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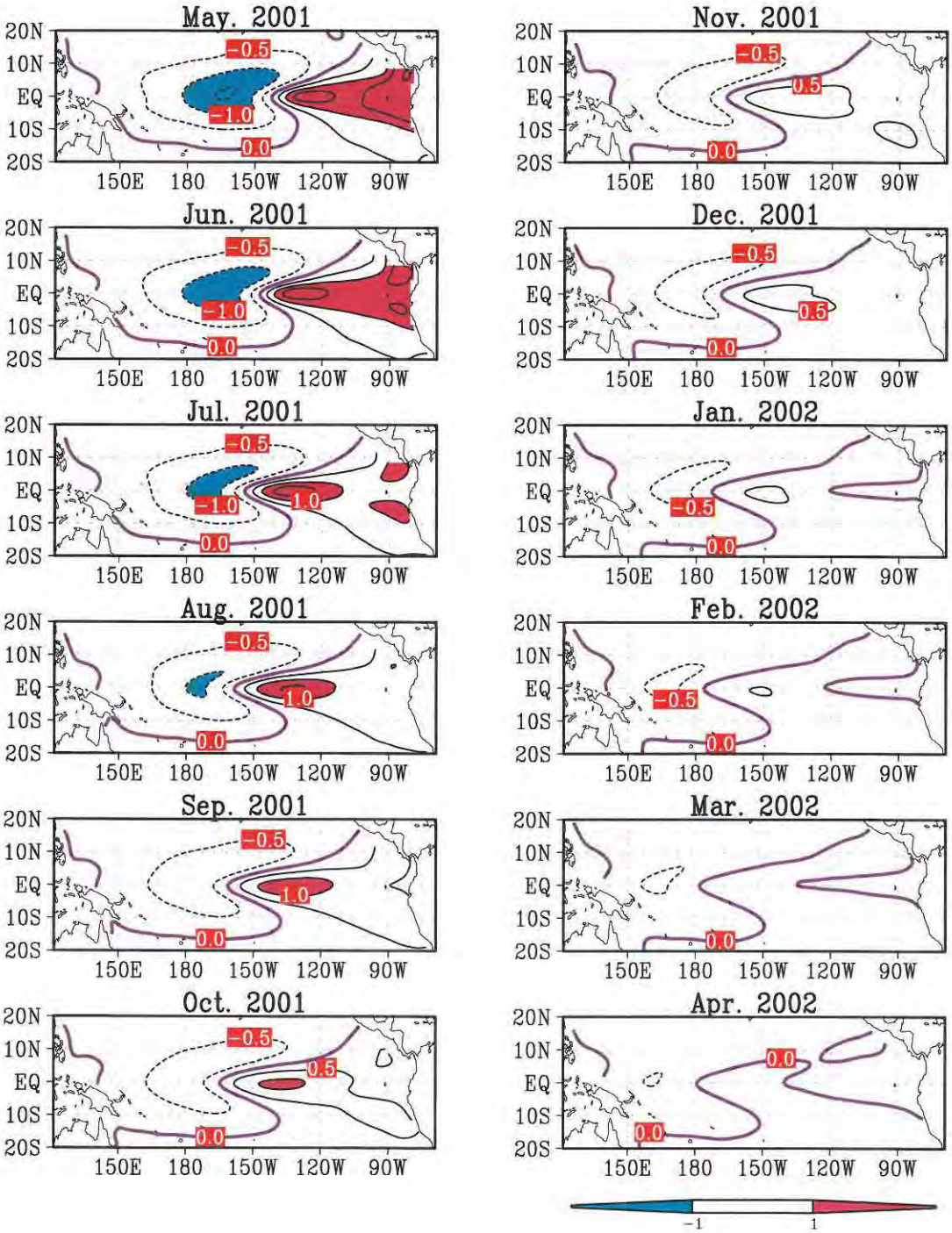

CMOS Bulletin SCMO
"at the service of its members
au service de ses membres"

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Cover page: The figure shown on the Cover Page illlustrates the predicted Sea Surface Temperature Anomalies of the tropical Pacific. Contour interval is 0.5 degrees Celsius, with negative anomalies indicated by dashed contours, positive anomalies by solid contours, and zero by thick contours. Shaded areas indicate anomalies of magnitude exceeding one (1) degree. To learn more, read the article on page **35**.

