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CMOS BULLETIN SCMO

Canadian Meteorological and Oceanographic Society

La Société canadienne de météorologie et d'océanographie

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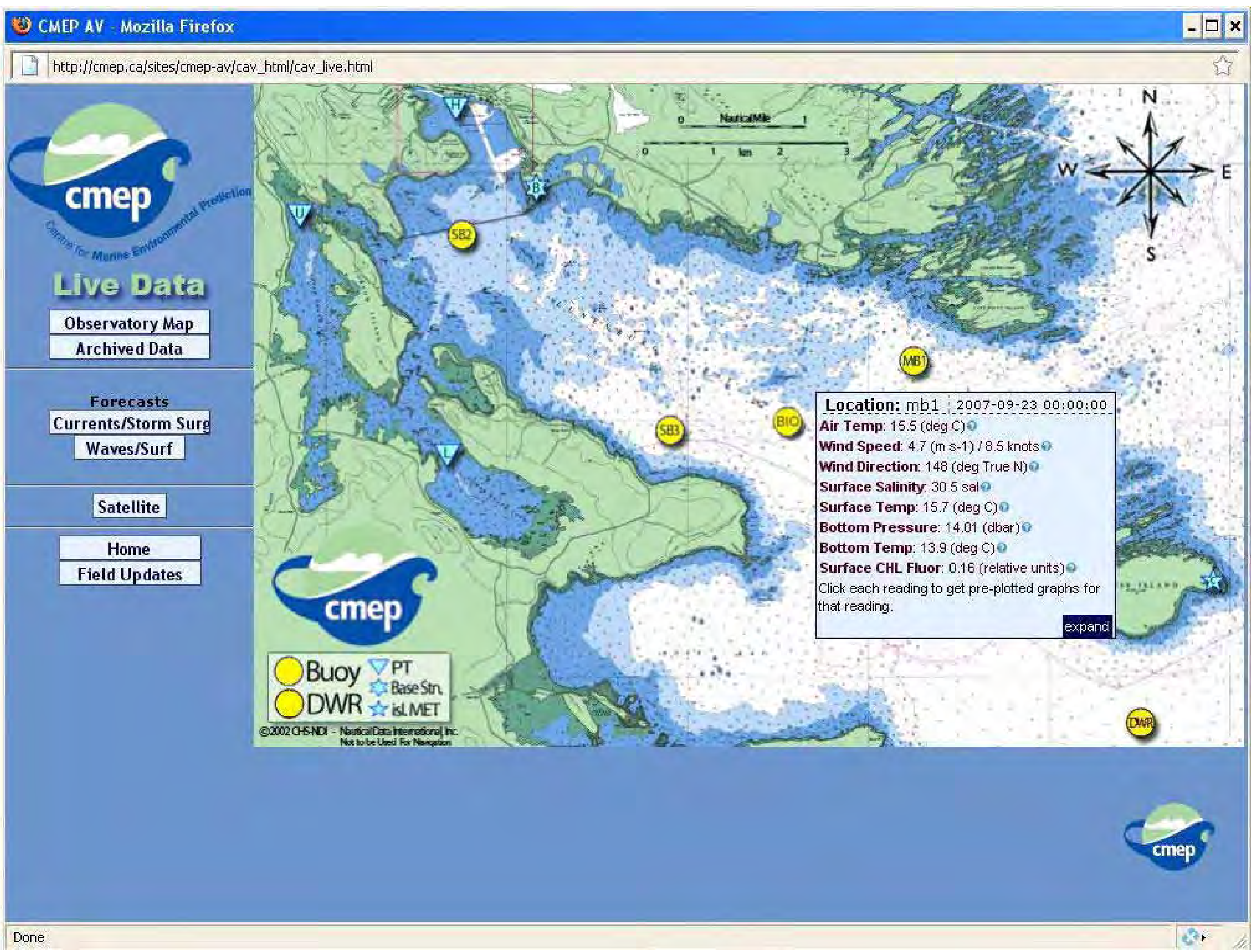

Lunenburg Bay Observatory web page
La page web de l'observatoire de la baie de Lunenburg

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

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Cover page: The Lunenburg Bay project has developed Canada's first real-time interdisciplinary ocean-atmosphere observation and forecast system. The advances achieved through this project have the potential to make Canada a world leader in real-time ocean analysis and forecasting. Shown on the cover page is the web page allowing users to access real-time meteorological and oceanographic data. To learn more on this major project, please read the article on **page 199.**

Page couverture: Le projet de la baie de Lunenburg a permis le développement du premier système canadien interdisciplinaire de prévision et d'observation océan-atmosphère en temps réel. Les réalisations obtenues grâce à ce projet ont la possibilité de faire du Canada un leader mondial dans la prévision et l'analyse marine en temps réel. Illustrée sur la page couverture est la page d'accueil permettant aux usagers d'accéder aux données météorologiques et océanographiques enregistrées en temps réel. Pour en apprendre plus sur ce projet majeur, prière de lire l'article en **page 199**.

....from the President's Desk

Friends and colleagues:

Andy Bush
President of CMOS / Président de la SCMO

I'm sure this fall has been a busy one for everybody, and I hope that it has been a productive one. North of the border, our federal election created some excitement, I'm sure, though the end result didn't change things much. One more recent development, however, is the introduction of Jim Prentice as our new Minister of the Environment.

The Canadian Foundation for Climate and Atmospheric Sciences is hosting an "Arctic Symposium" on November 25th in Ottawa at the Fairmont Chateau Laurier. I hope many of you may be able to attend. It is my understanding that Jim Prentice will be invited to attend and hopefully participate.

South of the border we will see whether the election of Barack Obama will provide a more "hospitable" environment for climate research both south and north of the border. Hopefully this will be the case!

International communication among various meteorological societies will take place at the January meeting of the American Meteorological Society, and our Executive Director, Ian Rutherford, has graciously taken on the duty of representing CMOS at this important meeting. In addition, I have been in contact with the presidents of both the American Geophysical Union and the American Meteorological Society in order to better coordinate our operations and our meetings.

Our vice-president, Bill Crawford, has been busy filling vacancies in next year's executive. Only the vice-president position for next year remains outstanding though there are many excellent candidates.

I will take this opportunity to wish everybody a peaceful and safe holiday season and all the best for the New Year.

Andy Bush
President / Président
CMOS / SCMO

Volume 36 No.6
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Articles

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Our regular sections / Nos chroniques régulières

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

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

Highlights of Recent CMOS Meetings

- Presidents of both the American Geophysical Union and the American Meteorological Society have been contacted to coordinate our respective activities including meetings;

- Ian Rutherford will attend the AMS meeting in January to represent CMOS in a meeting of international meteorological societies;

- Ken Denman has agreed to be the CMOS tour speaker for 2008-2009;

- Arrangements for the 2009 Halifax congress are proceeding well; advertisements will be submitted to the bulletins of the AMS and the CGU;

- Most upcoming vacancies in next year's executive have been filled, though we are still looking for a new vice-president;

- The Pelmorex Scholarship was awarded to Emily Collier from the University of Alberta;

- ATMOSPHERE-OCEAN continues smoothly with a number of special issues lined up through 2011. Our Director of Publications, Richard Asselin, is looking into alternative printing procedures that will be more cost-effective.

Andy Bush,
CMOS President
Président de la SCMO

URGENT - URGENT - URGENT - URGENT

Next Issue *CMOS Bulletin SCMO*

Next issue of the *CMOS Bulletin SCMO* will be published in **February 2009.** Please send your articles, notes, workshop reports or news items before **January 9, 2009** to the address given on page ii. We have an URGENT need for your written contributions.

Prochain numéro du *CMOS Bulletin SCMO*

Le prochain numéro du *CMOS Bulletin SCMO* paraîtra en **février 2009.** Prière de nous faire parvenir avant le **9 janvier 2009** vos articles, notes, rapports d'atelier ou nouvelles à l'adresse indiquée à la page ii. Nous avons un besoin URGENT de vos contributions écrites.

2009 CMOS Tour Speaker

Title and Abstract – CMOS lecture

Climate Change: a Collision of Science, Politics, Economics and Ethics

Kenneth Denman

Fisheries and Oceans Canada, EC Canadian Centre for Climate Modelling and Analysis,

With the completion in 2007 of the Intergovernmental Panel on Climate Change Fourth Assessment Report (AR4), public perception shifted from skepticism to a general sense that climate change is real and that humans are largely responsible. However, more recent research findings in several areas suggest additional cause for concern: e.g. the minimum summer extent of Arctic sea ice is decreasing faster than in any of the IPCC coupled models, global emissions of carbon dioxide over the last 6 years are increasing faster than in any of the IPCC SRES emissions scenarios, and evidence indicates that the Laurentide ice sheet, which covered much of the northern hemisphere at the last glacial maximum, at times during its retreat, shrank at faster rates than are forecast for the Greenland ice sheet during this century. Both as natural scientists and as members of society, the obvious question is "What do we do next ?"

Until now, scientists have resisted even discussing 'geoengineering' approaches to mitigating climate change or its impacts. But unless a post-Kyoto agreement on controlling emissions, scheduled to be reached in late 2009, is much more effective than the Kyoto agreement appears to be, then we should be doing research on some of the geoengineering approaches that have been proposed: injecting sulphur aerosols into the stratosphere, fertilizing the oceans with iron, large scale tree plantations for biofuels or to alter the albedo, etc. What about the cost of damage from projected climate change versus the cost of mitigating it ? The 2007 Stern Report argues strongly that the benefits of mitigating climate change far outweigh the costs of mitigation. His report has received much criticism because he used an unusually low discount rate for the value of future generations. He has countered that at the base of the economic calculations lies an ethical issue – how much do we value the welfare of future generations relative to our own welfare ? Another recent study argues that the Stern Report is right for the wrong reasons: that the statistics for rare extreme events are not properly accounted for in the assessment models. Therefore, the possibility of future unexpected 'disasters', where the costs may be enormous and continuing and beyond our current perception (e.g. Hurricane Katrina) should lead to a precautionary approach and a high value assigned to the wellbeing of future generations. More recently, the economic downturn has largely replaced climate change in the public consciousness. Clearly the climate change 'issue' extends far beyond the expertise of any scientific discipline. How can we, or should we, confine our activities on climate change to within our areas of scientific expertise ?

Conférencier itinérant de la SCMO 2009

Titre et résumé – Conférence de la SCMO

Le changement climatique : un choc d'idées scientifiques, politiques, économiques et éthiques

Kenneth Denman

Pêches et Océans Canada, Centre canadien de la modélisation et de l'analyse climatique d'EC,

Avec la présentation, en 2007, du Quatrième rapport d'évaluation (RE4) du Groupe d'experts sur le changement climatique, le scepticisme s'est estompé dans la perception du public pour faire place au sentiment général que le changement climatique est réel et que les humains en sont largement responsables. Cependant, des résultats de recherches plus récents dans plusieurs domaines soulèvent d'autres points préoccupants : par exemple, l'étendue minimale de la glace de mer arctique en été diminue plus vite que ce qu'indique n'importe lequel des modèles couplés du GIEC, les émissions de dioxyde de carbone dans le monde au cours des six dernières années augmentent plus rapidement que dans tous les scénarios SRES du GIEC et on trouve des indices à l'effet que la nappe glaciaire Laurentide, qui couvrait la plus grande partie de l'hémisphère Nord durant le dernier maximum glaciaire, a rapetissé, à certains moments durant son retrait, plus rapidement que ce qui est prévu pour la nappe glaciaire du Groenland au cours du présent siècle. En tant que spécialistes des sciences de la nature et en tant que membre de la société, la question qui se pose ici est "Que faisons-nous ensuite" ?

Jusqu'à maintenant, les scientifiques se sont abstenus même de discuter de stratégie de "géo-ingénierie" pour limiter le changement climatique ou atténuer ses impacts. Mais à moins qu'un accord post-Kyoto sur le contrôle des émissions, dont on prévoit la conclusion vers la fin de 2009, ne soit beaucoup plus efficace que l'accord de Kyoto semble l'être, nous aurons à faire des recherches sur certaines des stratégies de géo-ingénierie qui ont été proposées : injection d'aérosols soufrés dans la stratosphère, fertilisation des océans avec du fer, plantation d'arbres à grande échelle pour les biocarburants ou pour modifier l'albédo, etc. Que peut-on dire du coût des dommages causés par le changement climatique prévu par rapport au coût des mesures visant à le limiter ? Le rapport Stern de 2007 affirme que les bénéfices de la lutte contre le changement climatique dépassent de loin son coût. Ce rapport a fait l'objet de beaucoup de critiques parce que Stern a utilisé un taux d'actualisation inhabituellement bas pour la valeur des générations futures. Stern a rétorqué qu'à la base des calculs économiques se trouve une question éthique – quelle valeur donnons-nous au bien-être des générations futures par rapport à notre propre bien-être ? Une autre étude récente soutient que le rapport Stern est bon pour les mauvaises raisons : parce que les statistiques sur les événements extrêmes rares ne sont pas correctement prises en compte dans les modèles d'évaluation. Par conséquent, la possibilité de "désastres" futurs non prévus dont les coûts peuvent être énormes et permanents et échapper à notre perception actuelle (p. ex. l'ouragan Katrina) devrait nous inciter à adopter une approche prudente et à accorder une valeur élevée au bien-être des générations futures. Plus récemment, les difficultés de l'économie ont remplacé le changement climatique dans l'attention du public. Il est clair que le "problème" du changement climatique dépasse de loin l'expertise de toute discipline scientifique. Comment pouvons-nous, ou devrions-nous, limiter nos activités relativement au changement climatique à l'intérieur de nos domaines d'expertise scientifique?

Short Biography

Dr. Ken Denman is a Senior Scientist with Fisheries and Oceans Canada (DFO), seconded to the Canadian Centre for Climate Modelling and Analysis of Environment Canada, located at the University of Victoria where he is an Adjunct Professor in the School of Earth and Ocean Sciences. Previously he worked at DFO's Institute of Ocean Sciences in Sidney, BC and at Bedford Institute of Oceanography in Dartmouth, NS.

For the past decade he has worked at the Canadian Centre for Climate Modelling and Analysis in Victoria, developing coupled physical-biogeochemical models of the ocean, including carbon cycling and investigating the response of marine ecosystems to iron fertilization.

Dr. Denman is a Fellow of the Royal Society of Canada and has been a member of the British Columbia Premier's Climate Action Team, (2007-2008). He has contributed to the Intergovernmental Panel on Climate Change (IPCC), specifically as the Coordinating Lead Author in the IPCC Climate Change 2007 AR4 report of chapter titled "*Couplings between changes in the climate system and biogeochemistry*" and as Convening Lead Author in the IPCC Climate Change 1995 SAR report of chapter titled "*Marine biotic responses to environmental change and feedbacks to climate*". He has served on several committees including the International and Canadian SOLAS Scientific Steering Committees and the Joint Scientific Committee for the World Climate Research Programme between 2001-2006.

Among the awards that he has received are the CMOS President's Prize in 1987, the Parsons Award for Excellence in Ocean Sciences from Fisheries and Oceans Canada in 2006 and the Wooster Award for significant scientific contributions to North Pacific marine science, North Pacific Marine Sciences Organization (PICES) in 2007. The IPCC shared the 2007 Nobel Peace Prize with Al Gore for "*their efforts to build up and disseminate greater knowledge about man-made climate change and to lay the foundations for the measures that are needed to counteract such change*".

Bob Kochtubajda
Corresponding Secretary

Courte biographie

Le Dr Ken Denman est un scientifique chevronné travaillant pour Pêches et Océans Canada, détaché auprès du Centre canadien de la modélisation et de l'analyse climatique d'Environnement Canada, à l'Université de Victoria, où il agit à titre de professeur auxiliaire à l'École des sciences de la Terre et de l'océanographie. Il a auparavant travaillé à l'Institut des sciences de la mer de Pêches et Océans Canada, à Sidney (C.-B.) et à l'Institut océanographique de Bedford, à Dartmouth, en Nouvelle-Écosse.

Au cours de la dernière décennie, il a travaillé au Centre canadien de la modélisation et de l'analyse climatique à Victoria, plus précisément à concevoir des modèles physiques-biogéochimiques couplés de l'océan, incluant le cyclage du carbone et l'étude de la réponse des écosystèmes marins face à la fertilisation par le fer.

Dr Denman est membre de la Société royale du Canada et fût également membre de la British Columbia Premier's Climate Action Team, en 2007-2008. Il a participé au Groupe d'experts intergouvernemental sur l'évolution du climat (GIEC) en tant qu'auteur en chef coordonnateur du rapport AR4 GIEC 2007, et plus précisément du chapitre intitulé "*Couplage entre les changements du système climatique et la biogéochimie*". Il a aussi occupé le poste d'auteur principal convocateur du chapitre du Rapport SAR 1995 du GIEC "*Réponses biotiques des mers face aux changements environnementaux et rétroactions au climat*". Il a apporté grandement à plusieurs comités tels que les Comités canadien et international directeurs scientifiques SOLAS et le Comité scientifique mixte pour le Programme mondial de recherche sur le climat entre 2001 et 2006.

Parmi les nombreux prix qu'il a remportés, il est possible de mentionner le Prix du Président de la SCMO en 1987, le prix Parsons de l'Excellence en océanographie de Pêches et océans du Canada et de la SCMO en 2006 et le prix Wooster gratifiant des contributions scientifiques d'importance à la science de la mer du Pacifique Nord et de l'Organisation des sciences de la mer pour le Pacifique Nord en 2007. Avec les autres membres du GIEC, il a partagé en 2007 le Prix Nobel de la Paix avec Al Gore pour "*leurs efforts afin de renforcer et de diffuser de meilleures connaissances relatives aux changements climatiques d'origine humaine et de mettre en place les bases des mesures nécessaires pour compenser pour ces changements*".

Bob Kochtubajda
Secrétaire Correspondant

Lifting Gas for Meteorological Balloons in Canada

by Kenneth A. Devine[1]

Lifting gases, hydrogen or helium, have been used at meteorological stations for filling ceiling and pilot balloons but more particularly for large radiosonde balloons. With the development of the free rising balloon the information derived from these ascents added the third dimension to meteorological measurements and made forecasting possible. Like the present space explorations, unmanned balloon observations by 1892 were taking over from manned meteorological ascents that had been started as early as 1804 by Gay-Lussac and Biot[13].

