which needs further investigation. Thus, future estimates of sea level rise projected by coupled climate models need to be critically assessed. Furthermore, there are suggestions (see Stewart, 1989) that the observed sea level rise can be better explained by assuming coastal subsidence rather than by eustatic change. Consequently the link between sea level rise and greenhouse gas increase needs to be critically examined and thoroughly substantiated.

Need for an Open Scientific Debate

The above issues (and many others mentioned in the IPCC reports and elsewhere) need to be closely examined and discussed. At present time, the global warming issue is being debated in the Canadian media primarily to express concern about the greenhouse gas emission and its control, a topic expected to be hotly debated at the international climate conference to be held in Kyoto, Japan in December 1997. The scientific issues concerning global warming are hardly discussed, either in the news media or in scientific publications. There is a definite need to discuss the scientific issues relating global warming in an open scientific debate or a conference. A scientific conference (or a workshop) may help develop a general consensus on the science of global warming; such a consensus is needed to develop an appropriate strategy for voluntary (or mandatory) control on the greenhouse gas emission. The Canadian Meteorological and Oceanographic Society, in collaboration with other scientific societies like CGU (Canadian Geophysical Union), can take a lead in convening such a conference.

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Erratum

The title of the second book reviewed on page 136 of *CMOS Bulletin SCMO* October 1997 issue (Vol.25, No.5) should have read:

Now to the Weather
Confessions of a TV Weatherman

We apologize to the author of the book and to its reviewer for this error.
Editor, CMOS Bulletin SCMO.

Climate Change Special Publication

In the June 1997 issue of the *CMOS Bulletin SCMO* (Vol.25. No.3), we have sollicited from our Members articles on **Climate Change**. The purpose of this special effort was to celebrate the 25th anniversary of the *CMOS Bulletin SCMO* (formerly known as the *Newsletter*). The answer was overwhelming and we could not squeeze in a single issue all of the material we have received. Therefore, in the next issue of the Bulletin, we will publish more articles on the same topic.

Publication spéciale sur le Changement climatique

Dans le but de célébrer le 25ième anniversaire du *CMOS Bulletin SCMO (anciennement connu sous le nom du Newsletter)*, nous avons demandé dans le numéro de juin 1997 (Vol.25. No.3), des articles sur le **Changement climatique**. La réponse fut excellente et nous n'avons pu concentrer dans le même numéro tous les articles reçus de nos membres. Alors, nous publierons dans le prochain numéro (Vol. 26, No.1), d'autres articles portant sur le même sujet.

It is rather ironic that, while completing this special issue on Climate Change, the final editing work had to be delayed by a few days because of several major freezing rain storms hitting Eastern Ontario and Province of Québec. Dumping tons of ice over the course of five consecutive days, the storms caused severe and lengthy electrical power interruptions over the area, resulting in this unexpected delay.

Rightly or wrongly blamed on El Niño or Global warming, the storms left behind unprecedented scenes of desolation: large areas left in the dark with no heat and no light; trees bent in half with their branches broken; major roads closed to traffic because they looked like skating rinks; electrical poles and pylons severely damaged or lying on the ground, crushed by the weight of the ice; hydro workers, including those from the Canadian Army and workers from the US, busy cutting the remaining branches before re-establishing electrical power. This event brought thousands of voluntary workers helping as much as possible the most deprived in emergency shelters. Early in the new year, this unprecedented meteorological event will leave many of us pensive.

Il est plutôt ironique que, tout en finissant ce numéro spécial sur le Changement climatique, le travail final de correction a souffert d'un délai de quelques jours à cause de plusieurs tempêtes de verglas frappant l'Est de l'Ontario et la province de Québec. Après avoir déversé des tonnes de glace durant cinq jours consécutifs, les tempêtes ont causé des pannes électriques majeures et prolongées touchant de grandes étendues, causant par le fait même ce délai inattendu.

Les tempêtes ont laissé derrière elles des scènes de désolation inédites: de larges étendues laissées dans le noir sans chaleur ni lumière; des arbres pliés en deux avec leurs branches sectionnées; des routes principales fermées à la circulation parce que devenues impraticables tellement elles ressemblaient à une patinoire; des poteaux électriques et des pylônes sévèrement endommagés ou carrément couchés au sol, écrasés par le poids de la glace; des travailleurs de l'hydro, incluant ceux des forces armées canadiennes et des travailleurs américains, occupés à couper le restant des branches avant de rétablir le courant électrique. Sans compter les milliers de volontaires qui ont aidé du mieux possible les plus démunis dans les centres de refuge. En début de cette nouvelle année, cet événement météorologique exceptionnel laissera songeurs plusieurs d'entre nous.

Paul-André Bolduc, Rédacteur / Editor CMOS Bulletin SCMO.