Page couverture: La figure qui apparaît sur la page couverture illustre les prédictions des anomalies de température de surface pour l'océan Pacific tropical. Les intervalles de contour sont de 0,5 degrés Celsius. Les anomalies négatives sont indiquées par des lignes de contours pointillées; les anomalies positives par des lignes de contour continues et les lignes de contour pleines indiquent les anomalies égalant zéro. Les zones ombragées indiquent des anomalies dont la magnitude excède un (1) degré. Pour en savoir plus, lire l'article en page **35**.

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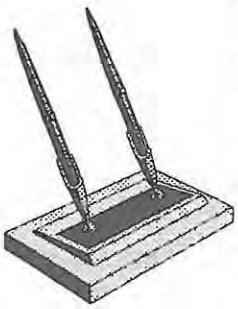
Canadian Meteorological and Oceanographic Society (CMOS)

Société canadienne de météorologie et d'océanographie (SCMO)

....from the President's Desk



Aujoud'hui (5 avril 2001) nous avons tenu la dernière réunion du Conseil de la SCMO avant le congrès de Winnipeg. Tout se déroule bien en ce qui concerne l'organisation du congrès et j'espère que vous compter y assister. Ils ont reçu cent vingt cinq papiers scientifiques. Il y aura une session pour présenter une stratégie industrielle pour le secteur privé, principalement en météorologie mais j'espère que c'est aussi important pour l'océanographie. Il y aura des présentations concernant la Fondation canadienne pour les sciences du climat et de l'atmosphère. Nos comités tiendront leurs réunions régulières, ainsi que la réunion générale annuelle de la Société. Un déjeuner au cours duquel nous présenterons les prix de la SCMO et de la SMC, et un banquet auront lieu pendant la semaine. Venez donc en grand nombre!

Spring has half arrived in Toronto, may eventually show up in Newfoundland and has no doubt been in BC for several months, but it has seemed like a relatively long winter. A few warm days will be appreciated - though I must confess to having spent one week last month at the annual meeting of the European Geophysical Society in Nice and enjoyed some warm sunshine there. The down side was that I was away when our tour speaker, Howard Freeland, made his presentation in Toronto. Reports on this year's tour from the Centres are all very enthusiastic and I am sorry to have missed it. The EGS meetings are getting rather large (about 5000 attendees this year) but do provide an excellent opportunity to meet up with European colleagues, plus an increasing number from Canada and the US. A week in Nice, now the regular venue for these meetings, in March or April, also has its appeal!

On the home front, our Private Sector Committee has been hard at work these past few months providing input to an Industrial Strategy document, which we believe can be beneficial to the long term health of meteorology, in both the private sector and government agencies. The School and Public Education Committee have continued their work on Project Atmosphere Canada and that continues to evolve as an important part of our strategy to increase awareness and interest in meteorology in the schools. Parallel initiatives in the ocean sciences would be welcome. Also in the area of school and public education, many of our Centres provide speakers for school groups, and play a role in local science fairs. Ron Hopkinson (Saskatchewan Centre) is working on a summary of our activities in the Science Fair arena and Richard Asselin is designing a generic award certificate that could be produced by the Ottawa CMOS team on request.

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April 2001 - avril 2001

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Articles

Our regular sections / Nos chroniques régulières

Printed in Kanata, Ontario, by Gilmore Printing Services Inc.
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Bill Pugsley, our past past president, suggests that I bring to your attention World Meteorological Day, which commemorates the entry into force, on 23 March 1950, of the Convention of the World Meteorological Organization. Each year, WMO celebrates the Day by focusing on a theme of interest to humanity. The theme of World Meteorological Day 2001 "Volunteers for weather, climate and water" was chosen to recognize all voluntary contributions to the advancement of the sciences of meteorology and hydrology and to the operational activities of WMO and the National Meteorological and Hydrological Services (NMHSs). The theme also coincides with the UN-designated International Year of the Volunteers in 2001. The key to our success as a Society is the work of our volunteers, in local centres, on committees, in council and especially in our Ottawa office. Many of our lobbying

activities (PAGSE, CCR), as well as our executive office, are Ottawa-based and we really do need strong support from our membership in that part of the country (which I would regard as including Montréal if we consider it within a reasonable commute for occasional meetings of organisations such as PAGSE or CCR).

Neil Campbell and his Ottawa team (Richard Asselin, Paul-André Bolduc, Bob Jones, Dorothy Neale and Uri Schwarz) put in an enormous effort which one probably only appreciates after a year or two on the Executive or Council. In my final "words" let me pay tribute to them and to their crucial role in maintaining the Society as a centre of activity in meteorology and oceanography in this country. Thank you, Neil et al, for making my job so much easier.