Since hydrogen and helium are lost from the earth's atmosphere due to their light density, they are respectively: produced chemically or located underground. In 1766 the English chemist Henry Cavendish found that by adding acid to a common metal, gas bubbles formed[16]. This gas, hydrogen, was eleven times lighter than air with a density of 0.09 gm/litre and produced an explosion when a flame was brought near. On the 27th of August 1783 the French physicist Jacques Charles, filled a rubber coated silk balloon with hydrogen. It remained aloft for 45 minutes and landed in a town 15 miles away. Charles had used the action of sulfuric acid on iron fillings to produce hydrogen but it took two days to fill the thirteen-foot diameter balloon. This was just two-and-a-half months after the Montgolfier brothers had sent the first hot air balloon aloft on June 4th. By 1857 hydrogen filled toy balloons made of ox intestine membranes, were being sold in Paris. "Illumination gas" which contained mostly methane (CH_4) like natural gas, was also used as a lifting gas[14] for early meteorological balloons. In 1910 John Patterson, a physicist with the Meteorological Service of Canada (MSC), began sending balloons aloft at Toronto with Dines meteorographs attached in order to determine the temperature profile of the troposphere[1]. Since hydrogen for the balloons was not available in Canada, it was at first generated from aluminum and caustic soda. Later Patterson employed calcium hydride (CaH_2) and water (H_2O) in a generator that was 10" in diameter and 30" high. Pieces of the calcium hydride were dropped into water to produce the hydrogen. The reaction was as follows:

$$CaH_2 + H_2O \rightarrow CaO + 2H_2$$

Due to impurity of the calcium chloride available, 1.4 grams were required to produce hydrogen gas with a lift of one gram. The Dines meteorograph and its protective reed sphere weighed 110 grams. The balloons were inflated with a lift equal to this plus an additional free lift of 250 to 330 grams. The rubber balloons used by Patterson weighed about 300 gm thus requiring a total of about 700 gm of lift.

During the Second Polar Year of 1932-33 a British expedition to Fort Rea, NWT, brought a unique hydrogen generator which had been built by the Royal Airship Works at Cardington, England[4]. The device produced hydrogen by combining boiling caustic soda (NaOH) and finely ground quartz (silicon dioxide, SiO_2). The hydrogen gas was pumped into a reservoir bag in an adjacent building. This technique proved very dangerous due the hot caustic spraying about during the reaction and also due to a leaking reservoir bag which once blew up the building. At the same time the Canadian team under R.C. Jacobsen at Coppermine, NWT, used bottled gas for their balloons that carried Moltchanoff radiosondes and Patterson flashing light meteorographs.

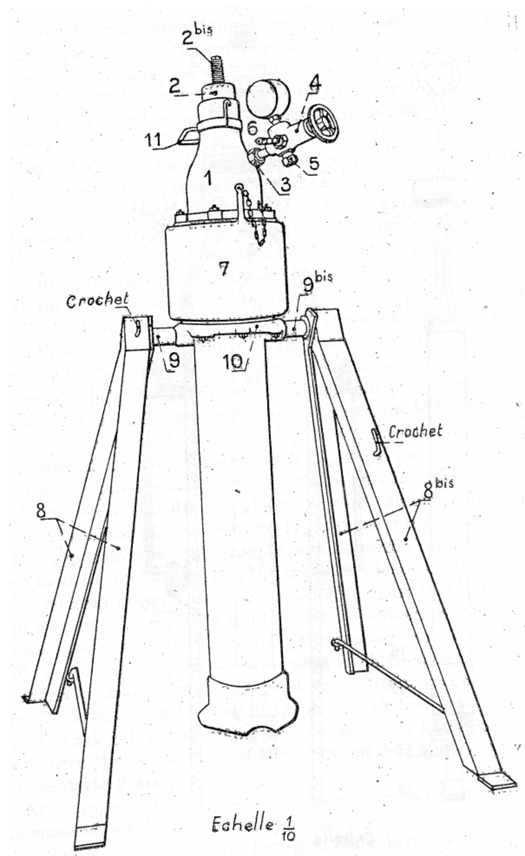

Figure 1. French High-Pressure Hydrogen Generator (La Météorologie, 1932)

[1] Meteorological Instrument Consultant, Aurora, Ontario, Canada

The first Canadian operational radiosonde station was opened in Gander, Newfoundland, in June 1941 using bottled gas. While there was a large increase in the number of radiosonde stations during the war due in part to the US military, many closed in 1945 only to be reopened shortly afterward. The aerological network continued to increase after that time until it reached a maximum of 35 stations in 1954. In 2008 there were 31 regularly reporting radiosonde stations. All of the network reduction has been at the most remote and hence the most expensive stations.

The transportation costs of bottled hydrogen to upper air stations proved to be quite high. A high-pressure gas cylinder weighs 57 Kg but only contains 0.486 Kg of hydrogen[9] or 5.4 m^3 at atmospheric pressure. Hydrogen was first produced locally at Canadian stations in 1943 using chemicals in a high-pressure generator. The high-pressure generator (Figure 1) had been developed in France in 1932[3]. The Pan American Airways generator (Model PAA 1940)[6] used in Canada produced hydrogen at a pressure of 2000 lb/in^2 (psi). A thin replaceable disk in the head of the generating tank would burst and prevent excessive pressures being developed. The German radiosonde station on Spitsbergen during WWII also used the high-pressure system so this technique appears to have been in common use at remote stations. The weight of chemicals being shipped to remote sites was about 1/10 the weight of the gas cylinders. The gas was stored in a bank of interconnected high-pressure cylinders for the subsequent filling of the radiosonde balloons. The chemical amounts used in the high-pressure generators have been variously reported as:

1) 3.5 lb. of ferrosilicon (FeSi was replaced by aluminum in 1943)[2], 7 lb. of caustic soda (NaOH), 4.5 lb. of water;

2) 4 lb. of aluminum, 3 lb. of caustic soda, and 25 lb. of water[6], or

3) 6 lb. of aluminum turnings, 2 to 2.5 lb. flake caustic soda or lye (3.5 lb. in cold weather)[5] with water.

The number of balloons these charges would fill is uncertain but anecdotal information indicated that there was only one reaction per day for the two flights. Also the balloons at that time were smaller considering the small size of the inflation sheds of the period with their six-foot high doors. These early balloons were made of natural rubber and were quite resilient to abrasions during release.

Due to the use of larger balloons for higher heights, the requirement for hydrogen "increased from 70 cu. ft. in 1940 to 120 cu. ft. in 1946"[7] per balloon. This resulted in larger charges in the high-pressure generator and subsequent pressures of 3000 psi. By 1948 ten hydrogen sheds had had fires and the analysis of a major explosion in October 1947[2] indicated that the reaction pressure had reached 5000 psi.

Figure 2. Gill Mark I and Mark II Low-Pressure Hydrogen Generators at Alert about 1963 (Courtesy of Monte Poindexter and the JAWS/HAWS web-site)

The Canadian Mark I[8] low-pressure generator designed by G.C. Gill[7] was first tested operationally at Moosonee, Ontario (Figure 2) in the winter of 1948/49 and had been under development at Toronto since 1945[2]. The maximum pressure was only 8 psi with safety releases. At the normal operating pressure of 2 psi, the balloon inflation took about fifteen minutes and produced 2.8 m^3 of gas. The gas was not stored as the balloon was filled directly from the generator during production. This low-pressure generator could operate at temperatures down to –50°F which was important since the inflation buildings were unheated. One third of all stations were using this safer hydrogen generator by the end of 1951[5] but improvements in operation and design of the high-pressure generators had also reduced their associated mishaps. The high-pressure generator required only about half the chemicals per charge as this new low-pressure generator. The chemical reaction in the low-pressure generator used aluminum pellets (98.5% Al) and caustic soda (NaOH)[11] plus water. The reaction was controlled by having the water drip slowly into the reaction chamber and the equation was as follows[8]:

$$\begin{array}{ccccccccc} 2NaOH & + & 2AL & + & 2H_2O & \rightarrow & 2NaAlO_2 & + & 3H_2 \\ 9 & + & 6.1 & + & 4.1 & = & 18.5 & + & 0.68\ \text{lb.} \end{array}$$

The same chemical reaction was used in both the square Mark I and the round Mark II[11] low-pressure generators. The Mark II generator[10] did not become encrusted internally as quickly as the Mark I, reducing the maintenance cycle. The Mark II was introduced during the 1958 to 1961 period at which time the balloons were using twice as much gas as they had in 1941[12]. Both generators were kept operational at aerological stations for redundancy purposes. At about this time large balloon shelters with fourteen-foot-high doors and a separate generator room were being introduced at the upper air stations in southern Canada.The hydrogen gas in the low-pressure generator was cooled by having the gas pass through tubes in a vertical boiler filled with diesel fuel.

This cooling liquid was later changed to an antifreeze solution. The gas still contained some moisture when it entered the balloon where it would condense. The water would drain down into the neck of the balloon and finally into the supply hose from the generator where it would be removed after the balloon was filled and tied. This moisture, in addition to the comprehensive grounding system, helped reduce the possibility of sparks. A small British electrolytic hydrogen generator had been tested in Toronto for use with pilot balloons in 1934[2]. But finally in the early 1960s the small M-70-600 electrolizer[12] was developed by the Electrolizer Corporation (Figure 3) in Toronto removing the need for chemicals and their associated toxic chemical dumps. This generator was introduced at most stations during the 1965 to 1969 period to replace the low-pressure generators and is used by other countries. A major refit of these units during the 1980s extended the life of the electrolizers to the present and reduced the maintenance requirements.

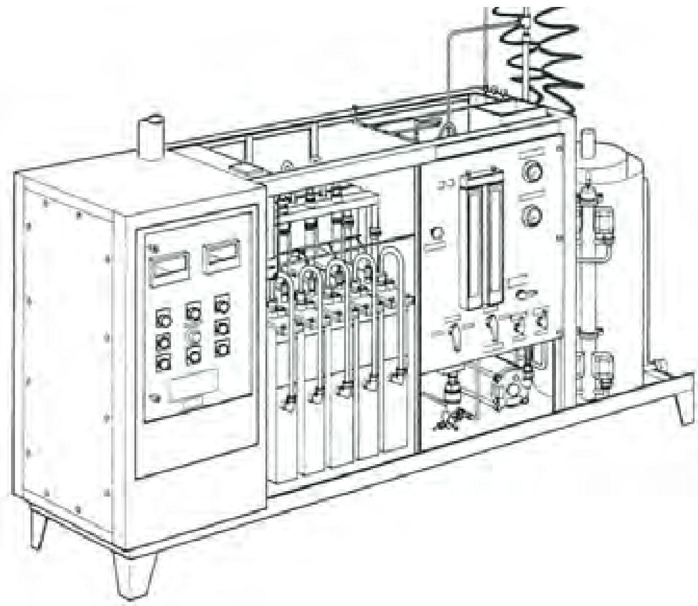

Figure 3. M-70-600 Electrolizer (TM 18-10-01, 1986)

The electrolizer[17] generates hydrogen by using power from the local diesel generators to separate the hydrogen and oxygen from water. A set of five Stuart electrolytic cells with a peak direct current of 250 amperes enables this separation. At maximum output the generator[15] produces up to 0.56 m^3 per hour which is more than enough gas for two flights per day plus some failed releases. A large tank holds 16.9 m^3 of hydrogen at a pressure of 100 lb/in^2, enough for nine balloons.

The other lifting gas, helium, with a density of 0.18 gm/litre, is produced in the earth's crust by the breakdown of radioactive isotopes which produce alpha particles (i.e. helium nuclei). The resulting helium is lost from the atmosphere. Helium was first discovered spectroscopically in the atmosphere of the sun during a solar eclipse in 1868. In natural gas deposits helium is retained if there is a layer of impervious clay above the gas deposit but this is not that common. John Patterson was seconded from MSC in 1917 to work on the extraction of helium during the First World War. This extraction is accomplished by liquefying natural gas under pressure. At the Joint Arctic Stations of Resolute and Eureka, that could be reached by ship, helium cylinders were supplied by the USA for radiosonde operation there and at the other Joint Arctic Stations (JAWS), from the late forties until the 1960s. By 1997 seventeen stations were using helium which had been introduced to many of the southern stations starting in 1989 as the station operations were turned over to contractors.

Since helium cannot react chemically, it is completely safe which is particularly important at stations where less-qualified staff are employed. Helium gas is now used at southern aerological stations where a tanker with one year's supply can be trucked directly to the station (i.e. Fort Nelson). Helium is also supplied in high-pressure cylinders for other southern stations such as Moosonee and Stephenville. The gas is obtained from commercial gas suppliers and the source could be either USA or Canadian natural gas deposits. Pilot balloons (pibal) whose uninflated diameter was 15 cm, were sent up four times a day to record upper winds up to the height at which the balloon disappeared. While pilot balloon observations began irregularly in 1920, the flight of the British airship R-100 triggered regular pibals at a number of stations by 1928[18]. The number of pibal stations in Canada reached a maximum of 71 in 1956 which was the same period when the radiosonde network also reached its maximum size. There have been no regular pilot balloon stations for many years. The pibal wind computation assumed that these 15 cm balloons rose at a constant rate of 180 m/min. The formula used in Canada[9] for ascent rate is:

$$V\ (m/min) = 72L^{0.63}/(L + W)^{0.42}$$

where L = free lift and W = balloon weight, both in grams. To account for irregular ascent in the first few minutes the balloon was released thirty seconds after zero time. The elevation and azimuth angles were measured every minute with a theodolite. The height of the balloon, Z, was computed from the flight time and the assumed ascent rate. The horizontal distance (D) was computed from Zcot(e) where e is the elevation angle. The wind speed and direction were derived graphically using the ground position of the balloon determined from the azimuth angle and distances (D) which were marked on a circular plotting board.Ceiling balloons are 7.5 cm in diameter and rise at a rate of 140 m/min. They are still used at airports to measure daytime cloud heights with bottled helium acting as the lifting gas. Each cylinder will fill about 60 ceiling balloons. The main balloon used for radiosonde flights in 2007 was the Totex TA800[19] which is made from a natural rubber latex compound film. About three of these balloons can be filled from a standard helium high-pressure cylinder. This balloon is designed for a payload of 250 gm. The volume at release is 1.76 m^3 and the nominal atmospheric pressure at burst is 8 hPa or about 33 Km in altitude. The nominal ascent rate is 320 m/min but the measured ascent rates are about 10% lower. The diameter at release is 1.5 m which increases to 7 m at burst. In 2002 the free balloon lift was adjusted to 1100 grams for the 800 gram Totex balloons with the 240 gm Vaisala RS80 radiosonde. The digital RS92 radiosonde which came into service in August 2007 for all stations, has a flight weight of 250 gm. A new hydrogen generator by Proton Energy Systems[20] was tested operationally at Stoney Plain, Alberta, in 2005. This generator is expected to have lower maintenance and has a smaller storage tank than the electrolizer. The Proton Hogen 20 generator uses an ion diffusion technique through a membrane to produce hydrogen at a rate of 0.56 m^3 per hour, the same as the Canadian electrolizer. At the present time (2008) these generators are not being used due to safety issues related to the requirement for a separate building to contain the hydrogen storage tank.

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REMINDER - REMINDER - REMINDER

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

RAPPEL - RAPPEL - RAPPEL

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

The Intergovernmental Oceanographic Commission (IOC) of UNESCO looks from the past to the future[1]

by Geoffrey L. Holland[2]

The IOC held its forty-first Executive Council meeting in Paris, June 22 – July 1, 2008. On its agenda were two related items, one discussing the details for the celebration of its fifty year anniversary in 2010, and the other looking at the future of the organization.

The IOC was established within the United Nations Education, Science and Cultural Organization (UNESCO) following an International Conference on Oceanic Research held in Copenhagen, Denmark, on 11–16 July 1960. The justification for the birth of this new and valuable United Nations organization was based on the need for international cooperation in ocean research, a need that exists to this day. By this act, ocean science took a major step forward in terms of intergovernmental political visibility, reflecting a growing awareness of the strategic importance of ocean science and information and its contribution to the resolution of a broad range of national, regional and global issues. The mandate of the organization has evolved over the years beyond ocean research per se, into areas such as coastal management, ocean health, climate change, ocean services and capacity-building.

As to the future, in the near-term the IOC will remain within UNESCO. Even though the demands for ocean sciences and services are growing even more critical, there is still little appetite amongst governments for the establishment of any new independent intergovernmental organization. Within its parent organization, the IOC is being increasingly recognized by UNESCO Member States as an activity that must be promoted and supported, but more needs to be done.

Nevertheless, despite its small size and limited resources, the IOC has achieved significant progress in terms of intergovernmental cooperation. The IOC has maintained a strong program of capacity building amongst its Member States. As the number of Member States has grown from an initial forty to the present 135, the proportion of those needing scientific and technical assistance has also increased. Donations from Member States to the IOC Trust Fund, or by direct in-kind assistance, have increased the size and value of IOC initiatives. For example, support from the Belgian government has led to the establishment of national ocean data centres in sub-Sahara Africa and a regional cooperative network in ocean knowledge and information.

The IOC operates through the collective efforts of its Member States and programs are also promoted through regional bodies. Again, the lack of resources has also hampered regional developments. Only a few permanent regional secretariat facilities exist. The Sub-Commission for the Western Pacific (WESTPAC), established in 1979, is the strongest of the regional organizations and traces its roots back to a regional investigation of the Kuroshio Current in 1965, with twelve countries participating.

Without the coordinating efforts of the IOC, the international exchange of ocean data would not exist. The International Oceanographic Data Exchange Working Committee (IODE) has a membership based upon representatives from the National Oceanographic Data Centres of participating Member States and has therefore kept current with the methods and operational developments in ocean data. It has recognized and adapted to the innovations brought about by the electronic age and has expanded its role to include information exchange. Automated observations, quality control software, and electronic communications have revolutionized data management. Ocean scientists themselves have gradually moved away from the concept of individual data ownership to an awareness and acceptance of the benefits of rapid exchange and access to data sets of all sources and types. Ocean data and information are essential to the management of our coastal and marine resources.

Information services cannot exist without the observational networks that collect the data. The Global Ocean Observing System (GOOS) and the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM), provide the intergovernmental framework that supports the global ocean system. Regional observation networks, such as the North-East Asia Regional GOOS (NEAR-GOOS) and EUROGOOS, reflect the need for responding to local priorities and needs, and their successes have been followed by other initiatives all around the globe. A tsunami warning system in the Pacific Ocean (ITSU) was established by the IOC as early as 1965, after two devastating tsunamis in that region. Unfortunately

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[1] First published in the *Ship & Ocean Newsletter* (OPRF), September 20th, 2008, Vol.195, (http://www.sof.or.jp/en/news/151-200/195_1.php). A Japanese translation is also available. Reproduced here with the authorization of the author and **O**cean **P**olicy **R**esearch **F**oundation.