Does the Weather Really Matter? The social implications of climate change

by William James Burroughs
Cambridge University Press 1997
Hardback ISBN 0-521-56126-4. 234 pages

Reviewed by Peter Hyde

One scarcely knows where to begin when commenting on an analysis so replete with insights and rich in illustration. This is the author's fifth book on the weather and in it he encompasses a vast amalgam of aberrant climatic events and disasters that have left their mark on society - some known to have resulted from the weather, others of uncertain origin. Despite the rhetorical question in the title, the Preface suggests that it is in the weasel word "really" that the answer may lie.

The reader soon discovers what is meant by this, for a careful path is trod between the real and the often erroneously perceived socioeconomic effects of climatic and weather anomalies, beginning in the valley of the Indus during the period from 2,500 to 1,500 BC and extending right up to the late 20th century. As is pointed out on page 80 and also in the concluding chapter, there is an underlying message in say, the events that were set in motion by an intense depression which led to a storm surge on 31 January 1953 that flooded the east coast of Britain and breached the dykes in the Netherlands. It caused massive damage to farmlands and the loss of nearly 2, 000 lives. The ensuing several decades were devoted to strengthening the dykes and installing massive flood control works in several west European estuaries, all completed in the nick of time for an almost identical storm sequence that swept in from the Atlantic in 1983. The message is that on the political level especially, "the historical impact of events may be all a matter of how they are perceived rather than what they really represent", and that "action flows from being confronted by overwhelming evidence of a real and a common threat".

The background of cited events includes archaeological remains; military conquests and debacles; agricultural crises in the form of disastrous grain- and wine harvests and the ghastly toll in human lives due to the rising prices of these commodities; the arrival in Europe of the bubonic plague/Black Death pandemic; the Dustbowl years of the mid-1930s in the US; the floods, cold winters, hurricanes and droughts that have afflicted Europe and America during the second half of this century; and El Nino Southern Oscillation (ENSO) events, desertification and the enormous loss of life from widespread drought and famine in sub-Saharan Africa. This and a great deal of other information is drawn upon to emphasize the importance of searching for clues in the mute testimony of the past - clues that might be applicable in finding solutions to urgent problems, not only now but in the future. The view is expressed that since there is no simple linkage between ENSO events and patterns of drought, all of this needs to be investigated in more detail. "What is clear, however, is that Africa stands to be a major beneficiary of greater understanding of how the atmosphere and oceans combine to produce major interannual and interdecadal changes in the climate".

The second half of the book concentrates on the immediate task of identifying the causes and attempting to predict and modify the outcome of 20th and post-20th century warming, regarded by many as evidence of the impact of human activities. A telling illustration on page 113 depicts the warming trend during the period 1860 to 1994, from which it is seen that most of this warming of between 0.3 and 0.6° C appears to have been concentrated in the 20 to 25-year period up to the early 1940s and from the mid-1970s on. There is a lengthy discussion of General Circulation Models (GCMs) and the discrepancy between heat-radiation data collected by orbiting weather satellites and infra-red radiometry by ground-based and satellite-borne instrumentation. The much shallower trend seen post-1979, when microwave radiometers were first flown in weather satellites has, as the author puts it, "led to much head-scratching, and the cause of it is the subject of a continuing debate".

As Burroughs has lived and worked mostly in the UK, with a three-year stint in Washington DC as a UK Scientific Attaché, he has been able to compare the methods and results obtained by GCMs in both countries. He points out that the model developed at the UK Meteorological Office's Hadley Centre at Bracknell "provides a measure of the latest thinking on the consequences of doubling the radiative forcing of CO_2 in the atmosphere, and of including the effect of sulphate aerosols created by the combustion of fossil fuels containing sulphur". He writes "This could help to explain why the 20th century warming and its temporary abatement between the 1940s and the 1970s has not followed the course predicted on the basis of the build-up of greenhouse gases alone". Later on he comments "The general conclusion of both the Hadley Centre work and various other efforts to detect the fingerprint of human activities on the climate is that it exists but, as yet, in a rather faint and smudged form".

As there is no attempt to choose between the views of "the optimists and the pessimists", and since a strong dose of realism runs like a thread throughout all of the many issues touched upon, it is not surprising that a balanced, incremental approach of "gradualism" is advocated, rather than "crashing off into the undergrowth when surrounded by seemingly impenetrable thickets of uncertainty". That he is at once scientist, thinker and communicator is crystal clear. As a non-professional bystander I wouldn't hesitate to commend it to all who are concerned about the impact of climate change, irrespective of their perception of the threat.

(Peter Hyde has worked for many years as a scientific translator. As the book is addressed to non-experts with an interest in the subject, it seemed fitting to have it reviewed by such a reader).