J'ai peur que ce message soit court (et en retard!) ce mois-ci. Je tenais cependant à mentionner que j'ai passé une année bien occupée, très intéressante et agréable en tant que Président de votre Société. J'espère que je pourrai bien soutenir notre nouveau président l'année prochaine et que notre nouveau Conseil executif travaillera bien ensemble comme ce fut le cas cette année.

Peter Taylor, President / Président

Letters to the Editor

Date: 26 January 2001

Global warming's future projections in doubt?

Empirical meteorologists with global experience are, for the most part, dubious that the global data base is sufficiently representative and accurate enough for confident analysis of climate change over the past 100 years, or more. This is particularly true over the 71% of the global surface covered by the sea.

Moreover, if, as the IPCC admits, we have no conception of the characteristics of the natural trend, then we have no baseline upon which to apply estimates of the effect of the anthropogenic component of climate change in the past, let alone the future.

The Hadley Centre for Climatic Prediction and Research - one of the most renowned centres for modelling - has recently concluded that the sea surface temperature data base is too inaccurate and unrepresentative for use in climate change models. David Parker of the Hadley Centre has found that the true value of temperature over the ocean, at the same height as that used for global terrestrial measurement, varies considerably from the sea surface temperature. Consequently, it is now estimated by the Hadley Centre that warming over the past 20 years has been overestimated by about 40%.

No sea temperature reading from a ship is accurate unless recorded by a probe extended forward from the bow, or the thermometer is streamed on the surface from a boom extending at least 3 metres from the ship's side. There are so many outlets along the side of a ship pouring effluents into the sea, ranging from ice water to steam, which pollute bucket readings, and, of course, in-take temperatures are notoriously unreliable as a measure of surface temperature.

One can only conclude that modellers are trying to make a silk purse out of a pig's ear when we bear in mind, also, the lack of homogeneity and the biases present in the terrestrial network.

M.R. Morgan, Dartmouth, N.S.

Date: 22 March 2001

A tribute to Cdr. M. R. Morgan!

It was a great pleasure to read about the achievement of Cdr. M.R. Morgan (*CMOS Bulletin SCMO*, Vol.29, No.1, p.23), a remarkable octogenarian who was awarded his Ph.D. degree recently in an area of Global Warming and Climate Change, a hotly debated topic of present-day meteorology. Morgan's achievement and his long career and dedication to the fields of Meteorology and Oceanography should be an inspiration to all CMOS members.

It may be useful to recall an earlier study by Morgan which has had a significant impact on Canadian Meteorology and Oceanography. More than thirty years ago, Morgan published a report on the analysis and forecasting of sea and swell conditions in deep water with particular reference to the Northwest Atlantic. In his report Morgan developed an empirical procedure based on a nomogram and the continuity principle to advect wave fields for short-term wave forecasting. Morgan's simple technique was converted into a computerized procedure which became the first computerized operational wave forecasting technique implemented by Environment Canada in the early eighties. This computerized procedure was known as the "Parametric Wave Model" and was driven by the surface winds provided by the CMC (Canadian Meteorological Centre) in Montréal. The Parametric Wave Model was developed on two grid domains, one covering the Canadian Atlantic and the other covering the Canadian Pacific. The Model provided a reasonable skill in forecasting wave fields and was continued in operational implementation till about 1991 when the first Canadian Spectral Ocean Wave Model was developed and implemented in the CMC Forecasting System.

On behalf of all CMOS members, I want to offer hearty congratulations to Dr. M.R. Morgan and wish him many more years of active participation in the sciences of Meteorology and Oceanography.

Madhav L Khandekar, Consulting Meteorologist

A neural-dynamical hybrid coupled model for forecasting the tropical Pacific sea surface temperatures

by Youmin Tang[1] and William W. Hsieh[1]

Résumé: Un nouveau modèle couplé hybride neuronal/dynamique a été développé pour produire des prévisions saisonnières des températures de la surface de la mer du Pacifique tropical. Un modèle océanique dynamique à 6 niveaux est exécuté avec les anomalies de contrainte du vent, fournies par l'Université d'état de la Floride; puis pendant la période de prévision (Tang et Hsieh, 2001a), le modèle océanique est couplé à un modèle atmosphérique neuronal non linéaire qui évalue les anomalies de contrainte du vent de surface à partir des anomalies de teneur en chaleur près de la surface de la mer (Tang et al, 2001). C'est la première fois qu'un modèle couplé hybride a été développé avec un modèle atmosphérique non linéaire, et pour notre groupe, c'est un deuxième modèle pour la prévision de l'ENSO, et également un modèle autonome.