[2] CMOS Member; former Chairman, IOC of UNESCO.

governments are slow to recognize the requirement for such networks and it took another disastrous tsunami in the Indian Ocean to galvanize support for the expansion of these warning networks into other world oceans.

The IOC has played a large role in intergovernmental cooperation in ocean science. In 1982, the IOC was a co-sponsor of a conference in Tokyo to study the need for large-scale ocean experiments under the WCRP. This Conference resulted in the largest ocean experiment ever undertaken. The World Ocean Circulation Experiment (WOCE), 1990-1997, which involved the efforts of thirty countries, yielded extremely valuable data. Such research provides the basis for predictions of global and regional climatic variations, and of changes in the frequency and severity of extreme events. A highly successful IOC programme on Harmful Algal Blooms (HAB) has been in existence since 1992, responding to a growing concern with the increase in the global occurrences of these events. These and many other science programmes underpin the knowledge and information services needed for effective management of ocean activities.

Address by Mr. Koichiro Matsuura, Director-General of UNESCO at an IOC Meeting in Paris

As the IOC approaches its fiftieth year, it is disappointing that the IOC does not occupy a larger and more significant role within the UN system. On the other hand, given its relatively small resources, the achievements of the IOC can be considered remarkable.

As to the future, in the opinion of the author there will be a change in the way we address the ocean. In the past we have spent too little time and too few resources in understanding this fundamental element of the planet environment. We must do better. We must recognize our ability to change what, in the past, we have considered unchangeable. We cannot continue to use the ocean with impunity, to disperse our wastes, for maritime trade, to hunt its living resources and to harvest its mineral wealth. We must manage these ocean activities in a sustainable way. Because the shallow coastal regions are the most vulnerable to our activities we are already recognizing and practising integrated coastal management in many areas and these programs must be extended and improved. More importantly perhaps, we must begin to consider ocean management on a grander scale, encompassing not only the coastal regions, but extending our attention beyond national jurisdictions into the international sea. To manage the oceans and coasts effectively, we will need more information and more research and, for the international ocean areas, we shall need intergovernmental agreements.

The UN Convention on the Law of the Sea (UNCLOS) was an epic global agreement, but is already out of date. It does not recognize the potential of new marine resources from the international area, such as genetic resources, international marine protected areas and the use of ocean space. When it was drafted, the environmental issues of climate change, ocean acidification, coral bleaching and loss of marine habitat were not as well known nor as predominant as in the present day.

I believe there will be other new activities to consider in the next fifty years. Eventually, we may learn to farm the seas and increase the protein yield many fold, but it must be done wisely and sustainably. We will turn increasingly to the sea for freshwater and renewable energy. We shall probably build towns and cities on the ocean surface, that are self-sustainable on energy and marine resources. We may genetically alter crops to grow in saltwater environments and will eventually learn to understand the climate engine that is the ocean and to predict climatic and other changes and their impacts.

Will governments recognize the need to provide the necessary resources for cooperative ocean research and the associated regional and global observation networks and information centres, or will it take some disaster, as was the case of the tsunami networks, to generate this attention and, if so, will the response be in time?

Note from the Editor: Please note on the photo opposite the presence of Dr. Savithri Narayanan, Dominion Hydrographer and Director General Ocean Sciences and Canadian Hydrographic Services, sitting as a Vice-President of IOC.

The Lunenburg Bay Project

by John Cullen[1], Alex Hay[1], Hal Ritchie[1,3], Sean Hartwell[1], Stéphane Kirchhoff[1], Tony Bowen[1], Mike Dowd[1], Blair Greenan[2], Jim Hamilton[2], Charles Hannah[2], Marlon Lewis[1], Will Perrie[1,2], Jinyu Sheng[1], Peter Smith[1,2], Helmuth Thomas[1], and Alain Vézina[1,2]

Abstract: The Lunenburg Bay Project concluded in March 2008, having attained its primary goal: the development of Canada's first real-time interdisciplinary ocean-atmosphere observation and forecast system. After five years of successful operation, and through the combined efforts of biological and physical oceanographers and atmospheric scientists from academia, government and industry, the project has significantly advanced the state-of-the-art in marine environmental prediction. The project achieved many of the original objectives of implementing and adapting operational atmosphere, ocean and wave models to conditions of Atlantic Canada, as well as developing observational techniques suitable for adaptation in the next generations of ocean observing systems on a global basis. Improved numerical models for describing and forecasting coastal ocean biological conditions have also been developed, which will be useful for further research and development. Together, these advances will contribute to the detection and prediction of marine conditions including severe cyclonic events in coastal environments and have the potential to make Canada a world leader in real-time ocean analysis and forecasting.

Résumé: [Traduit par la rédaction] Le projet de la baie de Lunenburg, terminé au mois de mars 2008, a atteint son but primaire: soit l'élaboration d'un système canadien interdisciplinaire de prévision et d'observation océan-atmosphère en temps réel. Après cinq années de développement couronné de succès et suite aux efforts combinés des océanographes biologiste et physicien et des scientifiques de l'atmosphère en provenance du milieu universitaire, des gouvernements et de l'industrie, le projet a avancé de façon significative et est à la fine pointe en ce qui concerne la prévision environnementale marine. Ce projet a réalisé plusieurs objectifs initiaux dans l'exécution et l'adaptation de modèles opérationnelles pour l'atmosphère, l'océan et les vagues aux conditions du Canada atlantique. De plus, le projet a développé des techniques d'observation appropriées pour l'adaptation aux futures générations de systèmes d'observation marine sur une base globale. On a aussi développé des modèles numériques perfectionnés pour la description et la prévision des conditions biologiques de la côte océanique, ce qui sera utile pour le futur dans la recherche et développement. Toutes ces réalisations vont contribuer à la détection et la prévision des conditions marines incluant les phénomènes cycloniques sévères dans les milieux côtiers et auront la possibilité de faire du Canada un leader mondial dans la prévision et l'analyse marine en temps réel.

Introduction

The Lunenburg Bay Project, initiated in 2002 with funding from the Canada Foundation for Innovation (CFI) and the Province of Nova Scotia, and supported since 2003 by the Canadian Foundation for Climate and Atmospheric Sciences (CFCAS), is a reflection of longstanding and ongoing cooperation among Dalhousie University, Fisheries and Oceans Canada (DFO), Environment Canada (EC) and private industry.

The primary goal of this project was development of a real-time interdisciplinary prediction capability for the coastal regions of Atlantic Canada, using data assimilative and coupled models guided directly by observations from oceanographic and meteorological instrument arrays. The project included strong commitments to observations and modelling, supported by fundamental research. It was a collaborative effort, beginning in 2003 with 12 principal investigators and 13 subprojects, with additional project elements for data and project management. With the addition of a remote sensing add-on in 2005 and modest reprofiling for a two-year extension, the network ultimately comprised 11 research elements led by 15 investigators, and support elements for field operations, data services and project management.

The primary objectives were:

- To develop an advanced, relocatable, real-time observation and modelling system for coastal and inner shelf environments;
- To use this system to test and improve our ability to predict change on short to medium range time-scales (e.g., days to weeks) in the coastal marine environment.

The network also committed to studying coastal dynamics including: (1) the role of wind-wave forcing on the circulation within relatively shallow bays during storm events; and (2) the dynamics of the flow in tidal channels, the associated ebb tide jet, and their effects on mass and momentum

[1] Dalhousie University

[2] Fisheries and Oceans Canada

[3] Environment Canada

mixing in Lunenburg Bay. The research was by its nature innovative and at the cutting edge: we committed to developing an integrated, interdisciplinary observation and modelling system that reported data and forecasts to users in near-real time. This was a first for Canada, and one of the first in the world. The work involved conducting scientific research, finding technical solutions, and coordinating operational efforts to:

- deploy and maintain a comprehensive coastal ocean observatory and data management system;
- integrate and constantly improve an interdisciplinary environmental modelling system that spanned atmosphere and ocean, treating winds, waves, currents and hydrography, as well as relevant aspects of marine chemistry and biology;
- develop and validate procedures for using novel optical data streams to describe biological variability in coastal waters;
- describe key dynamical processes to improve mechanistic understanding and to promote development of the next generation forecast systems; and
- present data and results to users in new ways, using the internet and other forms of communication.

The project terminated in March, 2008. Its web site is http://cmep.ca/, where the live data feature is replaced by a retrospective simulation of the web site ("Time Machine") as it appeared for any day of its operation, as chosen by the user.

The Integrated Observation and Forecast System

The Marine Environmental Prediction System Lunenburg Bay (MEPS-Bay) observatory included three major components, each including many elements:

1. *Observing Component*: A real-time observation system was deployed in Lunenburg Bay, a typical coastal inlet. Three radio-telemetering moorings and a shore-based meteorological station provided real-time observations of atmospheric forcing and variability in the physical and optical properties of the Bay. The moorings included meteorological instruments and oceanographic sensors to monitor the water temperature, salinity, velocity, surface waves, bottom stress and sea level. Newly developed optical sensors recorded the colour and clarity of the water, which were related to the amount of plant life, suspended sediment and coloured dissolved organic matter in the water. An array of temperature recorders was deployed on one of the moorings to give sub-metre scale measurements in the vertical. At other locations around the Bay, bottom pressure sensors measured sea level and acoustic current meters measured velocity and surface waves. Directional wave measurements were also conducted outside the Bay using a pitch-and-roll buoy. Meteorological sensing systems included a standard weather observing station (XLB) that was established at Battery Point and continues as a project legacy, a weather station with additional visibility sensor for fog on nearby Cross Island, and a wind profiler and radio acoustic sounding system that observed winds and temperature in the marine atmospheric boundary layer from a location near Battery Point. Supplementary specialized microphysical instrumentation for fog measurements produced rich data sets during June 2006 and June 2007 as part of Environment Canada's Fog Remote Sensing and Modelling (FRAM) field experiment. The project also included a Shelf element which provided offshore measurements of temperature, salinity, fluorescence, irradiance and the partial pressure of carbon dioxide in seawater. The direct observations were complemented by a remote sensing program to provide images of sea surface temperature and chlorophyll from ocean colour, archived and also presented as a layer on Google Earth, as well as coastal vector winds from satellite scatterometers.
2. *Communications Component*: Instrument systems were in wireless contact with a base station at Battery Point, which relayed data to an internet connection at the Fisheries Museum of the Atlantic and on to Dalhousie University. Communications were two-way, and instruments could be controlled remotely. Communications with offshore instruments utilized the Iridium satellite network.
3. *Modelling and Analysis Component*: Considerable effort was devoted to the development of state-of-the-art atmosphere, ocean and waves models and data management including presentation, web-based visualization and archiving. Data include measured variables as well as the output of a variety of models in the interdisciplinary modelling system, as described in our Results and Achievements section.

Over the course of the project, elements of the observation and forecast system were integrated and then tested during a demonstration project in 2007 as described below.

Challenges

Despite the technical complexity of the project, and the need to deploy instrument systems in a sometimes harsh coastal environment, the system was successfully developed, then operated for years with few significant delays or interruptions (buoys were hauled out during winter because of ice conditions). There were some failures or losses of instrumentation, including the SeaHorse profiling system in 2003 and 2004, and a radiometer and fluorometer in 2007 (victims of a careless boater). Due to weather and predictable wear and tear, some observing system elements were out of service for periods of time, awaiting repair. Most repairs were completed quickly, and sometimes achieved remotely because real-time information from sensors was provided to a highly-qualified technical team that responded quickly and dependably. The principal investigators developed a strong appreciation for the level of dedication and commitment – both in terms of people and financial resources – required to keep an observing system operational for years on end. We also found out that a system of this complexity requires effective management at all levels — requiring teamwork among technically-proficient personnel. With support from CFCAS and partners in government, the Lunenburg Project developed this management capability.

Results and Achievements

During its five years, the network met the vast majority of its many milestones, mostly associated with individual project elements. More fundamentally, we achieved our ambitious primary goal, the development of a real-time interdisciplinary prediction capability for a coastal region, using data assimilative and coupled models guided directly by observations from oceanographic and meteorological instrument arrays. Specifically:

- The Lunenburg Project generated interdisciplinary forecasts of weather, waves, currents, other ocean conditions and ocean biology — all in near-real time.
- Forecast models from different disciplines were coupled, for example to describe the influences of weather on waves and ocean circulation or the influence of currents on the distributions of phytoplankton.
- High-resolution local models were nested within larger scale models to comprise a regional forecast system.
- Data from the real-time observing system were assimilated — that is, used directly to test and adjust forecasts to improve their accuracy.
- All of this was supported by an interdisciplinary coastal ocean observatory unparalleled in Canada, feeding data in real time to a web-based system that included Google Earth access to data and forecasts, reports to cell phones, and easy downloading of graphics and data.

Also, the Lunenburg Bay Project achieved more than had been originally planned by the addition of 1) a remote sensing component that furnished satellite imagery and data for presentation and synoptic analysis, 2) an enhanced coastal dynamics research element and 3) a shelf processes component that deployed autonomous measurement systems on the Nova Scotia shelf to provide key information on physical and biogeochemical processes in the waters that strongly influence Lunenburg Bay.

Because interdisciplinary observation-based forecasting of ocean processes is in its infancy, there is still much work that needs to be done. Indeed, we succeeded in developing a capability that had not been in the grasp of Canadian science. However, the system that we developed reached only the earliest stages of what could ultimately evolve into an operational capability for monitoring and predicting change in Canadian coastal waters for the protection of coastal communities, ecosystems, and resources, while managing recreational and commercial use.

The following summaries of project elements focus on high-level results that have been, or are ready to be, taken up by user groups for policy development and operational improvements.

Interdisciplinary Modelling System. The Lunenburg Bay interdisciplinary modelling system consists of various multidisciplinary numerical models and an atmospheric model. The atmospheric model is Environment Canada's GEM-LAM, a nested limited area version of the Global Environmental Multiscale (GEM) Model. The ocean circulation model is a five-level nested-grid coastal ocean prediction system known as NCOPS-LB (Figure 1, Yang and Sheng, 2008), which includes DALCOAST3 for the three-dimensional shelf circulation over the Scotian Shelf and the Gulf of St. Lawrence and a z-level ocean model known as CANDIE for circulation over coastal waters and nearby shelf areas. Wave models include a fine-resolution shallow-water SWAN model, nested within coarser-grid, basin-scale WaveWatch 3 (WW3). Ecosystem models include the Biology module and the Diagnostic Bay model. In all, there are 4 nested wave model grids and 5 nested ocean model grids. This system provided the core modelling capability for many of the sub-projects and the Demonstration Project described below.

Coastal Ocean Observatory. Observing system operations made up the backbone of the Lunenburg research project. By deploying the observing system for 6 to 8 months every year over the last 5 years, this project element provided quality data both above and below sea-level to nested atmospheric and oceanographic models to support the novel interdisciplinary forecast capabilities of the Lunenburg Bay Project. This capability is a legacy of the project, and it shows that Canadians can conduct near real-time interdisciplinary coastal observations and forecasts, if and when they decide to do so.

Fundamental Research on Coastal Dynamics. One of the principal goals of this element was to investigate the limits of predictability during intense forcing conditions, and specifically the role of surface gravity wave forcing. We demonstrated conclusively that wave forcing is equally important as the wind forcing during storms in driving circulations over the exposed, relatively shallow bays typical of Nova Scotia's Atlantic coastline. Since wave-forcing is typically not included in the present generation of coastal circulation models, predictions made using these models will consequently be inaccurate. Thus, our work indicates that improved forecasts of currents along the coast during storm conditions require the use of models which incorporate surface gravity wave forcing, a surface gravity wave module, and two-way coupling between waves and currents. With regard to operational requirements and policy development, we note that predictions during storm conditions are needed for a variety of operational requirements including search-and-rescue and oil spill response operations; further, the need for forecasts is often greatest when the conditions are the worst: that is, when the waves are highest. We note that there is at present no model in the nation which has the required capability. Results from this project element are available for development of new Canadian models. There are efforts under way internationally to develop and improve the necessary models, the Delft3d Community Model Development Program being one example, the Community Sediment Transport Model development project in the US being another. The latter is an open source project, and one in which Canada has some involvement.

During the development of the sophisticated nested-grid coastal circulation prediction system for Lunenburg Bay (NCOPS-LB), various components of the system were used in the study of circulation and variability during storms in Lunenburg Bay (Wang et al., 2007), the dispersion and hydrodynamic connectivity of surface waters associated with tidal and wind-driven currents in the Bay (Sheng et al., 2008), and synoptic variability of circulation and hydrography in the Bay affected by the generation and propagation of baroclinic waves (Zhai et al., 2008). Efforts were also made in developing a computationally efficient scheme to assimilate hydrographic observations at moorings in the Bay to a three-dimensional coastal circulation model (Zhai and Sheng, 2008).

Automated Optical Assessment of Biological Variability. We provided validated optical data from the moorings, requiring a great deal of analysis, programming and reprocessing. The legacy data set from Lunenburg now includes the best available continuous estimates of biological variability in the Bay (Huot et al., 2007). This has served as a resource for modelling and will continue to be used in research on bio-optical properties of coastal waters and new approaches to modelling. The data are particularly valuable because they are accompanied by an extensive set of in-situ validation measurements from the field sampling program.

Our analysis of the strengths and limitations of passive optical observations has led to significant advances in the understanding of variability in the optical properties of coastal waters and our ability to detect biological variability. One legacy is the next generation of ocean observatories being developed by our industrial partner, Satlantic. Their LOBO systems rely more on active optical measurements (e.g., fluorometers), which we now know how to interpret more accurately. Ultimately we will combine active and passive measurements to develop even more robust observation strategies. This activity will be associated with planned deployments of the SeaHorse profiling system on the Nova Scotia Shelf, and another legacy of the Lunenburg Project, the Bedford Basin Ocean Monitoring Buoy (BBOMB), being deployed in Halifax.