Images in Weather Forecasting
A practical guide for interpreting satellite and radar imagery

by M.J.Bader, G.S.Forbes, J.R.Grant, R.B.E.Lilley and A.J.Waters
Cambridge University press 1995, 449 p.

Livre présenté par André April[1]

L'idée de concevoir ce manuel est venue lors d'une session internationale sur l'imagerie satellitaire et radar par l'Office météorologique Britannique en 1987. Les chapitres ont été discutés par les auteurs et prévisionnistes lors d'une autre session de travail en 1989. Le contenu a été révisé par des gens du Service météorologique, des universités et des prévisionnistes.

Le livre est constitué d'une introduction, de huit chapitres principaux, d'un glossaire et d'un index. L'introduction et les trois premiers chapitres expliquent le rôle de l'imagerie dans un environnement opérationnel, comment les images sont obtenues et comment elles sont reliées aux analyses conventionnelles et les modèles conceptuels du fonctionnement de l'atmosphère. Les cinq chapitres suivant précisent avec plus de détails les phénomènes observés aux latitudes moyennes de l'hémisphère nord comme les fronts nuageux, les dépressions et la cyclogénèse au-dessus du sol ou des océans, les patrons de nuages convectifs, les zones de turbulence, le brouillard et les nuages bas, les effets orographiques et les phénomènes polaires.

La présentation du manuel est de type pratique puisque chaque imagerie est complétée d'un texte explicatif, de cartes provenant d'un modèle numérique de prévision, et/ou d'un schéma conceptuel, et parfois de téphigramme. L'imagerie satellitaire principalement représentée est de type visible, infrarouge et à émission provenant de l'absorption de vapeur d'eau. L'imagerie radar est de type à présentation horizontale, verticale ou Doppler. Les écoulements atmosphériques sont relatifs ou non au système en question et sont expliqués dans le contexte synoptique dans lequel ils se situent. Le manuel présente près d'un millier de figures dont la moitié est de l'imagerie.

C'est un livre que les prévisionnistes et les étudiants gradués auront beaucoup de plaisir à consulter, et qui complète agréablement une session de cours de synoptique. Les étudiants apprécieront les explications fournies à chaque imagerie, qu'ils pourront appliquer aux imageries de plus en plus disponibles sur les sites Internet.

Images in Weather Forecasting
A practical guide for interpreting satellite and radar imagery

by M.J. Bader, G.S. Forbes, J.R. Grant, R.B.E. Lilley and A.J. Waters
Cambridge University Press, 1995, 449 p.
Book reviewed by André April[1]

The idea to write this guide came to the author at an international session on satellite and radar imagery given by the British Meteorological Office in 1987. In 1989, during a work group, the authors and forecasters discussed the different chapters. The content was revised by people from Meteorological Services, universities and by forecasters.

The book is made up of an introduction, eight main chapters, a glossary and an index. The introduction and the first three chapters explain the role of imagery in an operational environment, how images are obtained and their connection to conventional analyses and conceptual models of atmospheric functions. The following five chapters explain, with more details, the phenomena observed at medium latitudes in the northern hemisphere such as cloud fronts, depressions and cyclogenesis over land and oceans, convective cloud patterns, areas of turbulence, fog and low level clouds, orographic effects and polar phenemena.

Explanations provided with each imagery, as well as either maps taken from numerical models of forecasting, and/or conceptual diagrams, and sometimes of tephigrams, make this book's presentation very practical. The types of satellite imagery mainly presented are visible, infrared and with emissions due to water vapour absorption. The radar imagery presented are Doppler, vertical and horizontal. Atmospheric flow can be relative to the system in question and is explained in the synoptic context in which it is found. This guide presents about one thousand figures, half of which are imagery.

Both forecasters and graduate students will greatly enjoy consulting this book, which is a great complement to a semester of synoptic classes. Students will particularly like the explanations given with each imagery, which they will be able to apply to imageries increasingly available on the Internet.

1:André April
Sciences de l'Atmosphère
Département des Sciences de la Terre
Université du Québec à Montréal.

Louis Legendre

Lauréat du Prix Marie-Victorin 1997

Les Prix du Québec 1997 ont été décernés cette année à dix personnalités québécoises d'envergure internationale. L'attribution de ces prix rend hommage à leur excellence pour leur carrière remarquable comme modèles pour l'ensemble de la société. Louis Legendre, professeur-chercheur de l'Université Laval, a reçu le prix Marie-Victorin, en sciences pures et appliquées, pour ses travaux en océanographie. "L'oeuvre de Louis Legendre a contribué à mieux faire comprendre le fonctionnement de l'ensemble de l'écosystème et a profondément influencé le domaine des sciences de la mer en général, au Québec, au Canada et à l'étranger", a déclaré M. Roger Bertrand, ministre délégué à l'Industrie et au Commerce, responsable des Prix du Québec dans le domaine scientifique.