Integrated Interdisciplinary Observation-Forecast System. Much of the project was devoted to developing individual components of the observation and prediction capability, but as it proceeded, these were joined into an integrated observation, data assimilation, forecasting and verification system that was implemented in a demonstration project that started in June 2007 and continued into the fall. The essential elements included atmosphere, ocean, wave and biology models in a (one-way) coupled system, assimilating Lunenburg Bay data, evaluating skill, and presented on the Lunenburg Bay project web site. During the demonstration period there were interactions with meteorologists at the EC National Laboratory for Marine and Coastal Meteorology in collaboration with the Atlantic Storm Prediction Centre (ASPC), and real-time access to observations, analyses and forecasts through the Lunenburg Bay Project website for evaluation by the ASPC, DFO and other users.

Distribution of Data and Forecasts to the Public and to Researchers. The CMEP-Access / Visualization system developed many innovative capabilities for distributing data and forecasts to the public and to researchers, including a capable web site with easy procedures for graphing and downloading data, real-time displays of environmental measurements through Google Earth, and cell phone access. As planned, our data distribution system moved beyond accessing, processing, presenting and archiving data from the observatory, by providing visualized forecast model output on the website (www.cmep.ca, Figure 2). Several data products, including remote sensing imagery, were provided as layers on Google Earth. The models include the Scotian Shelf and Lunenburg Bay waves model forecast from DFO and the nested-grid coastal circulation prediction system for Lunenburg Bay (NCOPS-LB, see Figure 1). Both the ocean and wave models were very successful at presenting “now-cast” conditions inside Lunenburg Bay (Mulligan et al., 2008); A Ph.D. student, Ryan Mulligan, was able to use our flexible data system to upload his model results to the web site.

Real-time data, accessible on the CMEP web site and on PDA devices, proved to be a valuable asset for observing systems since they provide current environmental conditions as well as status information for the equipment. This has been an invaluable tool for the field operations team in charge of the maintenance of the observing system. During the open house in the town of Lunenburg (entitled “The Underwater Weather”) in September 2007 and during numerous Dalhousie and Bedford Institute of Oceanography open house events, we were able to display our website and our Google Earth graphical interface to the enthusiastic young school crowd. To the public, the observing system in Lunenburg was the visible tip of an information iceberg. Fish harvesters, boaters, surfers, divers, coastal residents and regional students logged on to visit the buoy sites and view the latest conditions. The lobster harvesters of the Lunenburg region always had a keen interest in bottom temperatures as it determined the presence of the resource.

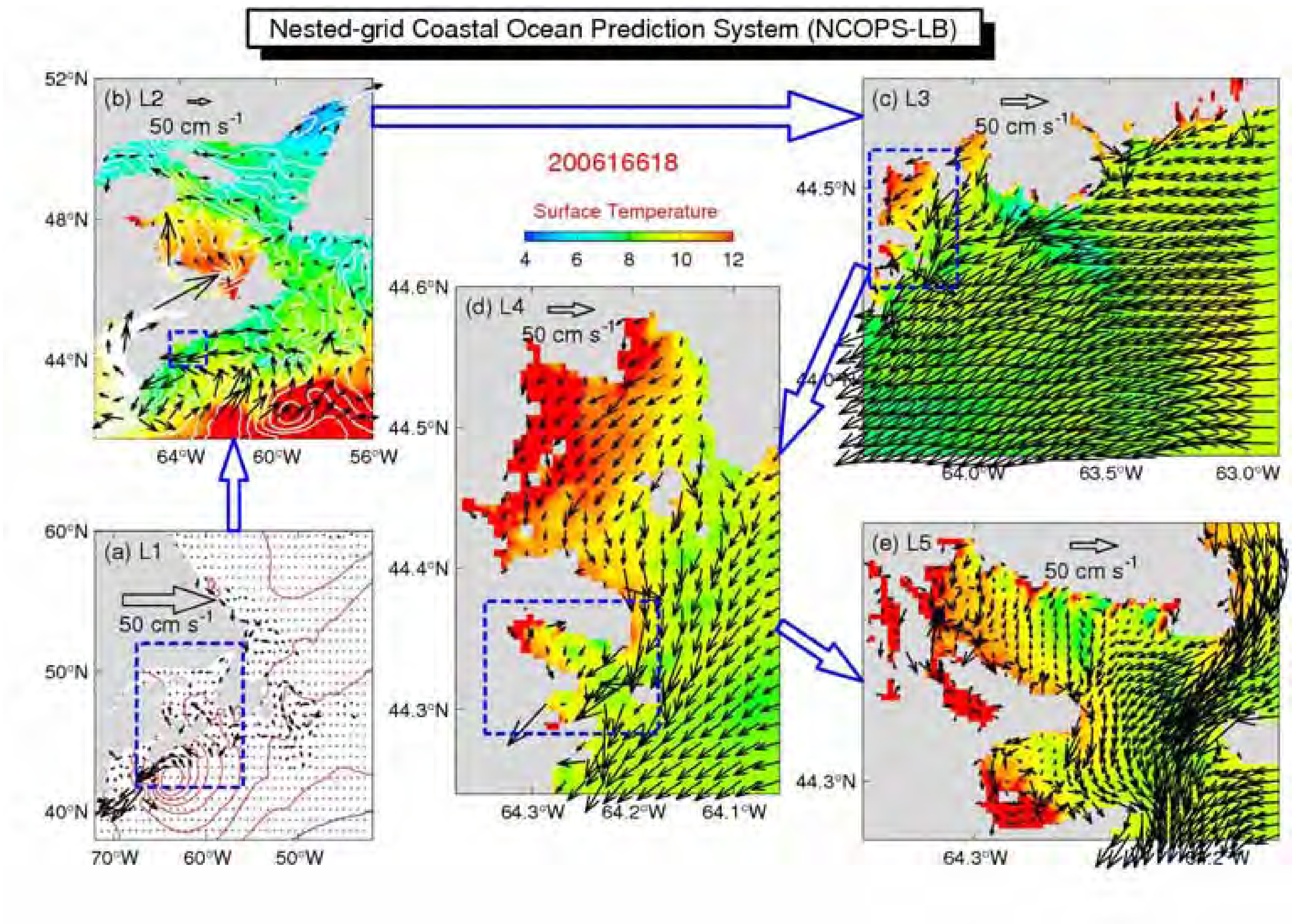

Figure 1. Model results at 1800 June 15 (day 166.75) of 2006 during tropical storm Alberto produced by the nested-grid coastal circulation model (NCOPS-LB, Yang and Sheng, 2008). The centre of the storm at this time was located over the central Scotian Shelf. (a) Simulated depth-mean currents (black arrows) and total surface elevations (red/blue contours for positive/negative values with the contour interval of 5 cm) produced by sub-model L1; (b) surface currents (black arrows) and sea surface temperatures (images) produced by sub-model L2; and (c-e) near-surface (1.5 m) currents and temperature produced by sub-models L3-L5 of the NCOPS-LB in the control run. For clarity, velocity vectors are plotted at every (a) 9th, (b) 10th, (c) 4th, (d) 3rd, and (e) 2nd model grid point.

Data originated from different sources, mainly from the field operations (research buoys, meteorological sensors and discrete field sampling), remote sensing and from model output, spreading across various levels of complexity from raw formats to processed and quality controlled formats. Efforts have been initiated to make the complete datasets and associated metadata available to the general public in co-operation with the Department of Fisheries and Oceans (DFO - ISDM).

This project has made many advances in data management, data visualization and archiving, providing a blueprint for future work in ocean monitoring and forecasting. One of the first tangible outcomes is the utilization of the Lunenburg Project data system as the foundation for a new Dalhousie - DFO collaborative ocean observatory project, the Bedford Basin Ocean Monitoring Buoy (http://cmep.ca/). This system utilizes a remodelled Lunenburg buoy deployed in Bedford Basin, a site which has 40 years of observations by the Bedford Institute of Oceanography. A new, real-time interdisciplinary observation capability is being established at a fraction of the cost of a new ocean observatory, solely because we can use the hardware, expertise and data systems from the Lunenburg Project.

Training of personnel. One of the most important measurable outputs generated by this project element is the training of highly-qualified personnel. The observatory was a test bed for meteorological and oceanographic instruments and their integration; consequently the expertise acquired by the personnel was of much value beyond their training in the operation of individual sensors. The team was often composed of students, interns, young technicians and volunteers. The Lunenburg ocean observatory has without a doubt served as a great learning platform that inspired many to continue working or studying in the field of oceanography.

Upon termination of our project, potential users in Canada did not immediately initiate programs of interdisciplinary marine environmental prediction in the coastal zone, but government laboratories have hired several of our personnel to contribute to their marine modelling efforts. Other students and staff are working on oceanographic and atmospheric projects in Canada and abroad. These researchers, steeped in their Network experience, represent a core contribution to Canada's next generation of ocean and atmosphere modellers and observing system specialists. The training of highly-qualified personnel and advances in novel interdisciplinary modelling are tangible and significant contributions to operational improvements and policy development as government priorities require marine environmental prediction.

Benefits to industry. Companies involved in the making of the various components of the observing system have learned a great deal from this long term monitoring experiment. The constant stress on the components provided important benchmark values that can be used for future product development. We have shared some of the Lunenburg data with Vaisala Inc. on their meteorological sensor, which innovates by having no moving parts. Our interaction and collaboration with Satlantic Inc., based in Halifax, enabled improvements for many of their sensors and the designs of their monitoring buoys. Their next generation monitoring systems, including the Land / Ocean Biogeochemical Observatories (LOBO), have many innovations that are rooted in learning from Lunenburg Bay, and represent a legacy of our project.

Conclusion

Many changes occurring in the ocean and atmosphere have profound effects on our society. A few examples of these include sea level rise, coastal flooding, storm track changes, droughts and harmful algal blooms. Some of these changes are expressed as short-term events related to long-term trends in the climate of the Canadian maritime region. At present, we do not fully understand the magnitude of these changes, their causes and their consequences, which can make it difficult to prepare for and adapt to future change adequately.

Ocean and atmosphere observations are collected at global, national, regional and local scales and impact many facets of our daily lives. At the regional and local scales, the Lunenburg Bay Project has provided significant advances to the oceanographic and atmospheric research community in Canada and globally through the development of new observational and modelling techniques. One of the key benefits of this project has been the training of the next generation of scientists and technical staff who are now capable of applying their knowledge in academia, government organizations and the private sector.

No single agency or organization in Canada has the capacity or resources to implement fully a national interdisciplinary atmosphere-ocean observing system. The demonstration of a successful collaboration in the Lunenburg Bay Project among universities, government agencies and the private sector could provide important lessons as the community moves forward in the development of the next generation of observing systems.

Acknowledgments

This project was a joint effort of more than 100 researchers, technicians, programmers, engineers, postdoctoral fellows, graduate students, summer students and volunteers (listed on our web site, http://cmep.ca/), including many from government agencies who participated with personal enthusiasm mirroring that of their university colleagues, making the project a true partnership. The authors sincerely appreciate the contributions of the Lunenburg Project team members, who — through their dedication, talent and hard work — were essential to the success of this effort. We also acknowledge encouragement and support from DFO, EC and Dalhousie University, coordinated through the Centre for Marine Environmental Prediction Advisory Board, and critical management contributions from Jim Elliott and Raymond St-Pierre. Members of the Canadian Foundation for Climate and Atmospheric Sciences provided excellent guidance throughout.

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This project was made possible through the combined efforts of our sponsors and partners listed below. The authors would like to express their sincere appreciation to these agencies and groups.

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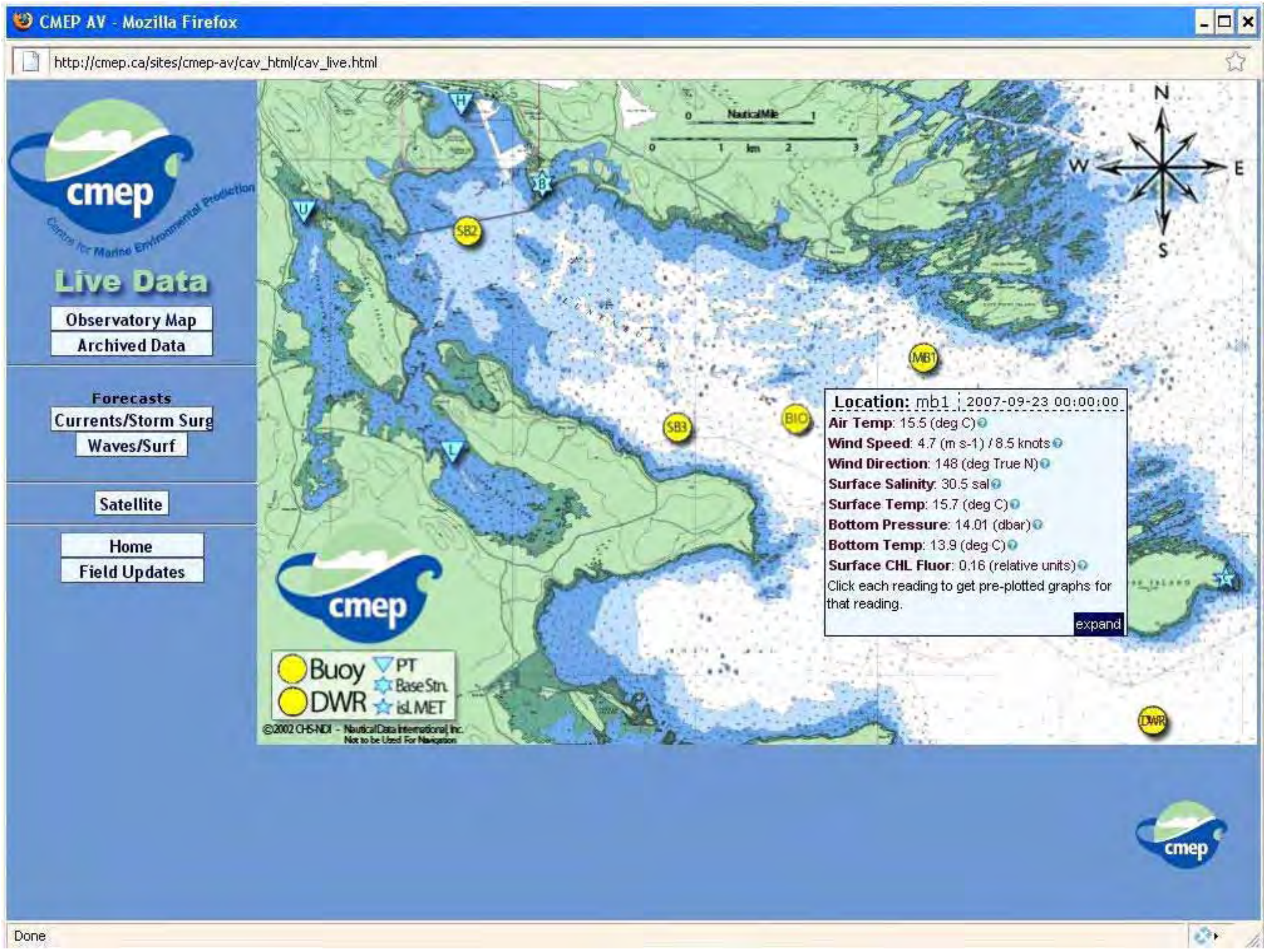

Figure 2: Lunenburg Bay Observatory web page which allowed users to access real-time meteorological and oceanographic data. Instrumentation type is indicated by the legend in the lower left of the image.

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A-O Abstracts Preview

Avant Première des résumés de A-O

The following abstracts will soon be published in your **46-4** ATMOSPHERE-OCEAN publication.

Les résumés suivants paraîtront sous peu dans votre revue ATMOSPHERE-OCEAN **46-4**.

1) Special Section / Section thématique: *Plumes and Gravity Currents in Stratified Environments / Les panaches et les courants de gravité dans les environnements stratifiés*

Transition of Two-Layer Stratified Flow from the Slope of Bottom Topography to a Horizontal Channel

HESHAM FOULI and DAVID Z. ZHU

Abstract
An experimental study was conducted to investigate the transition of two-layer stratified flow from the slope of bottom topography to a horizontal channel. Three experiments, with a reduced gravity of g = 1.64, 6.47 and 18.0 cm s^{-2}, were performed. Particle image velocimetry and planar laser-induced fluorescence were used to obtain the measurements of velocity and concentration fields. The flow rate, obtained from the measured velocity field, increases significantly toward the toe of the topography by almost 40% from that at the sill crest due to the interfacial wave activities. In the horizontal channel, however, the flow rate only increases marginally. Estimates of the composite Froude number indicate that the supercritical flow on the slope of the topography goes through the transition to the subcritical flow in the horizontal channel. The transition is mainly due to the increase in the lower-layer thickness because of increasing internal friction caused by the breaking of interfacial waves, and no internal hydraulic jumps are observed. The measured mean concentration field showed the formation of an intermediate layer of medium density, which increased its thickness with g and helped to suppress turbulence. Spectral analysis of the density interfacial fluctuations indicated that the interfacial waves that developed on the slope of the topography broke up downstream of the toe into smaller amplitude waves at larger frequencies. The waves at several channel cross-sections were also examined.

Résumé
Nous avons mené une étude expérimentale pour examiner la transition d'un écoulement stratifié en deux couches entre la pente de la topographie du fond et un canal horizontal. Nous avons fait trois expériences, avec une gravité réduite de g = 1,64, 6,47 et 18,0 cm s^{-2}. Nous nous sommes servis des techniques de vélocimétrie par images de particules et de fluorescence induite par laser planaire pour obtenir des mesures de champs de vitesse et de concentration. Le débit, déterminé à partir du champ de vitesse mesurée, augmente de façon importante vers le bas de la pente, par près de 40 % par rapport à celui observé à la crête du seuil, en raison des activités de vagues interfaciales. Dans le canal horizontal, cependant, le débit n'augmente que légèrement. Les estimations du nombre de Froude composite indiquent que le débit supercritique sur la pente de la topographie subit la transition pour devenir un débit sous-critique dans le canal horizontal. La transition est principalement causée par l'augmentation d'épaisseur de la couche inférieure sous l'effet d'une augmentation du frottement interne résultant du déferlement des vagues interfaciales, et aucun ressaut hydraulique interne n'est observé. Le champ de concentration moyenne mesurée a montré la formation d'une couche intermédiaire de densité moyenne, dont l'épaisseur a augmenté avec g et qui a aidé à supprimer la turbulence. L'analyse spectrale des fluctuations interfaciales de densité a révélé que les vagues interfaciales qui se sont formées le long de la pente de la topographie se sont brisées en aval du bas de la pente en vagues de plus petite amplitude et de plus grande fréquence. Nous avons aussi examiné les vagues en plusieurs sections transversales dans le canal.

Mixing in Downslope Flows in the Ocean - Plumes versus Gravity Currents

PETER G. BAINES

Abstract
The nature of downslope flows into stratified environments as revealed by laboratory experiments is described, and the results are then applied to interpret particular downslope flows into the ocean. In the laboratory, non-rotating downslope flows can be divided into two main types: detraining gravity currents over sufficiently gentle slopes, where the buoyancy force of the dense downflow is mainly balanced by bottom drag, and entraining plumes over sufficiently steep slopes, where the buoyancy force is balanced by vigorous entrainment of environmental fluid from above. This mixing character of the flow is determined by the bottom slope, the drag coefficient and the buoyancy number $B = QN^3/G^2$, where Q and G are the volume flux and buoyancy of the downflow, and N is the buoyancy frequency of the environment. These experiments may be applied to situations in the ocean where the flow is in approximate geostrophic balance with its transverse pressure gradient, and the parameters are applied to the flow path on the slope. Examples are provided for a number of downslope flows in various locations, including the Red Sea outflow, the Mediterranean outflow into the Black Sea and the Atlantic, the Denmark Strait overflow and the outflow from the Ross Sea.

Résumé
Nous décrivons la nature des écoulements descendants dans les environnements stratifiés en nous basant sur des expériences en laboratoire et nous nous servons ensuite des résultats pour interpréter certains écoulements descendants dans l'océan. Au laboratoire, on peut regrouper les écoulements descendants non rotatifs en deux grandes catégories : les courants de gravité détraînants le long de pentes suffisamment faibles, où la force hydrostatique du courant descendant est principalement équilibrée par la force de traînée contre le fond, et les panaches entraînants le long de pentes suffisamment fortes, où la force hydrostatique est équilibrée par un vigoureux entraînement du fluide environnemental au-dessus. L'importance de ce mélange de l'écoulement est déterminée par la pente du fond, le coefficient de traînée et le nombre de flottabilité $B = QN^3/G^2$, où Q et G sont le flux volumique et la flottabilité de l'écoulement descendant et N est la fréquence de flottabilité de l'environnement. Ces expériences peuvent s'appliquer dans un contexte océanique où l'écoulement est approximativement en équilibre géostrophique avec son gradient de pression transversal et les paramètres sont appliqués au trajet de l'écoulement le long de la pente. Nous donnons des exemples pour un certain nombre d'écoulements descendants en divers endroits, y compris la sortie de la mer Rouge, la sortie de la Méditerranée dans la mer Noire et dans l'Atlantique, les eaux de débordement du détroit du Danemark et la sortie de la mer de Ross.

The Dynamics of Steady, Partial-Depth Intrusive Gravity Currents

M. R. Flynn

Abstract
Experiments of intrusive gravity currents generated by lock exchange offer insights into atmospheric and oceanic flows. However, whereas many previous investigations have considered the 'full-depth' lock exchange problem, in which the intermediate density fluid initially spans the entire channel depth, less is known about `partial-depth' releases, which represent a more appropriate analogue to environmental flows where the inceptive, localized interfacial mixing is relatively weak and/or the upper and lower ambient layers are of significant vertical expanse. Here, we consider this circumstance using a combination of experimental, (two-dimensional) numerical and analytical techniques with a particular focus on equilibrium flow for which there is no auxiliary concentration or dilution of the active scalar, and the interface ahead of the intrusion remains approximately horizontal. In this case, the initial (steady) speed of propagation, U, can be well-predicted by adapting a shallow water model for gravity currents that employs as its front condition the relationship of Benjamin (1968). When, in the initial state, the upper and lower halves of the density field are (stretched) mirror images of one another, the front travels at constant speed beyond 10 lock lengths, as was noted in the case of full-depth lock releases by Sutherland et al. (2004) and Sutherland and Nault (2007). However, when this symmetry is broken either by altering the relative depth of either ambient layer or by changing the intrusion density so that $\varepsilon \neq 0$, the flow begins to decelerate after travelling as few as three lock lengths.

Résumé [Traduit par la rédaction]
Les expériences de courants de gravité inclusifs générés lors d'un échange à une écluse aident à comprendre les écoulements atmosphériques et océaniques. Cependant, alors que plusieurs études précédentes ont porté sur le problème de l'échange à une écluse « sur toute l'épaisseur », dans lequel le fluide de densité intermédiaire occupe initialement toute l'épaisseur du canal, on en sait moins sur les « libérations sur une épaisseur partielle », qui offrent une analogie plus appropriée avec les écoulements environnementaux dans lesquels le mélange interfacial localisé initial est relativement faible et/ou les couches ambiantes inférieure et supérieure ont une extension verticale considérable. Ici, nous étudions cet aspect de la question en nous servant d'une combinaison de techniques expérimentales numériques et analytiques (bidimensionnelles), en portant une attention particulière à un écoulement d'équilibre pour lequel il n'y a pas de concentration ou de dilution auxiliaire du scalaire actif et l'interface en avant de l'intrusion demeure approximativement horizontale. Dans ce cas, on peut prévoir adéquatement la vitesse de propagation initiale (constante), U, en adaptant un modèle d'eau peu profonde pour les courants de gravité qui emploie comme conditions à son front la relation de Benjamin (1968). Lorsque, dans l'état initial, les moitiés supérieure et inférieure du champ de densité sont symétriques (étirées) l'une par rapport à l'autre, le front se déplace à vitesse constante sur plus de 10 fois la longueur de l'écluse, comme cela a été observé par Sutherland et coll. (2004) et Sutherland et Nault (2007)dans le cas d'une libération sur toute l'épaisseur. Cependant, quand cette symétrie est rompue soit en modifiant l'épaisseur relative de l'une ou l'autre des couches ambiantes soit en changeant la densité de l'intrusion pour avoir $\varepsilon \neq 0$, l'écoulement commence à décélérer après n'avoir progressé que d'aussi peu que trois fois la longueur de l'écluse.

Turbulent plumes in stratified environments: A review of recent work

N. B. KAYE

Abstract
This paper reviews recent developments in the theoretical modelling of Boussinesq turbulent plumes in both stratified and unstratified quiescent environments. The review focusses primarily on extensions to the classic entrainment model of Morton et al. (1956; MTT). Recent analytic solutions for the rise height in a stratified environment, for the rise height of turbulent fountains, and for the near-source flow in large area source plumes are reviewed. Extensions to the theory of MTT are then reviewed, including models for plumes with a buoyancy flux that varies with height, and for plumes with a buoyancy flux that varies with time. Recent experimental results are also reviewed and compared to these theoretical developments. Some open questions in turbulent plume theory are then discussed. It is shown that MTT is unable to model the rise of weak fountains satisfactorily and the significance of this result for the rise height of plumes in a stratified environment and, more generally, turbulent mixing at a density interface are discussed. The value of the entrainment coefficient α is also discussed. Methods for measuring α are reviewed and variable entrainment models and their limitations are discussed. Finally, the appropriate values of α for plumes, jets and fountains are discussed.

Résumé
Cet article examine les développements récents dans la modélisation théorique des panaches turbulents de Boussinesq, dans les environnements calmes tant stratifiés que non stratifiés. L'examen se concentre principalement sur les extensions du modèle d'entraînement classique de Morton et coll. (1956; MTT). Nous examinons des solutions analytiques récentes pour la hauteur d'élévation dans un environnement stratifié, pour la hauteur d'élévation des fontaines turbulentes et pour l'écoulement près de la source dans des panaches de sources de grande surface. Nous examinons ensuite des extensions de la théorie de MTT, y compris des modèles pour des panaches avec un flux de flottabilité variant avec la hauteur et pour des panaches avec un flux de flottabilité variant avec le temps. Nous examinons aussi des résultats expérimentaux récents et nous les comparons à ces avancées théoriques. Nous discutons ensuite de certaines questions actuelles dans la théorie des panaches turbulents. Nous montrons que le MTT ne peut pas modéliser l'élévation de fontaines faibles de façon satisfaisante et nous discutons de l'importance de ce résultat pour la détermination de la hauteur d'élévation des panaches dans un environnement stratifié et, plus généralement, du mélange turbulent à une interface de densité. Nous discutons aussi de la valeur du coefficient d'entraînement α. Nous examinons les méthodes de mesure de α et nous discutons des modèles d'entraînement variable et de leurs limites. Finalement, nous discutons des valeurs appropriées de α pour les panaches, les jets et les fontaines.

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2) Regular Section / Section régulière

Study of cloud-to-ground lightning in Quebec: 1996-2005

JACQUES MORISSETTE AND SYLVIE GAUTHIER

Abstract
Using data from Hydro-Québec, a spatio-temporal summary study of cloud-to-ground lightning in Quebec (45°-53°N; 81°-65°W) for the 1996-2005 period was performed on a sample of close to 4 million strokes of lightning. The annual number of lightning strokes and the ratio of negative to positive lightning (76:24) do not differ significantly from one year to the next. Despite the fact that there was an average of 239 lightning days per year, the lightning strokes were concentrated over a period of a few days. Between 1996 and 2005, 50% of total annual lightning was distributed over 11 days, 75% over 25 days, and 90% over 44 days. Overall, the peak in the average annual cycle occurs on July 15. Between 1996 and 2002, the number of days with at least one positive lightning stroke remained higher than the number of days with at least one negative lightning stroke. The tendency reversed from 2003 until 2005. Most of the annual lightning occurred during June, July and August. The average minimum number of lightning strokes per hour occurred at approximately 14:00 UTC, and the maximum number occurred at 21:00 UTC. The percentage of positive lightning strokes remained constant throughout the day.

Both the density and the number of lightning days were mapped out for the 10-year period. The spatial distribution of lightning indicates a higher density in the southern and western parts of the study area with an average of 0.52 to 1.27 lightning strokes km^{-2} yr^{-1}. The St. Lawrence Lowlands ecoregion receives the greatest number of lightning strokes annually (from 0.73 to 1.27 km^{-2} yr^{-1}). The spatial distribution of the number of lightning days per year is approximately the same as that of the density. The same two gradient axes can be observed crossing from north to south and from east to west. The spatial distribution of the percentage of positive lightning strokes varies considerably in the area, ranging from 0 to 65% depending on the location. While the St. Lawrence Lowlands ecoregion has the highest density and highest number of lightning days, it has the lowest number of positive strokes. Additional research must be done to establish a correlation between our results and environmental variables, such as topography and vegetation, as well as the spatial variations of lightning and instances of forest fire.

Résumé [traduit par la rédaction]
À partir des données d'Hydro-Québec, nous avons effectué une étude spatio-temporelle sommaire des éclairs nuage-sol au Québec (45°–53°N; 81°–65°O) durant la période 1996-2005 sur un échantillon de près de 4 millions de

décharges électriques. Le nombre annuel de décharges électriques et le rapport éclairs positifs sur éclairs négatifs (76/24) varie peu d'une année à l'autre. Même s'il y a eu en moyenne 239 jours d'éclairs par année, les décharges étaient concentrées sur une période de quelques jours. Entre 1996 et 2005, 50 % du nombre annuel total d'éclairs étaient distribués sur 11 jours, 75 % sur 25 jours et 90 % sur 44 jours. Dans l'ensemble, la crête du cycle annuel moyen se produit le 15 juillet. Entre 1996 et 2002, le nombre de jours avec au moins une décharge positive est demeuré plus élevé que le nombre de jours avec au moins une décharge négative. La tendance s'est inversée de 2003 à 2005. La plupart des éclairs pendant une année quelconque se sont produits en juin, juillet et août. Le nombre minimum moyen de décharges par heure s'est produit vers 14 UTC et le nombre maximum moyen s'est produit vers 21 UTC. Le pourcentage de décharges positives est demeuré constant durant toute la journée.

Nous avons cartographié à la fois la densité et le nombre de jours d'éclairs pour la période de 10 ans. La distribution spatiale des éclairs révèle une densité plus élevée dans les parties sud et ouest de la région étudiée, avec une moyenne de 0,52 à 1,27 décharge km^{-2} an^{-1}. La région écologique des basses-terres du Saint-Laurent reçoit le plus grand nombre de décharges électriques sur une année (de 0,73 à 1,27 km^{-2} an^{-1}). La distribution spatiale du nombre annuel de jours d'éclairs est approximativement la même que celle de la densité. On peut observer les deux mêmes axes de gradient s'étendre du nord au sud et de l'est à l'ouest. La distribution spatiale du pourcentage de décharges électriques positives varie considérablement dans la région, allant de 0 à 65 % selon l'endroit. Bien que la région écologique des basses-terres du Saint-Laurent ait la plus forte densité et le plus grand nombre de jours d'éclairs, c'est dans cette région qu'on observe le plus petit nombre de décharges positives. D'autres recherches restent à faire pour établir une corrélation entre nos résultats et les variables environnementales, comme la topographie et la végétation, ainsi que les variations spatiales des éclairs et les cas de feux de forêt.

Study Evaluating Regional Atmospheric Water Vapour Estimates Derived from GPS and Short Range Forecasts of the Global Environmental Multiscale Model in Southern Alberta

C.D. Smith, N. Nicholson, S. Skone and G.S. Strong

Abstract
Integrated atmospheric moisture has been derived from a network of Global Positioning System (GPS) receivers established in southern Alberta. GPS receivers and post-processing techniques provide the ability to estimate integrated precipitable water vapour (PWV) at temporal and spatial scales not usually available using conventional observational techniques and without costly expendables. GPS-derived PWV was evaluated during the Alberta GPS Atmospheric Moisture Evaluation (A-GAME) using nearby radiosonde observations from the Airdrie, Olds-Didsbury and Sundre airports during field campaigns in the summers of 2003 and 2004. For the 2004 A-GAME period, the regional (15 km) Global Environmental Multiscale (GEM)-modelled PWV was compared to the GPS-derived PWV using a distance weighting approach. GEM model performance was assessed with regard to prognosis time (from 0 to 9 hours), grid cell elevation, location and the presence of storms in the study region. The results show that there is good agreement between radiosonde-derived PWV and PWV derived from nearby GPS sites with correlations (r^2) ranging from 0.76 to 0.84; the GPS-derived PWV showed a small dry bias averaging 0.6 mm. When compared to GPS-derived PWV, GEM model performance was found to be favourable out to the hour-3 prognosis with an overall correlation (r^2) of 0.63. Performance decreased with increasing prognosis time and as a result of the presence of storm activity in the study region but did not decrease with increasing grid cell elevation.

Résumé
L'humidité atmosphérique intégrée a été dérivée à partir d'un réseau de récepteurs GPS (système mondial de localisation) établi dans le sud de l'Alberta. Grâce aux récepteurs GPS et à des techniques de post-traitement, il est possible d'estimer la vapeur d'eau précipitable (VEP) intégrée à des échelles spatiales et temporelles que ne permettent habituellement pas les techniques classiques d'observation et sans employer de coûteux dispositifs non récupérables. La VEP dérivée par GPS a été évaluée lors du projet *Alberta GPS Atmospheric Moisture Evaluation (A-GAME)* au moyen d'observations par radiosonde faites à proximité, aux aéroports de Airdrie, Olds-Didsbury et Sundre, pendant les études sur le terrain menées au cours des étés de 2003 et 2004. Pour la période A-GAME de 2004, la VEP modélisée par le GEM (modèle global environnemental multi-échelle) régional (15 km) a été comparée à la VEP dérivée par GPS à l'aide d'une technique de pondération en fonction de la distance. La performance du GEM a été évaluée par rapport à la portée de la prévision (de 0 à 9 heures), à l'altitude de la maille de la grille, à l'endroit considéré et à la présence d'orages dans la région à l'étude. Les résultats montrent que la VEP dérivée des sondages concorde bien avec la VEP dérivée des sites GPS à proximité, avec des corrélations (r^2) allant de 0,76 à 0,84; la VEP dérivée par GPS a affiché un léger biais sec de 0,6 mm en moyenne. Par comparaison à la VEP dérivée par GPS, la performance du GEM s'est révélée favorable jusqu'à la prévision pour l'heure 3, avec une corrélation générale (r^2) de 0,63. La performance a diminué à mesure que le temps de prévision augmentait et lorsqu'il y avait de l'activité orageuse dans la région à l'étude, mais elle n'a pas diminué à mesure qu'augmentait l'altitude de la maille.

Atmosphere-Ocean 46-4 Paper Order for which abstracts are reproduced above

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Nominations for the 54th International Meteorological Organization Prize

The World Meteorological Organization (WMO) is requesting that Permanent Representatives of WMO submit nominations for the fifty-fourth International Meteorological Organization (IMO) Prize, which is issued by WMO annually.

The IMO Prize, the most prestigious prize awarded by WMO, serves the purpose of rewarding individuals for outstanding work in the field of meteorology or in any other field referred to in Article 2 of the WMO Convention, which appears in the nomination form. Each member country of WMO may submit several candidatures for the IMO Prize. However, the WMO Executive Council is of the view that nominations should not exceed three candidates.

Detailed guidelines for nominations of this award can be found on the WMO form at:

http://www.cmos.ca/WMO_IMOPrize_forms2009.pdf

Names of suggested nominees should be returned to the office of the Permanent Representative of Canada with WMO (David Grimes), to the attention of Sharon Ribero (see coordinates below), copy to Bruce Angle (Bruce.Angle@ec.gc.ca). Please have suggested nominations for the IMO Prize submitted not later than **January 31st, 2009.**

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Candidatures pour le 54e Prix de l'Organisation météorologique internationale

L'Organisation météorologique mondiale (OMM) demande à ses représentants permanents de lui soumettre des candidatures pour le 54e Prix de l'Organisation météorologique internationale (OMI), décerné annuellement par l'OMM.

Le Prix de l'OMI, le plus prestigieux remis par l'OMM, a pour but de récompenser le travail exceptionnel accompli par un particulier dans le domaine de la météorologie ou dans un des autres domaines mentionnés à l'article 2 de la Convention de l'OMM. Chaque pays membre de l'OMM peut présenter plusieurs candidatures au Prix de l'OMI, mais le Conseil exécutif de l'OMM juge bon de ne pas dépasser trois candidatures.