Louis Legendre, qui est détenteur d'un doctorat en océanographie de l'Université Dalhousie (1971), a entrepris ses premiers travaux sur le comportement des masses d'eau et leurs effets sur la productivité biologique. Les recherches qu'il mène depuis vingt-cinq ans et pour lesquels il bénéficie de la prestigieuses bourse Killam sont faites au sein du GIROQ (Groupe interuniversitaire de recherche océanographiques du Québec), conjointement animé par l'Université Laval et l'Université McGill. Les différentes synthèses du chercheur québécois font autorité auprès de ses collègues répartis dans diverses institutions de recherche à travers le monde: l'Institut Maurice-Lamontagne, l'Université Queen's, la National Academy of Sciences (États-Unis), l'Alfred Wegener Institute (Allemagne), l'Institut océanographique de Paris (France), la Société royale de Belgique, l'Université du Cap (Afrique du Sud) et l'Université de Tokyo (Japon).

Homme de terrain, Louis Legendre poursuit de façon personnelle et intensive ses travaux sur le Saint-Laurent, ainsi que sur les océans Arctique, Atlantique et Pacifique. Il a mis sur pied et animé les meilleures équipes de recherche en océanographie et a participé au lancement de nombreux projets de recherche nationaux et internationaux: *Ocean Production Enhancement Network, Joint Global Ocean Flux Study, Lake Biwea Transport Experiment, International Northeast Water Polynya Study, International Northwater Polynya Study.* Il a été organisateur et le principal animateur scientifique du projet *Saroma Resolute Study*, mené en collaboration avec des chercheurs japonais.

Le professeur Legendre est membre de nombreuses instances internationales notamment certains groupes de travail du Scientific Committee on Oceanic Research et le Conseil de direction de l'Institut océanographique (Fondation Albert 1er, Prince de Monaco). Il a publié près de 200 articles scientifiques, une quinzaine de livres, dont *Écologie numérique*, en collaboration avec son frère Pierre Legendre, spécialiste des écosystèmes et professeur à l'Université de Montréal; tout cela sans négliger ses activités d'enseignement et de formation d'étudiants aux trois cycles universitaires.

De nombreux prix scientifiques et distinctions ont récompensé son oeuvre: il a reçu le prix Michel-Jurdant (1980) et Léo-Parizeau (1986), de l'Association canadienne-française pour l'avancement des sciences; en 1988, il a été nommé membre de l'Académie des sciences de la Société royale du Canada et, en 1977, il a obtenu un doctorat *honoris causa* de l'Université de Liège (Belgique).

Le prix Marie-Victorin porte le nom du célèbre botanique qui a joué un rôle de premier plan dans le mouvement scientifique des années 20. Le prix est décerné à des chercheurs des sciences pures et appliquées, à l'exception du domaine biomédical. Les groupes ou disciplines intéressés sont les sciences exactes et naturelles, les sciences de l'ingénieur et technologiques, ainsi que les sciences agricoles.

<u>Source d'information:</u>
Guy Roussel,
Direction des communications
Ministère de l'Industrie, du Commerce, de la Science et de la Technologie,
Gouvernement du Québec.

Ocean Circulation and Climate
The Conference of the
World Ocean Circulation Experiment
Halifax, Nova Scotia, Canada
24 - 29 May 1998

WOCE is a component of the World Climate Research Programme investigating the role played by the ocean circulation in the earth's climate system. Its aim is to develop improved ocean circulation models for use in climate research. Planning started in the early 1980s to take advantage of new earth observing satellites and of the advances in computer power to model the global ocean.

The WOCE observational phase from 1990-1997 has used satellites and *in-situ* physical and chemical measurements to produce a data set of unprecedented scope and precision. It has resulted in the development of new observational techniques that have changed our view of the oceans. None of this would have been possible without the wholehearted co-operation of scientists in the over 20 countries involved.

WOCE is now entering its phase of Analysis, Interpretation, Modelling and Synthesis (AIMS) which will continue until 2002. The reconciliation of model results and observations, and ultimately the assimilation of ocean data into models, present the ocean science community with a novel set of challenges. The results from WOCE are having a profound influence on understanding the physics, chemistry and biology of the world's oceans and their interaction with the atmosphere.

Science Organizing Committee

Prof Gerold Siedler, Chair, Germany;
Dr Trevor McDougall, Australia;
Dr Bernard Barnier, France;
Prof Carl Wunsch, USA;
Dr Nobuo Suginohara, Japan;
Dr Allyn Clarke, Canada;
Dr John Gould, WOCE/IPO, UK;
Dr Andrea Frische, WOCE/IPO, Germany.