Vous trouverez les directives détaillées du processus de mise en candidature sur le formulaire de l'OMM à:

http://www.scmo.ca/WMO_IMOPrize_forms2009.pdf

Prière de communiquer le nom des candidats proposés au bureau du Représentant permanent du Canada à l'OMM (David Grimes), à l'attention de Sharon Ribero (coordonnées ci-dessous), avec copie à Bruce Angle (Bruce.Angle@ec.gc.ca). La date limite pour les soumissions est le **31 janvier 2009.**

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Project Atmosphere 2008

Reported by Matteo Babini[1]

For two weeks in July, 2008, I was given the opportunity to learn about the fascinating world of American meteorology through an annual American Meteorological Society (AMS) Education Program workshop titled “Project Atmosphere”. The Program’s new director, Dr. Jim Brey, welcomed the participants: eighteen secondary school teachers from across North America. The workshop, sponsored by the National Oceanic and Atmospheric Administration (NOAA) and the National Science Foundation (NSF), was held at the National Weather Service Training Center (NWSTC) in Kansas City, Missouri. I am a grade 12 geography teacher from École Panorama Ridge Secondary School in Surrey, British Columbia, and the thirteenth Canadian to be selected by the Canadian Meteorological and Oceanographic Society (CMOS) and the Canadian Council for Geographic Education (CCGE) to represent Canada at this event. I was accompanied by teachers from California, Oregon, Colorado, Kansas, Minnesota, Massachusetts, New York, Maryland, Virginia, Tennessee, North Carolina and Delaware.

Topics Covered

AMS staff developed and delivered an intense, interactive fourteen-day workshop covering a variety of subjects. Topics of study included: the atmosphere, oceans, solar radiation, weather, climate, weather systems, clouds, the coriolis effect, El Niño, La Niña, hazardous weather conditions, storms, lightning, hurricanes, tornadoes, automated surface observation systems, aerosondes, radiosondes, radar, weather satellites, satellite imagery, general forecasting and monitoring for aviation purposes. Presentations on the topics listed above were delivered by professionals in the meteorology field. Keynote speakers included: Dr. Louis Uccellini, Director of the National Center for Environmental Prediction (NCEP); Dr. Joseph Schaefer, Director of the Storm Prediction Center in Norman, Oklahoma; and General David L. Johnson, Director of the National Weather Service (NWS) in Silver Spring, Maryland. Unfortunately, Mr. Max Mayfied, Director of the Tropical Prediction Center in Miami, Florida could not be present at the workshop as he was detained by Hurricane Fay.

Some Interesting Facts:

■ The folk wisdom that the southwest corner of a structure is the safest place for shelter during a tornado is FALSE (Schaefer, 2008);

■ The number one greenhouse gas found in the atmosphere is water vapour (Uccellini, 2008);

■ The number one export from Canada is nasty weather (Everyone, 2008);

■ The average warning lead time for tornadoes is 16 minutes, but the longer the warning period the public gets, the less likely they are to heed it (Schaefer, 2008).

Into the Field

Educational modules and a summary of classroom application procedures accompanied each lecture or presentation. Evening sessions allowed for collegial discussion, Royals baseball games, listening to Blues music, and sharing of ideas. I had the opportunity to share British Columbia’s curricular expectations for Geography 12 and Earth Science as well as to answer classmates’ questions regarding our educational and health care systems.

Daily presentations and lessons were further complemented by a field trip to the National Weather Service (NWS) station in Topeka, Kansas, where we had the opportunity to witness real time surface chart and satellite imagery analysis, as well as a radiosonde launch. During our visit the office issued a tornado warning for a few adjacent counties, which instantly appeared on CNN and the weather radios of the affected counties. A second field trip took us to the National Aviation Weather Center in Kansas City, Missouri. There we had the opportunity to observe surface and upper level weather conditions via radar and satellite imagery. Meteorologists work at this facility twenty-four hours a day, seven days a week. It was amazing to discover that there is a satellite that provides a live view of the entire Northern Hemisphere.

What I have brought back

In the end, I learned a great deal about the American education system, I was taught by some amazing teachers and gained new a appreciation for the complexities of weather forecasting.

The information and materials gathered during this two-week experience will be shared with fellow teachers and students in the Surrey School District. My goal is to increase their understanding of the science behind meteorology, promote recent technological advances, and encourage them to further explore and possibly pursue this evolving and influential field.

I am truly grateful to CMOS and the CCGE for supporting my participation in the program. Hopefully, Canadian interest and participation will continue for years to come.

[1] École Panorama Ridge Secondary School in Surrey, British Columbia, Canada

Extreme Events: A Physical Reconstruction and Risk Assessment

by Jonathan Nott

Cambridge University Press, 2006
ISBN 0-521-82412-5, Hardback, US$70

Book reviewed by John Stone[1]

This is an enormously readable book for those who are interested in disasters. However, for those more interested in risk assessment it is, despite its title, less satisfying. The book takes the reader through droughts, floods, tropical cyclones, tsunamis, earthquakes, landslides, volcanoes and asteroids. Many meteorologists may find this list incomplete and be disappointed that there are no discussions on heat-waves, ice and snow storms as well as extreme precipitation events.

Jonathon Nott is a professor of geomorphology at James Cook University in Queensland, Australia whose main interest is the reconstruction of past tropical cyclone climatology. The book introduces the reader to novel sub-disciplines such as paleo-tempestology – the reconstruction of past extreme events from sedimentary or erosional evidence. Most of the examples are from the Southern Hemisphere, reflecting the authors' own research interests.

The author's stated aim in this book is to point out that the risks posed by natural hazards such as hurricanes, floods, droughts, tsunamis and the like must properly be based on long-time records so that the full range or magnitude of natural variability is revealed. Unfortunately, the book is to a large extent blinded by the past, usually taken to be the last five thousand years or perhaps the whole Holocene. Except for a limited discussion at the end of the book, it overlooks the fact that we are now in a period where the past is not a useful analogue for the future. We have taken the planet Earth into unknown territory. The inadequate attention to global warming and the now-imperative need to adapt is the book's biggest weakness.

Weather and climate extremes have always had significant impacts on society and, as climate change progresses, extreme events are likely to pose increasingly difficult challenges. Climate change is expected to give rise to an increase in the frequency and severity of extreme events. Small changes in the averages of many climate variables result in larger changes in extremes. The book draws attention to extreme events in an almost entertaining way. It offers very little regarding how we may respond regardless of whether the events are part of natural variability or as a result of anthropogenic climate change.

For a sense of the book, one may select the chapter on tropical cyclones. The chapter usefully begins with an explanation of tropical cyclones and the factors we believe are crucial to their formation and dissipation - temperatures in excess of 27 °C, frictional coupling with the ocean surface, and shear winds in the upper troposphere as well as the possible influence of large-scale circulation patterns such as the Southern Oscillation and El-Niño.

The author then describes the damage that can be caused by tropical cyclones through the impacts of wind, waves and sea-surges on settlements and the natural environment, and the important roles off-shore bathymetry and coastal topology can play. He makes the interesting point in passing that the damage (measured only in dollars - lives lost are not included) due to land-falling hurricanes in the United States as a function of intensity is exponential. However, there is no elaboration of the fact that hurricanes are not simply meteorological events but occur in the context of development. This is central to any consideration of risk and vulnerability.

Vulnerability is determined by exposure, sensitivity and adaptive capacity. Exposure clearly depends on the meteorological evolution of the event. The author makes an important observation (that is applicable to all extreme events) that the cumulative effect of a short sequence of tropical cyclones can have a far larger impact than if they were spread out over a longer period of time. In other words the frequency of occurrence is critical. Sensitivity and adaptive capacity are both amenable to human intervention. The first depends on factors such as the location of threatened infrastructure (a building close to the tide-line will be more sensitive to any storm surge than one built on a headland). Adaptive capacity depends more on social and economic factors such as the availability of resources, adequate building standards, the provision of social services, the facility to share risk, etc.… Unfortunately, these matters are not discussed in the book.

The book's focus is on the use of paleo-techniques in reconstructing past tropical cyclones. These techniques are clearly valuable in overcoming the short and often subjective human observational record. The author is quite realistic about the inherent difficulties in making such reconstructions such as the erosion of evidence by subsequent wave action. The real shortfall, however, is that this technique is limited to only land-falling hurricanes. For a more comprehensive record we must rely on remote

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sensing observations and data reanalyses which only exist from the middle of the last century.

Results from paleo-studies suggest that there was a distinct change in cyclone frequency between 3,400 and 1,000 years BP but quieter since then. There is some evidence that this has been modulated by El Niño activity and that intense cyclones have occurred in clusters. In comparison, over the last 100 years it is likely that the annual number of tropical cyclones and their destructive potential (a combination of intensity, duration and frequency) in the North Atlantic has recently increased in parallel with the increase in sea-surface temperatures. It is possible that this is just a result of a century-scale quasi-periodicity and a return to the situation at the beginning of the last century rather than climate change. Of particular worry, however, is that it seems there has been a greater increase in the most intense cyclones (category 4 and 5 have almost doubled in number). The correlation with sea-surface temperatures is likely to be important as oceans warm in response to climate change.

Climate change is only dealt with in the last page-and-a-half of the book. I have a sense that may be because the author in fact doubts the evidence. He suggests, for example, that the increase in insured losses from natural hazards is mostly due to “increased population and community vulnerability” and we should be wary of the temptation “to suggest that global climate change may be at least playing a role..”. The author suggests rather that trends that might have been observed in the recent climate record may be part of a natural cycle. We are well aware that there are indeed long-term cycles in some atmospheric variables, but the evidence portrayed in the famous IPCC “hockey stick” diagram, showing that the warmth of the last half century is unusual in at least the previous 1,300 years, is now unequivocal.

In support of the contention that a limited consideration of recent records may give an incorrect impression of the risk of the occurrence of extreme events, the author engages in the search for long-term periodicities but without a detailed discussion of the statistical challenges or any suggestion of the physical processes involved. Unless periodicity can be rigorously established and physically explained, such a search provides little of value in an era of anthropogenically-driven climate change. Climate change poses a threat; we have to treat it as risk management problem. This means we have to thoroughly assess all the available data looking for trends (especially over the past century or so), variability (over all time scales) and sudden regime shifts (or surprises). Unfortunately this book treats these questions in a biased manner. The book may have some value in the classroom but risks giving students a misleading impression of contemporary climate science, and would seem to prepare them more for the past than the future.

Waves in oceanic and coastal waters

by Leo H. Holthuijsen

Cambridge University Press, 2007
ISBN-13 978-0-521-86028-4.
387 pp., Hardback, US$80

Book reviewed by Dr. Ram Yerubandi[2]

Although several books on ocean waves exist, this book is refreshingly new and a welcome addition to that list. This book is useful to anyone who has an interest in ocean waves. It is exceptionally well-organized with key concepts high-lighted using very clear illustrations. As one of the earlier reviewers mentioned, the author’s vast experience, both as a teacher and a leading researcher, shaped the structure and contents of the book. The wind-generated surface gravity waves (ocean waves) were first treated in open ocean and later discussed in more complicated coastal waters. The author presupposes a basic familiarity with mathematics, statistics and physics. The author discusses prediction of ocean waves both in terms of observations and a theoretical framework, and in the end provided a description of SWAN, a popular computer model for predicting waves in the coastal waters.

The author warms up the reader in Chapter 1 with a brief introduction of scales of ocean waves and the structure of the book. In Chapter 2, author introduces ocean waves by reviewing the basic observation techniques. Chapter 3 is one of the most important chapters because it introduces the concept of variance density spectrum to the reader. This is indeed nicely presented, starting with a simple approach from basic description of the waves in terms of wave height and wave period to the more sophisticated variance density spectrum of the sea-surface elevation. This provides the basis for modeling the physical aspects of the waves. Chapter 4 introduces relevant statistical distributions that are used for describing both short- and long-term characteristics of wind waves. Several important concepts, for example estimation of significant wave height from the spectrum, are well discussed. Long-term statistics (wave climate) are dealt with in a succinct manner. This is extremely important to coastal engineers for obtaining design conditions for marine structures. The author finished off the chapter by providing practical information of examples of wave atlases of the world’s oceans.

Wave motion is explained by linear wave theory in Chapter 5 by avoiding unnecessary mathematical derivations which are left to the appendix. Non-linear effects are treated in later chapters. Nevertheless, this chapter is crucial as it explains wave-induced orbital motions, pressure fluctuations, wave energy and propagation. Discussion of

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nonlinear wave theories is limited to classical theories such as Stokes and cnoidal theory for shallow waters. Chapter 6 starts with a review of wave growth in idealized conditions. In these conditions, one dimensional wave spectrum has a universal shape, and the author summarized the historical aspects of the theory very briefly. To consider realistic ocean wave conditions, the energy balance equation is presented in an Eulerian framework, which is used in present day advanced wave modelling. As the author noted, it is indeed one of the most important concepts in the book. In the rest of the chapter, the author illustrates the evolution of the wave spectrum based on the generation, propagation, wave-wave interaction and dissipation. The linear wave theory discussed earlier is extended to include the complex conditions in the coastal waters in Chapter 7. The corresponding phenomena of shoaling, refraction, diffraction, reflection are clearly described. I particularly liked the way wave-induced momentum transport has been discussed and illustrated. The notes in the boxes are very helpful to refresh the concepts.

In Chapter 8 the author extended modelling of waves in oceanic waters to the more challenging modelling in coastal waters. Table 8.1 summarizes the relative importance of various processes in deep and shallow waters. Although modelling waves in coastal waters is conceptually a straightforward extension of modelling of waves in deep water, it needs to account for shoaling, refraction and diffraction. Furthermore, the source terms also have to account for triad wave-wave interactions, bottom friction and surf-zone breaking. This chapter also discusses the changes required to the energy balance equation to accommodate ambient currents. In the last chapter, the physical and numerical techniques of SWAN model are briefly described. This short summary will be very useful to SWAN model users.

Although the book is carefully set with very good illustrations and the text is in general free from errors, there are a number of smaller errors as noticed by the author in his website. Exercises are not provided at the end of the chapters but they are available at the publisher's website, which are of value to the readers to gain deeper insight into the subject matter. The book is strongly recommended to students, as well as atmospheric and oceanographic professionals interested in modelling of wind waves in deep and shallow waters.

The Emergence of Numerical Weather Prediction: Richardson's Dream

by Peter Lynch

Cambridge University Press, 2006, $75
Hard Cover, 279 pages, ISBN 0-521-85729-5

Book reviewed by Loren D. White[3]

This long overdue work is, to a large extent, a book about a book. While dealing in a significant way with the life of Lewis Fry Richardson, the emphasis is clearly on revisiting his remarkable contribution "*Weather Prediction by Numerical Process"* (WPNP), which was first published in 1922. Peter Lynch has provided not only a descriptive analysis of Richardson and his foundational work on the principles of numerical weather prediction, but has shown through modern theory and modeling the genius and the hidden problems in Richardson's attempt. Much of the book is particularly concerned with evaluating the causes of the failure of Richardson's seminal attempt at a primitive equations numerical forecast. The book should be of significant interest to numerical modelers, forecasters, and science history buffs, as well as mathematicians. Lynch is to be commended for his mathematical thoroughness as well as his attention to historical detail. If there is a weakness in the book, it would be that it is somewhat uneven in its difficulty. The fact that such a thorough examination of Richardson's contributions (using a slide rule!) has required the passage of eight decades and development of modern supercomputers is a testimony to the impeccable attention to detail of a man who conducted a large part of his research on sheets of paper in the battle trenches of World War I.

Chapter 1 gives an overview of the state of meteorology in the early 20th century, of the life of Richardson, and of the contents of WPNP. The correspondence between the basic equations of motion as used by Richardson and as commonly represented now is covered in Chapter 2. Following upon the first couple of chapters that are quite easily readable to those with moderate experience in numerical modeling, Chapter 3 is a somewhat jolting headlong dive into application of normal mode theory to atmospheric tides. While the author points out the need "to study the rich variety of oscillations that the atmosphere can sustain", it is not convincingly explained why the discussion then concentrates so heavily with expressions related to extension of the Laplace tidal wave equations. Nevertheless, it is impressive how concisely these equations are manipulated to limiting cases applicable to Rossby waves and gravity waves.

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In Chapter 4 begins a reanalysis of Richardson's integration of the linearized shallow water equations (Chapter 2 of WPNP). Aside from succinctly describing Richardson's "introductory example" model and forecast for comparison to a global barotropic model, Lynch does a remarkable job in pointing out the relation of this chapter to the remainder of WPNP. In a clear case of both how much Richardson was ahead of his time and how important clear communication of scientific ideas is to their advancement, he implies that this example was recognized by modelling pioneers for its value, in contrast to "the remainder of WPNP [which] is heavy going, with the central ideas often obscured by extraneous material". Another interesting aspect, both here and in later sections, is that in many respects Richardson showed a perfectionist tendency to concentrate on use of greater accuracy and precision in his data than were (or are) standard. A particular example of note was his use of a more precise rate of rotation for the earth (using a sidereal day) than is commonly used. Although this introductory forecast produced more physically consistent results than his more well-known primitive equations forecast, he was limited in his application and interpretation by ignorance of the jet stream and assumption of a basically barotropic atmospheric structure within the mid-latitudes.

We are introduced to the numerical methods utilized by Richardson for his classic failed forecast in Chapter 5. In many ways his approach to the problem set the standard for modern numerical modelling using finite difference methods. Richardson later noted how the finite difference method corresponds to using methods from before the development of calculus, "postponing the limit until after the problem has been solved for a moderate number of moderately small differences". Since Richardson had initially developed finite difference methods for application to stresses in masonry dams, one wonders whatever came of his contributions to dam engineering. The analog that Richardson gave between iterative solution of elliptic boundary value problems for partial differential equations and the deliberations of a jury is a useful illustration of the nature of the technique. Besides his application of what is now commonly referred to as a leapfrog time differencing scheme, Richardson also recognized the potential value of implicit schemes, although the resulting systems of equations were quite intractable for his manual computations. There is a good discussion of the Courant-Friedrich-Lewy (CFL) stability criterion in relation to knowledge at the time and Richardson's severe violation of its requirements, although this is shown not to be the primary cause of his failure. Good physical insight is shown in Richardson's recognition of the "need" and usefulness of having at least five vertical layers of equal mass, which brought together contemporary knowledge of atmospheric structure, the standard chart levels of Bjerknes, and the role of Dines compensation.

There is a fascinating discussion in Chapter 6 of the nature of meteorological observations that Richardson had available to him in the early twentieth century. It turns out that the day chosen for the forecast (20 May 1910) was during an intensive observing period over Europe associated with interest in the passage of Halley's comet. Reanalysis of the data available indicates good agreement in the thermodynamic fields, but significant problems in the momentum fields due to the sparseness of data. In Chapter 7 begins an examination of specific problems in Richardson's one-time step "forecast" of tendencies, and speculation on how awareness of an earlier work by Margules might have changed his approach in favour of eliminating the continuity equation.