The Conference

The 1998 WOCE Conference "Ocean Circulation and Climate" marks the end of the observational phase and looks towards the challenges of WOCE AIMS. It will be WOCE's first global meeting since the 1987 Planning Conference in Paris.

It will provide an opportunity for scientists who have been involved in the observational and modelling activities to display the progress made towards the programme's objectives and to highlight the intellectual challenges that remain to derive maximum benefit from the enormous investment already made in WOCE.

It is planned to issue the first set of WOCE data CD-ROMs to conference participants.

The conference is sponsored through the WCRP by the World Meteorological Organization, the Intergovernmental Oceanographic Commission, the International Council for Scientific Unions and the Scientific Committee on Oceanic Research. It will be organized in association with the Canadian Meteorological and Oceanographic Society and the Department of Fisheries and Oceans.

Conference Structure

Registration will commence on Sunday, 24th May 1998. In order to provide the greatest opportunity for interaction between the scientists with varying interests. There will be no parallel sessions. Each day will have a particular theme relating to the overall objectives of WOCE:

- WOCE Overview - its Origins, Technologies and Issues;
- The Large-Scale Heat, Freshwater, Carbon and Momentum Fluxes;
- The Global Flow Field;
- Formation and Circulation of Water Masses;
- The Future.

A series of invited plenary lectures will be given in the mornings. Afternoons will be dedicated to posters. Posters will, as far as possible, be related to the daily themes and will be available for viewing throughout each day. The list of plenary session speakers has been published in the second announcement already issued in August 1997.

Poster submissions

The call for poster presentations was made in August 1997 with a submission deadline of February 1998. A book of poster abstracts will be produced prior to the meeting.

Venue

The Conference will be held in the Halifax World Trade and Convention Centre located in the centre of Halifax, the capital of Nova Scotia. It is within easy reach of hotels, shops, restaurants and local transportation. It is close to various historical sites and to the Halifax waterfront.

Accommodation

A block of rooms is being held in three business class hotels linked to the Conference Centre by enclosed pedways. Other accommodation options will range from luxury hotels to university dormitories.

Registration

Completion of the registration form found on the WOCE Conference WWW Page

http://www.soc.soton.ac.uk/OTHERS/woceipo/wconf

will ensure that you receive the second circular (issued in August 1997) containing details of the plenary lectures, poster submissions and accommodation options.

Travel Support

Limited funding will be available to support the participation of students presently or planning to be involved in WOCE research and to scientists from countries with emerging economies. An indication of whether you may require support should be made at the time of initial registration.

Sponsorship

The organizers welcome financial sponsorship of the conference. This could be in the form of sponsorship of specific events such as receptions and coffee breaks or could be used to reduce the planned conference registration fee or to fund travel grants. The Director of the WOCE Project Office would be happy to discuss any offers of sponsorship.

Call for Papers
32nd Annual CMOS Congress
Dartmouth, N.S. --- 1-4 June, 1998

The Halifax Centre of the Canadian Meteorological and Oceanographic Society (CMOS) will host the 32nd Annual CMOS Congress at the Holiday Inn in Dartmouth, N.S. during 1-4 June, 1998. The theme of the congress is *"Atmosphere-Ocean Climate Variability"*, to reflect major national and international research initiatives in this field. Contributions are particularly sought in areas of climate variability and impacts at both global and regional scales, but oral or poster papers and commercial exhibits are invited from all areas of meteorology and oceanography. Special sessions are presently planned for WOCE/CLIVAR research, Arctic marine and atmospheric chemistry, biological cycles and ocean biogeochemistry at high latitudes, and forecasting of the coupled atmosphere-ocean system. Additional sessions will be organized according to the scientific content of the contributions. As well, one of the congress days will be designated for Education, and another for Industry, in order to encourage the participation of local educators and to showcase the work of local industries.

Immediately preceding the CMOS Congress, the Conference of the World Ocean Circulation Experiment will be held in Halifax, N.S., during 24-29 May, 1998.

CMOS abstracts must be received by the Scientific Program Committee (Co-chairs: P.C. Smith, D.G. Wright) by 5:00 PM on Friday, February 6, 1998. Authors are strongly encouraged to submit abstracts via E-mail. A template for sending an electronic abstract may be obtained from the conference web site:

http://dfomr.dfo.ca/science/ocean/cmos/congrs98.html

For those without Internet access, a template and instructions may be obtained by sending an E-mail message to:

template@georgs.bio.dfo.ca

The automatic reply will contain all the information needed to submit an abstract via E-mail. The Committee will greatly appreciate all efforts to submit abstracts electronically, as this will facilitate the approval and printing processes considerably, and produce a faster response to the authors. Hard- (paper) and soft-copy (diskette) submissions will also be received by:

Dr. Peter C. Smith, Co-chair
CMOS Congress '98 Scientific Program
Bedford Institute of Oceanography
P.O. Box 1006
Dartmouth, N.S. B2Y 4A2 CANADA

For soft-copy submissions, please use either MS-Word, Word Perfect, or Word Star, and label the diskette with the name and version number of the word processor used. Most questions regarding CMOS Congress '98 may be answered by accessing the homepage address given above. For other general inquiries regarding the scientific program, please contact Dr. Peter Smith at:

E-mail: pc_smith@bionet.bio.dfo.ca
Tel: (902) 426-3474 or (902) 426-3857;
Fax: (902) 426-7827.

For general inquiries regarding registration, accommodation, or other local arrangements, please contact Dr. Clive Mason at:

E-mail: c_mason@bionet.bio.dfo.ca
Tel: (902) 426-6927 or (902) 426-3857;
Fax: (902) 426-7827.

Invitation à présenter des communications 32ième congrès annuel de la SCMO Dartmouth, N.-É.--- 1 au 4 juin 1998

Le centre d'Halifax de la Société Canadienne de Météorologie et d'Océanographie (SCMO) sera l'hôte du 32e congrès annuel de la SCMO qui se tiendra à l'hôtel Holiday Inn, Dartmouth, N.-É. du 1er au 4 juin 1998. Le thème du congrès, la *"Changement climatique dans l'atmosphère et l'océan"*, a été choisi pour refléter les importantes initiatives de recherche entreprises au niveau national et international dans ce domaine. Nous invitons les auteurs à soumettre des résumés en particulier dans les domaines de la variabilité climatique et de ses impacts autant au niveau global que régional, mais également dans tous les domaines de la météorologie et de l'océanographie en présentation orale, en affiche ou en kiosque commercial. A l'heure actuelle, des sessions spéciales sont prévues pour la recherche WOCE/CLIVAR, la chimie marine de l'arctique, les cycles biologiques et la biogéochimie de l'océan aux hautes latitudes, et finalement, pour la prévision du système couplé atmosphère-océan. Des sessions additionnelles seront ajoutées en fonction du contenu scientifique des résumés soumis. De plus, une des journées du congrès sera dédiée à l'éducation et une autre à l'industrie, pour encourager la participation des éducateurs de la région et pour offrir une vitrine de présentation du travail des industries de la région.

Il est à noter que la conférence " World Ocean Circulation Experiment " se tiendra à Halifax immédiatement avant le congrès de la SCMO, du 24 au 29 mai 1998.

Les résumés des communications pour le congrès de la SCMO devront être reçus par le comité du programme scientifique (co-présidents: P.C. Smith et D.G. Wright) avant 17h00 HNM, le vendredi 6 février 1998. Nous encourageons fortement les auteurs à soumettre leur résumé par courrier électronique. Un formulaire pour envoyer un résumé par voie électronique peut être obtenu au site WEB du congrès:

http://dfomr.dfo.ca/science/ocean/cmos/congrs98.html

Pour ceux qui n'ont pas un accès à Internet, un formulaire avec les instructions pertinentes peuvent être obtenus en envoyant un message par courrier électronique à:

template@georgs.bio.dfo.ca

Une réponse automatique fournira l'information nécessaire pour soumettre un résumé par courrier électronique. Le comité vous sera grandement reconnaissant de vos efforts pour soumettre les résumés par voie électronique puisque ceci facilitera les processus d'approbation et d'édition tout en permettant une réponse plus rapide aux auteurs. Les résumés peuvent également être soumis sous forme papier ou sur disquette par courrier à:

Dr. Peter C. Smith, co-président,
Programme scientifique, Congrès de la SCMO 1998,
Institut océanographique de Bedford,
C.P. 1006,
Dartmouth, N.-E. B2Y 4A2 CANADA

Pour les soumissions électroniques, veuillez utiliser MS-Word, WordPerfect ou Word Star et indiquer sur la disquette le nom et la version du traitement de texte utilisé. La plupart des questions pour le congrès 1998 de la SCMO ont leur réponse au site Internet cité plus haut. Pour d'autres questions d'ordre général concernant le programme scientifique, vous êtes prié de contacter Dr Peter Smith aux coordonnées suivantes:

E-mail: pc_smith@bionet.bio.dfo.ca
Tél.: (902) 426-3474 ou (902) 426-3857;
Fax: (902) 426-7827.

Pour des questions d'ordre général concernant l'inscription, le logement et autres informations locales, vous êtes prié de contacter Dr Clive Mason aux coordonnées suivantes:

E-mail: c_mason@bionet.bio.dfo.ca
Tél.: (902) 426-6927 ou (902) 426-3857;
Fax: (902) 426-7827.