Chapter 8 examines the role of quasigeostrophic balance in the atmosphere, the desirability of filtering out high frequency oscillations for initialization in the mathematical context of a slow manifold, and the use of digital filtering techniques. These techniques are applied in Chapter 9 to a reconstruction of the 1910 forecast, showing the much more realistic results obtained when the initial fields are more suitably filtered.

A departure begins in Chapter 10 from intensive concentration on the works of Richardson to the fulfilment of his dream by modern computing methods. The author discusses factors behind the first successful numerical forecasts on the ENIAC machine and subsequent growth of the field up to the 1970s, all in relation to the visionary efforts of Richardson. A good summary of the current status of numerical weather prediction (although without specific mention of the specialized case of climate modelling) is given in Chapter 11. Finally, he revisits the "fulfilment of the dream" of Richardson's "forecast factory", bringing together an assessment of his problems, his innovations, and some remarkable similarities between the strategies of his proposed manual forecast factory and the techniques of modern massively parallel computing architectures. A final idiosyncrasy carried over into the book from Richardson's is the listing of a table of notation in Appendix 1 both in English and in an artificial language (Esperanto). This is a nice symbolic nod to Richardson's hope that such an international language would help to bring an era of world peace.

If you are interested in reviewing one of the books listed on pages 213-214 for the *CMOS Bulletin SCMO*, please contact the Editor at the e-mail address provided below. Of course, when completed, the book is yours. The instructions to be followed when reviewing a book for the *CMOS Bulletin SCMO* will be provided with the book. Thank you for your collaboration.

Si vous êtes intéressés à faire la critique d'un des livres listé en pages 213-214 pour le *CMOS Bulletin SCMO*, prière de contacter le rédacteur-en-chef à l'adresse électronique mentionnée ci-bas. Bien entendu, le livre vous appartient lorsque vous avez terminé la critique. Les instructions qui doivent être suivies lors de la critique d'un livre dans le *CMOS Bulletin SCMO* vous parviendront avec le livre. Merci pour votre collaboration.

Paul-André Bolduc, Editor / Rédacteur-en-chef
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Hurricanes: Causes, Effects and the Future

by Stephen P. Leatherman and Jack Williams

Voyageur Press, September 2008, 72 pages, Soft cover, $19.95 CAD, ISBN: 978-0-7603-2992-4

For more information see Voyageur Press' website at www.voyageurpress.com.

Book reviewed by Dov Richard Bensimon[4]

General description of sections and chapters

This book offers a general overview of the phenomenon of hurricanes. It is relatively short (72 pages), and is broken down into 7 chapters.

The first chapter gives a brief overview of some facts related to hurricanes, as well as some mention of historical cases of significance. Chapter 2 discusses some of the basics of how hurricanes form and how they operate. Some very helpful illustrations are found in this chapter to explain the phenomenon further. The following chapter discusses tools that have been instrumental in understanding hurricanes, such as radars, satellite images and hurricane-hunting planes. This is followed by a chapter which discusses forecasting of hurricanes, and some of the challenges that this involves. They also explain how track and intensity of a hurricane are forecast.

Chapter 5 is entitled "Living with Hurricanes" and relates some of the dangers that hurricanes pose (e.g. strong winds, storm surge), while also offering safety tips to readers. Mention is also made of several areas of the U.S. which are particularly vulnerable to hurricanes, such as the Florida Keys, the Texas coast and New Orleans. Recognizing that hurricanes occur in various parts of the tropics across the globe, the authors devote the following chapter to describing the same phenomenon elsewhere in the world. They include a map which shows typical areas in which tropical systems form and typical tracks which they take. The final chapter gives a brief summary of the effect of climate change on hurricanes. It is very succinct, but does a good job of summarizing the current knowledge of the topic.

Comments on style, organisation and readability

This book is short, concise and written in a simple, easy-to-understand language. Being only 72 pages long, it makes for a quick read. The fact that the authors make use of many images to illustrate their explanations is a strong point of this book. The illustrations and photos presented are of a high quality. I found almost no typos or other errors, suggesting that the book was well edited.

The authors are quite knowledgeable on the topic of hurricanes. Dr. Leatherman is the director of the International Hurricane Research Centre at Florida International University. Jack Williams is the public outreach coordinator for the American Meteorological Society. A strong point of this book is the collaboration of two authors who are respectively well-versed in the science behind the phenomenon and explaining this in understandable terms to the public.

The book mostly discusses influences of hurricanes on the U.S., though a chapter is devoted to the same phenomenon elsewhere on the globe (known as typhoons or tropical cyclones).

An interesting aspect of the book is the fact that the authors remind the reader of the dangers associated with hurricanes, but also offer safety tips. They also comment on some consequences of human behaviour to hurricanes. For example, they mention that following the devastation in New Orleans in 2005 caused by the passage of Hurricane Katrina, people could have chosen to turn low-lying areas into parks and restored wetlands (one of several options). However, this is not happening, and they conclude that since people are just rebuilding the city essentially as it was before, it will continue to be a vulnerable area in the U.S. for another disaster.

Overall appreciation and recommendation for specific audiences

This book is good for people in the general public who wish to gain a general understanding of hurricanes, since it is a good, concise summary of what hurricanes are. It can also serve as a good review for meteorologists who haven't had much of a chance to study hurricanes. However, for a meteorologist looking for a comprehensive and in-depth discussion of hurricanes, this is not the best source to go to.

[4] Operational Meteorologist
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Montréal, Québec, Canada

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

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

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

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

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

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

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

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

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

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

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

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

The Dynamics of Coastal Models, by Clifford J. Hearn, Cambridge University Press, ISBN 978-0-521-80740-1, 2008, pp.488, Hardback, US$100.

Basics of the Solar Wind, by Nicole Meyer-Vernet, Cambridge University Press, ISBN 978-0-521-81420-1, 2008, pp.463, Hardback, US$132.

Mesoscale Dynamics, by Yuh-Lang Lin, Cambridge University Press, ISBN 978-0-521-80875-0, 2008, pp.630, Hardback, US$165. 2 copies available.

Chemical Oceanography and the Marine Carbon Cycle, by Steven Emerson and John I. Hedges, Cambridge University Press, ISBN 978-0-521-83313-4, 2008, pp.366, Paperback, US$90. 2 copies available.

An Introduction to Ocean Turbulence, by S. A. Thorpe, Cambridge University Press, ISBN 978-0-521-67680-9, 2007, pp.240, Paperback, US$60.

The Asian Monsoon, Causes, History and Effects, by Peter D. Clift and R. Alan Plumb, Cambridge University Press, ISBN 978-0-521-84799-5, pp.270, Hardback, US$150. 2 copies available.

Large-Scale Disasters, Prediction, Control and Mitigation, Edited by Mohamed Gad-el-Hak, Cambridge University Press, ISBN 978-0-521-87293-5, pp.576, Hardback, US$200. 2 copies available.

Mountain Weather and Climate, by Roger G. Barry, Cambridge University Press, ISBN 978-0-521-68158-2, pp.576, Paperback, US$80.

Aquatic Ecosystems: Trends and Global Perspective, Edited by Nicholas V.C. Polunin, Cambridge University Press, ISBN 978-0-521-83327-1, pp. 482, Hardback, US$160.

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*** Call for Papers ***

43rd Annual Canadian Meteorological and Oceanographic Society Congress

May 31 to June 4, 2009
Halifax, Nova Scotia, Canada

http://www.cmos.ca/Congress2009

The Canadian Meteorological and Oceanographic Society (CMOS) Congress 2009 will be held in Halifax, Nova Scotia, Canada at the World Trade and Convention Centre from May 31 to June 4, 2009. The Congress theme is "*Sea and Sky Come to Life*".

The Congress will feature:

- Plenary presentations by leading researchers;
- Science sessions that highlight top Canadian and international research contributions to climate, meteorology, oceanography, and hydrology, as well as the policy implications of research in these fields;
- An evening lecture of general-interest, open to the public, on the theme of hurricanes;
- A banquet, a hosted lunch, awards of CMOS prizes and the CMOS Annual General Meeting.

Please submit abstracts electronically to the link found on the Congress website (http://www.cmos.ca/Congress2009) after **January 7, 2009** and before the deadline of **February 15, 2009.** You will be asked to submit your abstract to one of several planned sessions that are listed on the website and to specify your preference for either an oral or a poster presentation. An abstract fee of $50 will be charged at the time of submission. Your abstract will be evaluated by the Congress's Science Program Committee and you will be notified by the end of March 2009 if your presentation has been accepted for oral or poster presentation.

Student CMOS members are welcomed and encouraged to apply for a Student Travel Bursary when submitting an abstract.

If you are an exhibitor, an educator, a member of the media, or anyone else with an interest in the meeting, please visit the Congress website

(http://www.cmos.ca/Congress2009)

and contact the Chair of the Local Arrangements Committee for further information.

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*** Appel de soumission des résumés ***

43e Congrès annuel de la Société canadienne de météorologie et d'océanographie

31 mai au 4 juin 2009
Halifax, Nouvelle-Écosse, Canada

http://www.cmos.ca/Congress2009

Le congrès 2009 de la Société de météorologie et d'océanographie (SCMO) aura lieu du 31 mai au 4 juin 2009 à Halifax en Nouvelle-Écosse, Canada, au World Trade and Convention Centre. Le thème du congrès est "*Mer et ciel s'animent*".

Le congrès inclura:

- Des présentations plénières par des scientistes à la pointe de la recherche;
- Des sessions scientifiques accentuant les contributions ultimes de la recherche canadienne et internationale dans les domaines du climat, de la météorologie, de l'océanographie et de l'hydrologie, ainsi que les implications politiques de la recherche avancée dans ces domaines.
- Une présentation en soirée d'intérêt général et ouvert au public sur le thème des ouragans.
- Un banquet, un petit déjeuner accueilli, remise des récompenses SCMO et réunion générale annuelle de la SCMO.

Veuillez soumettre vos résumés électroniquement en utilisant le lien sur le site du congrès (http://www.cmos.ca/Congress2009) entre le **7 janvier et le 15 février 2009**. Vous devrez soumettre votre résumé sous une des nombreuses sessions affichées sur le site et spécifier votre préférence quant à une présentation orale ou une présentation affichée. Des frais de $50 seront chargés au moment de la soumission. Votre soumission sera évaluée par le comité du programme scientifique du congrès qui vous avisera avant la fin du mois de mars 2009 de la décision de présenter votre contribution oralement ou avec une affiche.

Les membres étudiants de la SCMO sont les bienvenus et sont encouragés à appliquer pour une bourse étudiante d'aide au voyage lors de leur soumission.

Si vous êtes un exposant, un éducateur, un membre des médias, ou quelqu'un avec un intérêt pour le congrès, veuillez visiter le site Web du congrès

(http://www.cmos.ca/Congress2009)

ou contactez le président du Comité des arrangements locaux pour obtenir plus d'information.

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A New Eye in the Sky
Jason-2 Mission

The Ocean Surface Topography Mission/Jason-2 satellite was launched aboard a Delta II rocket from Space Launch Complex 2 at Vandenberg Air Force Base, California, on June 20, 2008. On a globe-circling voyage it will chart sea level, a vital indicator of global climate change. The mission will return a vast amount of new oceanographic data that will improve weather, climate and ocean forecasts.


Picture courtesy of NASA/JPL-Caltech

“Sea-level measurements from space have come of age," said Michael Freilich, Director of the Earth Science Division in NASA's Science Mission Directorate, Washington. "Precision measurements from this mission will improve our knowledge of global and regional sea-level changes and enable more accurate weather, ocean and climate forecasts."

Measurements of sea-surface height, or ocean surface topography, reveal the speed and direction of ocean currents and tell scientists how much of the sun's energy is stored by the ocean. Combining ocean current and heat storage data is key to understanding global climate variations. OSTM/Jason 2's expected lifetime of at least three years will extend into the next decade the continuous record of these data started in 1992 by NASA and the French space agency Centre National d'Etudes Spatiales, or CNES, with the TOPEX/Poseidon mission. The data collection was continued by the two agencies on Jason 1 in 2001.

The mission culminates more than three decades of research by NASA and CNES in this field. This expertise will be passed on to the world's weather and environmental forecasting agencies, which will be responsible for collecting the data. The involvement of the National Oceanic and Atmospheric Administration (NOAA) and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) as mission partners on OSTM/Jason 2 helps establish this proven research capability as a valuable tool for use in everyday applications.

OSTM/Jason 2's five primary instruments are improved versions of those flying on Jason 1. These technological advances will allow scientists to monitor conditions in ocean coastal regions -- home to about half of Earth's population. Compared with Jason 1 measurements, OSTM/Jason 2 will have substantially increased accuracy and provide data to within 25 kilometres (15 miles) of coastlines, nearly 50 percent closer to shore than in the past. Such improvements will be welcome news for all those making their living on the sea, from sailors and fishermen to workers in offshore industries. NOAA will use the improved data to better predict hurricane intensity, which is directly affected by the amount of heat stored in the upper ocean.

OSTM/Jason 2 entered orbit about 10 to 15 kilometres (6 to 9 miles) below Jason 1. The new spacecraft will gradually use its thrusters to raise itself into the same 1,336-kilometre (830-mile) orbital altitude as Jason 1 and position itself to follow Jason 1's ground track, orbiting about 60 seconds behind Jason 1. The two spacecraft will fly in formation, making nearly simultaneous measurements for about six months to allow scientists to precisely calibrate OSTM/Jason 2's instruments.

Once cross-calibration is complete, Jason 1 will alter course, adjusting its orbit so that its ground tracks fall midway between those of OSTM/Jason 2. Together, the two spacecraft will double global data coverage. This tandem mission will improve our knowledge of tides in coastal and shallow seas and internal tides in the open ocean, while improving our understanding of ocean currents and eddies.

CNES is providing the OSTM/Jason 2 spacecraft. NASA and CNES jointly are providing the primary payload instruments. NASA's Launch Services Program at the Kennedy Space Center in Florida was responsible for launch management and countdown operations for the Delta II. NASA's Jet Propulsion Laboratory in Pasadena, California, manages the mission for NASA's Science Mission Directorate, Washington.

To learn more about OSTM/Jason 2, please visit: http://www.nasa.gov/ostm

Please note that JPL is managed for NASA by the California Institute of Technology in Pasadena.

10th Anniversary of "The Year of the Ocean" and an Approaching Anniversary for the IOC

Ten years ago the United Nations declared 1998 as "The Year of the Ocean", a celebration that was led by the Intergovernmental Oceanographic Commission (IOC) of UNESCO and was supported by a national Canadian program based in the Department of Fisheries and Oceans. Notable occurrences throughout the world included the Ocean Expo in Lisbon, the formation and report of the Independent World Commission on the Ocean, commemorative postage stamp issues in over one hundred countries, the publication of a coffee table book and the Ocean Charter.

The Ocean Charter was of particular interest to Canada. The Charter was a non-legal document, adopted by the Member States of the IOC, and sent out to governments around the world to be signed as an affirmation of the need to sustain the ocean and its resources. It was signed at a senior political level by eighty or more countries. Canada sponsored the Charter which, in Canada, was signed by the Prime Minister, Jean Chrétien. It was subsequently taken to, and adopted by, the Francophonie countries in their Conference in New York. A less formal Charter, called "My Ocean Charter" was open for public signature and received many millions of signatures around the world.

In 2010, it will be the fiftieth anniversary of the formation of the IOC and plans are getting under way to celebrate that event.

Reported by *Geoffrey Holland*

World Climate Conference - 3

Climate Prediction and Information for Decision-making

Geneva – Switzerland
31 August – 4 September 2009

The First and Second World Climate Conferences (1979 and 1990) played a crucial role in alerting the world community to the need for a better understanding of climate systems, climate change and mitigation of its harmful effects, as well as an assessment mechanism and a framework for policy dialogue. This resulted in the establishment of the Intergovernmental Panel on Climate Change and the United Nations Framework Convention on Climate Change, respectively.

WCC-3 will build on the achievements of the First and Second World Climate Conferences. It will focus on how humankind can benefit from the advances in climate prediction and information services to manage climate-related risks as a way of developing resilience through adaptation. It will urge all countries worldwide to pool their resources and energies.

Together with predictions, climate information helps us manage the risks associated with climate variability — and this enhances our potential to adapt to climate change.

Recent natural disasters which inflicted devastating loss of life and property, and incurred food insecurity, demonstrate the urgency of jointly addressing climate-related risks for the benefit of society. WCC-3 is expected to propose global actions that will enhance the provision of climate prediction and information services and their integration into the decision-making process.

In this way, the world will be made safer, the use of natural resources optimized, food production enhanced and support to disaster risk reduction and adaptation to climate change increased.

WCC-3 will further the dialogue among countries at the 15th session of the Conference of Parties to the UNFCCC (30 November - 11 December 2009), by which they will agree on mechanisms to help meet the global goals of sustainable development.

Source: WMO Website visited 17 October 2008.

3e Conférence Mondiale sur le Climat

La prévision climatique au service de la prise de décision

Genève – Suisse
31 Août – 4 Septembre 2009

Les première et deuxième Conférences mondiales sur le climat, qui ont eu lieu en 1979 et en 1990 respectivement, ont largement contribué à sensibiliser l'opinion publique sur la nécessité d'avoir une meilleure compréhension des systèmes climatiques, du changement climatique et de ses effets néfastes ainsi que de disposer d'un mécanisme d'évaluation et d'un cadre de discussion politique. Elles ont débouché respectivement sur la création du Groupe d'experts intergouvernemental sur l'évolution du climat et de la Convention - cadre des Nations Unies sur les changements climatiques.

La troisième Conférence mondiale sur le climat va s'appuyer sur les réalisations des première et deuxième éditions. Elle sera consacrée à la manière dont l'humanité peut bénéficier des progrès accomplis dans les services de prévision et d'information climatiques afin de gérer les risques liés au climat et d'accroître la résilience par l'adaptation. Elle appellera les nations du monde entier à mettre en commun leurs ressources et leurs énergies.

Les récentes catastrophes naturelles qui ont entraîné des pertes humaines et matérielles considérables et fait surgir le spectre de l'insécurité alimentaire ont démontré l'urgence d'adopter une approche conjointe dans la gestion des risques d'origine au service des sociétés. La troisième Conférence mondiale sur le climat devrait proposer des actions à l'échelle mondiale visant à promouvoir les services de prévision et d'information climatiques et à mieux les intégrer dans les processus de décisions.