TOS and IOC Meeting on "Coastal and Marginal Seas" UNESCO Headquarters June 1-4, 1998 Paris, France

Program Co-chairs:
1) Kenneth Brink, Woods Hole Oceanographic Institution, USA, and
2) Katherine Richardson, Danmarks Fiskeriundersogelser.

In observance of the Year of the Ocean and the TOS 10th anniversary, THE OCEANOGRAPHY SOCIETY (TOS) and the INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION (IOC), announce their first jointly sponsored scientific meeting. The meeting format will include morning plenary sessions of invited talks on the daily session topics and interactive afternoon sessions of contributed poster abstracts focusing on, but not limited to, the day's session theme. Commercial and educational exhibits will be collocated with the posters.

More information will be available to our readers in the next issue of the CMOS Bulletin SCMO, in February 1998, or visit their homepage:

http://www.tos.org

Notes to the Editor

1) The Canadian Lightning Detection Network

On the 24th of September, Minister of the Environment Christine Stewart announced the establishment of the Canadian lightning detection network.

Last June, at our Saskatoon CMOS Congress, Gilles Foumier gave details of the system and its implementation. The $9.5 million network will include 81 state-of-the-art lightning detectors mixing Time-Of-Arrival and Magnetic Direction Finding methodologies to detect both cloud-to-cloud lightning and cloud-to-ground lightning. The network's sensors will be accurate to within 500 metres of where lightning hits and be capable of detecting more than 90 per cent of all lightning strikes. When lightning hits, the system will relay data about the strike from the detection unit to the central processing station via satellite and back to Environment Canada's weather centres in 30 seconds.

The Canadian network will be integrated with the American system, creating the first North American lightning detection system. Global Atmospherics, Inc. of Tucson, Arizona, will supply, install and operate the network, with TELESAT as sub-contractor to install instruments at all the sites. The entire system will be fully operational by the summer of 1998.

Environment Canada will provide the lightning data on a subscription basis to other government departments and agencies, as well as the private sector.

In Canada, lightning kills about seven people and seriously injures 60 to 70 people a year. According to the Canadian Forest Service, in 1994 there were 9,763 forest fires of which lightning caused 5,324. The total area burned was 6,292,021 hectares. Between 1979 and 1993, the average annual cost of forest fires caused by lightning was roughly $14 billion.

2) Canadian SPOT and LANDSAT: Distribution Agreement Renewed

RADARSAT International (RSI) of Richmond, British Columbia, Canada, is pleased to announce that The Canada Centre for Remote Sensing, Natural Resources Canada, has renewed RSI's licence agreement to process, market and distribute commercially SPOT and LANDSAT data products of Canada.

Under the agreement, RSI markets Canadian SPOT panchromatic and multispectral data, and Canadian LANDSAT TM and MSS data in Canada. Dr. John Hornsby, RSI's Director, Worldwide Sales, said, "We are now in our seventh year of distributing SPOT and LANDSAT data of Canada, and are pleased with the results we have achieved. Looking to the future, we are continuing to develop new products and services to meet the needs of new applications and market segments, and to work with the Canadian value-added industry to fulful these needs."

Under separate agreement with SPOT and Space Imaging EOSAT, RSI also distributes international SPOT and LANDSAT data in Canada.

RADARSAT International (RSI) is a world leader in providing information solutions from space. RSI distributes RADARSAT products worldwide, ERS products in North America and SPOT, LANDSAT and JERS products in Canada. RSI has its headquarters in Richmond (British Columbia, Canada) and offices in Ottawa (Ontario, Canada), Gatineau (Québec, Canada), and Farnborough (United Kingdom).

For more information, please contact Cory Aspden at (604) 231-4916 or Robert E. Tack at (604) 231-4913, or read their homepage at www.rsi.ca or www.radarsatinaction.com.

3) Global Climate Change Student Guide

With the study of climate change becoming increasingly relevant, higher education students involved in environmental sciences, atmospheric sciences, geosciences and geography are required to obtain detailed information on such topics. In response to this need, the Global Climate Change Information Programme has produced a detailed review of global climate change, both contemporary and throughout Earth History. The resource (60,000 words) is composed of 6 chapters and an extensive reference list (350+). This resource is also available as software for PCs with Windows.