Conjuguées aux prévisions, les informations sur le climat nous aident à gérer les risques associés à la variabilité climatique et nous permettent ainsi d'accroître notre potentiel d'adaptation au changement climatique.

De telles mesures devraient permettre d 'accroître la sécurité dans le monde, d'optimiser l'utilisation des ressources naturelles, d'accroître la production alimentaire ainsi que le soutien à la réduction des risques de catastrophes et à l'adaptation au changement climatique.

La troisième Conférence mondiale sur le climat encouragera le dialogue entre les pays participant à la quinzième session de la Conférence des Parties à la CCNUCC (30 novembre – 11 décembre 2009) afin que ces derniers conviennent de mécanismes visant à atteindre les objectifs mondiaux en matière de développement durable.

Source: Le site web de la WMO visité le 17 octobre 2008.

Prix Acfas – Michel-Jordant 2008
Sciences de l'environnement

René Laprise
Université du Québec à Montréal

L'Association francophone pour le savoir (Acfas) a décerné le prix Michel-Jordant 2008 (Sciences de l'environnement) au professeur René Laprise de l'Université du Québec à Montréal.

La plus grande contribution du lauréat a été de poser les bases de la modélisation climatique régionale en tant que discipline scientifique. Les méthodes numériques qu'il a mises en place sont aujourd'hui adoptées, entre autres, par le Canada, le Japon, la France et les États-Unis.

Le prix Acfas - Michel-Jurdant 2008 a été remis à René Laprise, professeur au Département des sciences de la Terre et de l'atmosphère de l'Université du Québec à Montréal. La photo est de Nathalie St-Pierre.

En tant que membre du Groupe d'experts intergouvernemental sur l'évolution du climat (GIEC), il est l'un des lauréats du prix Nobel de la paix 2007, attribué *ex aequo* au GIEC et à Al Gore. Son expertise lui a valu d'être un des principaux auteurs, et unique Québécois, du 4^{e} rapport d'évaluation du GIEC, dans lequel des experts du monde entier affirmaient que les activités humaines avaient des conséquences incontestables sur le climat.

René Laprise oeuvre dans les domaines de la dynamique de l'atmosphère, de la science du climat, des méthodes numériques de discrétion et de simulation de l'environnement physique. Ses travaux ont permis la mise au point d'une méthode unique de modélisation de la dynamique de l'atmosphère à l'échelle régionale. Avant d'aboutir au Modèle régional climatique canadien (MRCC), René Laprise a dû réaliser des travaux pour convertir les équations de dynamique de l'atmosphère de l'échelle globale à l'échelle régionale. Puis il a développé une technique de contre-vérification, appelée le protocole *Big Brother*, qui est devenue un champ d'études.

Au cours de sa carrière, René Laprise a aussi fait preuve d'une remarquable force fédératrice. Dès les années 1990, il crée le Réseau canadien de modélisation régionale du climat, un groupe d'une quinzaine de chercheurs, puis, en 2003, il fonde le Centre pour l'étude et la simulation du climat à l'échelle régionale (ESCER). Par la suite, le lauréat contribuera à l'implantation d'une chaire de recherche du Canada en modélisation régionale du climat à l'UQAM. Enfin, toutes ces initiatives ont conduit à la fondation du groupe Ouranos, auquel il participe activement en tant que collaborateur de l'axe "Recherche en modélisation climatique régionale".

René Laprise s'est fait remarquer notamment par son dynamisme, ce qui lui vaut aujourd'hui de jouir d'une importante reconnaissance au sein de la communauté scientifique. Mais surtout, il faut souligner sa contribution à la prise de conscience collective actuelle des effets néfastes des changements climatiques et de l'importance cruciale de développer des stratégies préventives de prévention.

Fait à souligner, René Laprise a été nommé *Personnalité de l'année 2007 La Presse/Radio-Canada* dans la catégorie

Sciences humaines, sciences pures et technologies.

Nos sincères félicitations au nouveau lauréat, René Laprise, de la part de toute la communauté de la SCMO.

A.G. Huntsman 2008 Award

The Huntsman Foundation is pleased to announce that the winner of the 2008 A.G. Huntsman Award is Dr. Roger François for his groundbreaking research and leadership in marine geochemistry. The medal was presented to Dr. François Thursday on November 27 in the main auditorium of the Bedford Institute of Oceanography, Halifax, Nova Scotia.

Dr. François holds a Canada Research Chair in the Department of Earth and Ocean Sciences, University of British Columbia. Dr. François obtained his PhD from the University of British Columbia in 1987 and spent the subsequent fifteen years of his career at the Department of Marine Chemistry and Geochemistry at the Woods Hole Oceanographic Institution, where he is still an adjunct scientist. He has been actively involved in large international programs with a biogeochemical focus, such as JGOFS and GEOTRACES.

Dr. François' research is centered at the intersection of physical, chemical and biological processes and has influenced our understanding of climate-related changes in ocean circulation and ocean chemistry. His research has focussed partly on the global carbon, nitrogen and silica cycles (past and present), and more recently on the global biogeochemical cycling of metals. He has been particularly innovative in applying novel techniques to address processes that have occurred in the past million years. Specifically, he has developed the use of light stable isotopes for understanding algal production and nutrient cycling in the ocean, and for determining past changes in water column stratification. Additionally, he has developed tracers that have paved the way for the reconstruction of past ocean circulation and its impact on global climate and his innovative techniques for measuring sedimentation processes are being used to explore the history of sediment burial. Dr. François is internationally renowned for his deeply insightful research in marine biogeochemistry, his innovative skill in data acquisition and analysis, and his interpretation of the complex behaviour of the ocean–atmosphere system over long-term climatic time scales.

Reported by *Alain Vézina*
Bedford Institute of Oceanography
President, Huntsman Foundation and Administrator of the Huntsman Award for Excellence in Oceanography

In Memoriam: Professor Warren S. Wooster

Professor (Emeritus), School of Marine Affairs, University of Washington, Seattle

Professor (Emeritus), School of Aquatic and Fishery Sciences, University of Washington, Seattle

Warren Wooster passed on last October 29 in Seattle, USA. He was one of the fathers of SCOR, PICES and he was the first Secretary of IOC almost 50 years ago. We lost one of the outstanding promoters of international oceanography and of mutual assistance, particularly with Latin America. Being a chemical oceanographer, he was one of the few great scientists who brought together physical, chemical and biological oceanography in support of fisheries science.


Professor Warren S. Wooster

Warren Wooster received his Bachelor of Science degree in Chemistry from Brown University in 1943; a Master of Science degree in Chemistry from California Institute of Technology in 1947 and his Doctorate in Oceanography from the University of California (UCLA/SIO) in 1953.

After having been professor at the Scripps Institution of Oceanography, 1963-1973, Warren became the Dean of the Rosenstiel School of Marine and Atmospheric Sciences of the University of Miami, 1973-1976, and later the Director of the Institute of Marine Studies of the University of Washington. He was appointed Professor Emeritus in the School of Marine Affairs of the University of Washington (1991-2008) and the School of Fisheries. Prior to this appointment, he had served as the director of the University of Washington's Institute of Marine Studies from 1979-1982 and was a professor in this same department from 1976 to 1991.

Warren served as President of the Scientific Committee on Oceanic Research (SCOR),1968-72; as President of the International Council for the Exploration of the Sea, 1982-85. He was instrumental in the creation and development of PICES (North Pacific Marine Science Organization), serving as its Chairman from 1992 to 1996.

From 1960 until 1963, Warren served as the first Executive Secretary of the Intergovernmental Oceanographic Commission, of UNESCO in Paris. Warren began his tenure as Executive Secretary of the IOC by coordinating the International Indian Ocean Expedition. The idea for the project was born during the 1957-58 International Geophysical Year and grew from a one-year survey to a six-year multi-disciplinary research program. Wooster, along with Roger Revelle, George Deacon, and Anton Bruun, realized that a program of this scope and complexity required governmental approval and commitments. With his typical wit, Warren wrote at the time: *"I think the International Indian Ocean Expedition was the greatest uncoordinated expedition in oceanographic history. I ought to know. I was coordinator part of the time. It was the only way to explore such a region. Scientists with curiosity would not have come in, if it had been done any other way*".

Warren's professional memberships included the International Council for the Exploration of the Sea, the Ocean Sciences Board of the National Research Council (chairman), the National Advisory Committee on Oceans and Atmosphere, president of the Scientific Committee on Oceanic Research, and chairman of the University National Oceanographic Laboratory System. Wooster was a Fellow of the American Geophysical Union and the American Meteorological Society.

Warren's major recent scientific interests involved long-term variations of circulation features in the world ocean and their relationships with the variability of biota and fisheries, and management of fishery science and marine resources. He was the author of more than 100 scientific publications. In his web-page he summarized what, in his view, were his main drivers in science:

"*I have long been involved in exploring the role of international institutions that promote scientific studies of the ocean and the application of their findings to the rational use of living marine resources. These institutions are either intergovernmental or non-governmental, and global or regional. My experience has been with organizations in all these categories, including the Intergovernmental Oceanographic Commission of Unesco, the Scientific Committee on Oceanic Research, the International Council for the Exploration of the Sea (ICES), and most recently the North Pacific Marine Science Organization (PICES).*

While these organizations have dealt with the generation of scientific information relevant to the management of fisheries, they do not have management responsibilities. One dilemma has been to bridge the gap between the academic study of ocean characteristics and populations and the practical and political problems of determining and establishing allowable catch rates. Crossing this bridge is more salient than ever with recognition of the need for ecosystem management and growing awareness of the influence of environmental variations on the abundance and distribution of fish stocks. My interest in these questions is illustrated in the attached list of recent publications". [Not shown here].

Warren trained many doctoral and masters students and kept extremely active in the national and international Marine Sciences scene. Even after the University of Washington granted him a well-deserved Emeritus Professorship, his list of recent publications gives ample evidence of his engagement and untiring energy and vitality.

Last Monday, 27 October, I was in Dalian participating in the 2008 ceremony of the Warren Wooster award, granted this year to Professor Charlie Miller of Oregon State University. Warren sent a written message that was read by the Chairman of PICES. Alex Bychkov, PICES Executive Secretary, sensed a bad omen when he commented that Warren had only sent a brief written message instead of a video or a sound message as requested......*"if he doesn't even feel in the mood to do this, he must be very down*". As events happened, he was right. This is a major loss for international cooperation in oceanography and marine sciences in general. We certainly will miss Warren's warmth and jovial personality and his fast and sharp sense of humour.

Dear Warren, Rest in Peace.

Patricio A. Bernal
Executive Secretary of IOC

Source: IOC website visited November 6, 2008.
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Canadian scientists discover snow falling from Martian clouds

TORONTO, September 29, 2008 – A team of Canadian scientists, led by York University, has discovered snow falling from Martian clouds – a first in observations from the surface of the red planet. A laser instrument designed to gather knowledge of how the atmosphere and surface interact on Mars, detected snow from clouds approximately four kilometres above the NASA Phoenix spacecraft's landing site. Data show the snow vaporizing before reaching the ground.

"Nothing like this view has ever been seen on Mars," said York University professor Jim Whiteway, lead scientist for the Canadian-supplied meteorological station on Phoenix.

"We'll be looking for signs that the snow may even reach the ground," said Whiteway, who announced the findings today during a news briefing at NASA's Washington headquarters.

The meteorological station gathers crucial information about the climate on Mars, and provides a comprehensive picture of the atmosphere at the landing site, 1,200 km from the planet's north pole. It consists of temperature, wind, and pressure sensors, as well as a laser-based-light-detecting-and-ranging (lidar) system. The lidar shoots pulses of laser light into the Martian sky, precisely measuring components of the atmosphere such as dust, ground fog, and clouds, from the surface up to a range of 20 km.

Il neige sur Mars !

De la neige tombant des nuages au-dessus de la planète Mars a été observée par la station météorologique canadienne installée à bord de la sonde Phoenix de la NASA. Les cristaux observés se sont toutefois évaporés avant d'atteindre la surface de la planète Rouge. C'est le lidar (un instrument laser qui recueille des informations sur les interactions entre l'atmosphère et la surface de Mars), conçu par le Canada, qui a détecté la présence de neige à quatre kilomètres au dessus du site d'atterrissage de Phoenix. D'après Jim Whiteway, de l'Université de York, nous n'avons jamais rien vu de tel sur Mars. Et toujours d'après le Dr. Whiteway, ils allaient chercher des indices révélant que la neige pourrait même atteindre le sol !

Extrait du site web de Radio-Canada avec la Presse canadienne et l'Agence spatiale canadienne

At the briefing, NASA also announced that experiments have provided evidence of past interaction between minerals and liquid water, processes that occur on Earth.

Experiments also yielded clues pointing to calcium carbonate, the main component of chalk, and particles that could be clay. Most carbonates and clays on Earth form only in the presence of liquid water.

Since landing on May 25, Phoenix confirmed that a hard subsurface layer at its far-northern site contains water-ice. Determining whether that ice ever thaws would help answer whether the environment there has been favourable for life, a key aim of the mission.

The Phoenix mission, originally planned for three months on Mars, has begun its fifth month. However, it faces a decline in solar energy that is expected to curtail and then end the lander's activities before the end of the year.

The lander's meteorological component is a collaboration led by York University, in partnership with the University of Alberta, Dalhousie University, the University of Aarhus (Denmark), the Finnish Meteorological Institute, MDA Space Missions, and Optech Inc., with $37 million in funding from the Canadian Space Agency. The mission is a joint project of NASA's Jet Propulsion Laboratories and the University of Arizona.

Source: York University website visited early October 2008.

It must be noted that the Phoenix Mars Mission has now ended as the spacecraft has gone silent since November 2.

Australia taking climate change seriously

Australia may have scored a first by entering a climate change forecast in a land planning judicial decision. The Victorian Civil and Administrative Tribunal overturned a planning permit application granted by South Gippsland Shire Council to build six seaside homes on low-lying land in Toora. Their decision was based, in part, on projections that sea-level rises associated with climate change would make the land unsuitable for housing. More information at: http://www.theage.com.au/environment/climate-guide-call-for-coastal-homes-20080805-3qj5.html

Australia – The Victorian state Government, has also established a Climate Change reference Group to " provide advice to government on climate change policy in the context of a national Carbon Pollution Reduction Scheme, opportunities for Victoria in terms of innovation, technology and industry, and the type of support and assistance our vulnerable communities will need to make the transition to a low-carbon economy" (Victorian Premier, Mr. John Brumby). For more information, please consult: http://www.premier.vic.gov.au/newsroom/climate-change-reference-group-to-provide-expert-independent-advice.html

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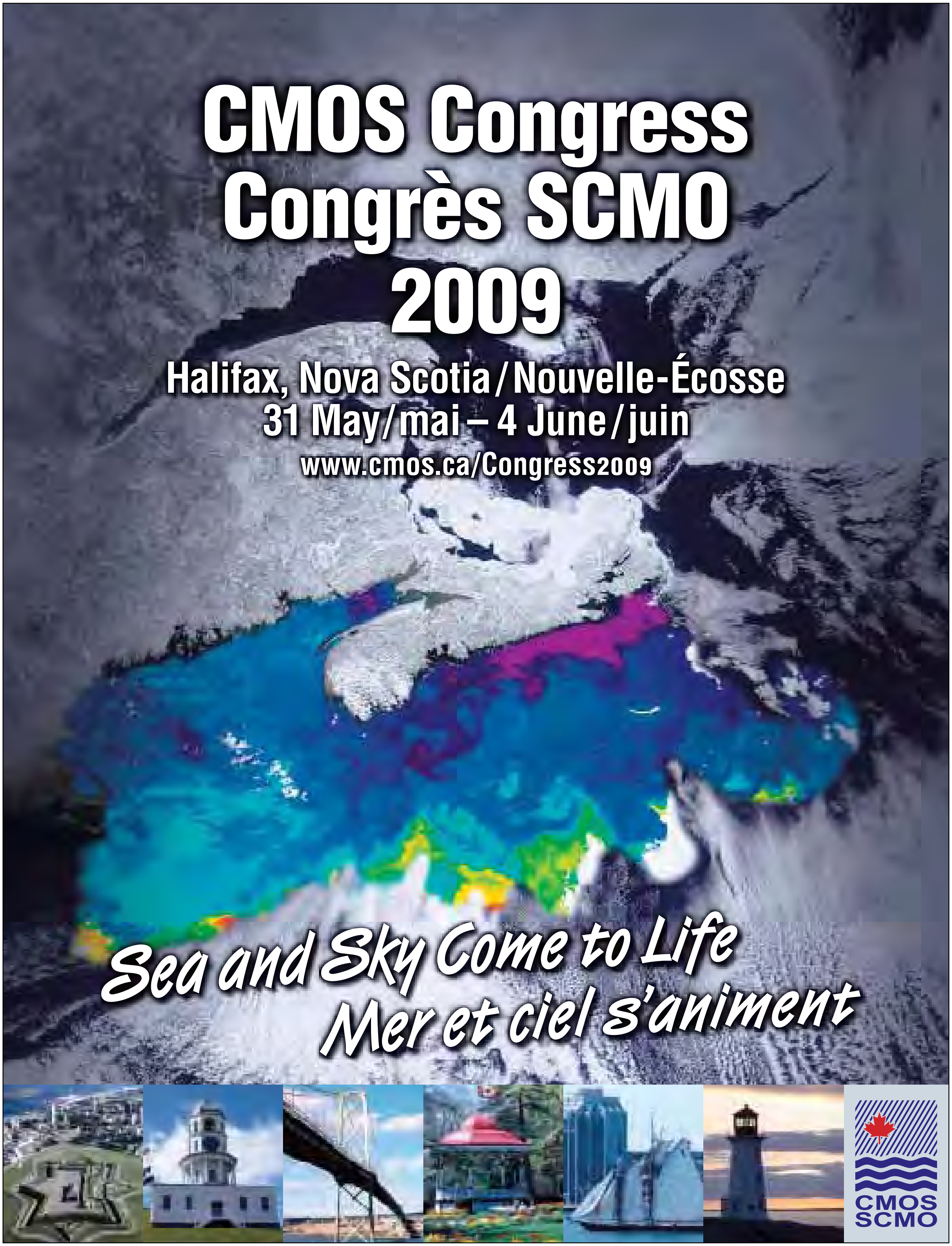

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