Both the hard copy and software are ideal for university and college students as well as lecturers, teachers and researchers in this field, and details of how to purchase them are provided at the bottom. Alternatively, further information is available on our web site at:

http://www.doc.mmu.ac.uk/aric/student.html
http://www.doc.mmu.ac.uk/aric/software.html

The Student Guide contains:

i) The Climate System

The Atmosphere; The Oceans; The Cryosphere; The Biosphere; The Geosphere.

ii) Causes of Climate Change

Non-Radiative Forcing; Radiative Forcing; Time Scales of Climate Change; External Forcing Mechanisms; Internal Forcing Mechanisms; Climate Feedback; Climate Sensitivity.

iii) Empirical Study of the Climate

Climate Construction from Instrumental Data; Palaeoclimate Reconstruction from Proxy Data.

iv) Climate Modelling

Simplifying the Climate System; Modelling the Climate Response; Climate Models; Confidence and Validation.

v) Palaeoclimate Change

Climate Change; Precambrian Climates; Phanerozoic Climates; Quaternary Climates.

vi) Contemporary Climate Change

The Greenhouse Effect; The Enhanced Greenhouse Effect; Sources, Sinks and Concentrations of Greenhouse Gases; Radiative Forcing of Greenhouse Gases; Aerosols; Observed Climate Variations; Detection of Anthropogenic Global Warming; Future Climate Change; Impacts of Future Climate Change; Response to Anthropogenic Climate Change.

The hard copy global climate change student guide is available at a cost of US $18.50. Cheques can be received (payable to Manchester Metropolitan University) in US dollars, although no invoicing facilities are available, unless the resource is purchased in pounds sterling (10 pounds). No credit card facilities available. The software is available at the slightly higher cost of US $27.00 (15 pounds), but the purchasing institution may freely copy it within its own departments.

If you would like to purchase either of these resources, either contact the address below, or provide your name and address to the same address and quoting the number of hard copies requested (US $18.50 each) or the number of software (US $27.00 each) and return with payment to the Global Climate Change Information Programme.

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4) Alden Electronics and WELS Research Enter into Marketing and Sales Alliance

Westborough, Ma (October 31, 1997). Jimmie Smith, Vice President of Marketing and Sales, Alden Electronics, Inc., today announced an agreement with WELS Research Corporation to market and sell the WELS WeatherPro System. The agreement is designed to expand Alden's offering of weather products and services to its current customer base, as well as opening up new national and international markets.

The WELS WeatherPro System provides the user with highly detailed and accurate weather forecasts for very specific geographic locations or regions. It is a unique "distributed weather system" which is PC based and can support the demands of meteorologists and end users in such diverse fields as agribusiness, highway maintenance and traffic control, ski area operations, avalanche control, commercial weather forecasting operations, and many other activities that are affected by weather.

WELS WeatherPro consists of three major elements, a customized numerical prediction model, an interactive graphical user interface (GUI), and an Artificial Intelligence (AI) based expert weather advisor.

The core of the system is the WELS Numerical Weather Prediction Model. The WELS Model is a 9-layer model that produces a 24-hour forecast in approximately 12 minutes running on a Pentium-class Personal Computer. The output of the WELS Model includes predictions of temperature, dew point, dew point depression, relative humidity, precipitation potential, wind velocity and direction, 3-hour total precipitation, and cumulative precipitation. Some variables are predicted for the surface and for 400 metres above the terrain, others are predicted for only the surface or for 400 metres above the terrain.

The predictions generated by the WELS Model are developed for an area roughly the size of the United States with a resolution of 60 kilometres between grid points. At the state level, the prediction are interpolated to a resolution of approximately 20 kilometres. Forecasts are automatically updated every 12 hours and can be adjusted by the user to take into account real time observations from the National Weather Service, local sensors, or other available information sources. WeatherPro is displayed in a graphical user interface (GUI) which can be customized for the unique needs of each custumer, and presented in readily understood formats. The thrust of the system design is to enable users to gain timely and invaluable weather information which will enable them to make critical tactical decisions to adjust the magnitude and tempo of their current operations to meet the demands of newly developing weather events.

Mr. Smith, in announcing the agreement, stressed the importance of the WeatherPro System for Alden's existing customers as well as for new custumers. "WeatherPro will provide a new and important capability to many of our customers that are involved with operations that require detailed and precise forecasts for a local area. We are very pleased to be working with WELS Research and look forward to delivering this exciting product to our customers," said Mr. Smith. After signing the agreement, David Doyle, CEO of WELS Research said: "We're enthused that we now have the opportunity to work with Alden. We know and respect Alden since they have been our source of weather data from the beginning of our company. Alden's marketing and sales force, its established customer base, and its willingness to move into new markets wil enable us to more rapidly reach a wide range of national and international customers."

Alden's Electronics, Inc., based in Westborough, Massachusetts, operates independently as a member of the Platinum Equity Holdings, LLC portfolio of companies. WELS Research is located in Boulder, Colorado and Austin, Texas. For more information about WeatherPro, contact Jimmie Smith (800) 225-9492, ext.2228, e-mail to smithj@alden.com, or check Alden's Web Site at http://www.alden.com.

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