Model

A new neural-dynamical hybrid coupled model has been developed for giving seasonal predictions of the tropical Pacific sea surface temperatures. A 6-layer dynamical ocean model of the tropical Pacific is driven by the Florida State University wind stress; then during the forecasting period (Tang and Hsieh, 2001a), the ocean model is coupled to a nonlinear neural network atmospheric model, which estimates the surface wind stress anomalies from the upper ocean heat content anomalies (Tang et al, 2001). This is the first time a hybrid coupled model has been developed with a nonlinear atmosphere, and it gives our group a second, independent model for ENSO prediction.

Data

For better forecast skills, different types of data - surface wind stress, upper ocean heat content anomaly (HCA) (White, 1995), sea surface temperature (SST) and sea surface height anomaly - have been assimilated into the coupled model using a 3D-Var data assimilation scheme (Derber and Rosati, 1989). The results show that assimilating HCA (kindly provided by Warren White and Ted Walker at SIO) yields the greatest improvement in the forecast correlation skills (Tang and Hsieh, 2001b). Fig. 1 shows the correlation skills of the predicted SST anomalies (SSTA) in the NINO3 region in the equatorial eastern Pacific during 1980-1989 and 1990-1999 using our model with HCA assimilation. The predictions were made at three-month intervals (starting on 1 January, 1 April, 1 July and 1 October) and continued until a lead time of 15 months. Fig. 2 shows the prediction of the NINO3 SSTA starting from April 1994 to February 2001 at lead times of 3, 6, 9 and 12 months.

Results and Conclusion

Fig 3 shows our latest forecasts (initialized using data till the end of February, 2001), indicating that the moderate cool anomalies in the western equatorial Pacific and the moderate warm anomalies in the eastern equatorial Pacific present during late spring, 2001, will gradually fade away to near normal conditions by November, 2001, and remaining near normal till spring, 2002. Future forecasts will be posted at our web site http://www.ocgy.ubc.ca/projects/clim.pred.

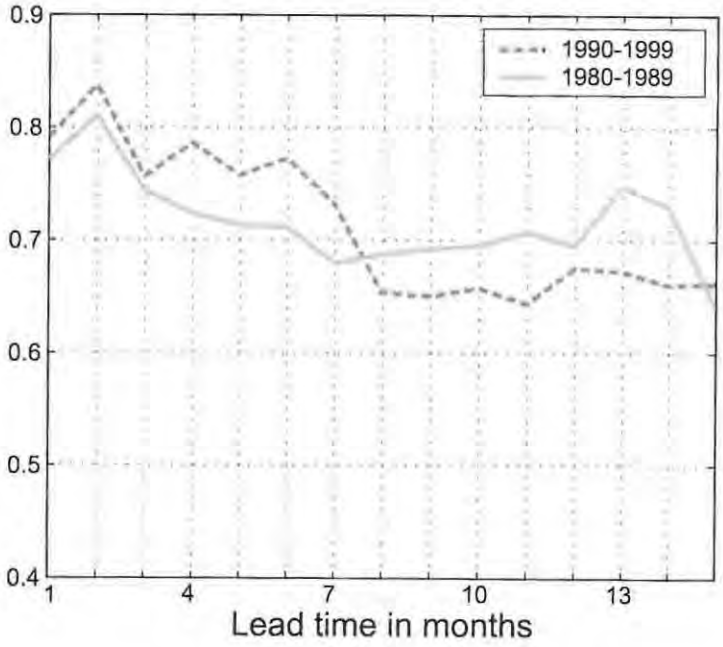

Fig.1 Correlation skills of the predicted NINO3 SSTA

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References:

Derber, J. and A. Rosati, 1989: *A global oceanic data assimilation system.* J. Phys. Oceanogr., 19, 1333-1347.

Tang, Y., and W. W. Hsieh, B. Tang and K. Haines, 2001: *A neural network atmospheric model for hybrid coupled modelling.* Clim. Dynam., 17, 445-455.

Tang, Y. and W.W. Hsieh, 2001a: *Hybrid coupled models of the tropical Pacific -- ENSO prediction.* Clim. Dynam. (submitted). [http://www.ocgy.ubc.ca/~william/pubs.html]

Tang, Y. and W. W. Hsieh, 2001b: *Impact of data assimilation on ENSO simulations and predictions.* J. of Climate (submitted). [http://www.ocgy.ubc.ca/~william/pubs.html]

White, W.B., 1995: *Design of a global observing system for gyre-scale upper ocean temperature variability.* Prog. in Oceanogr., 36, 169-217.

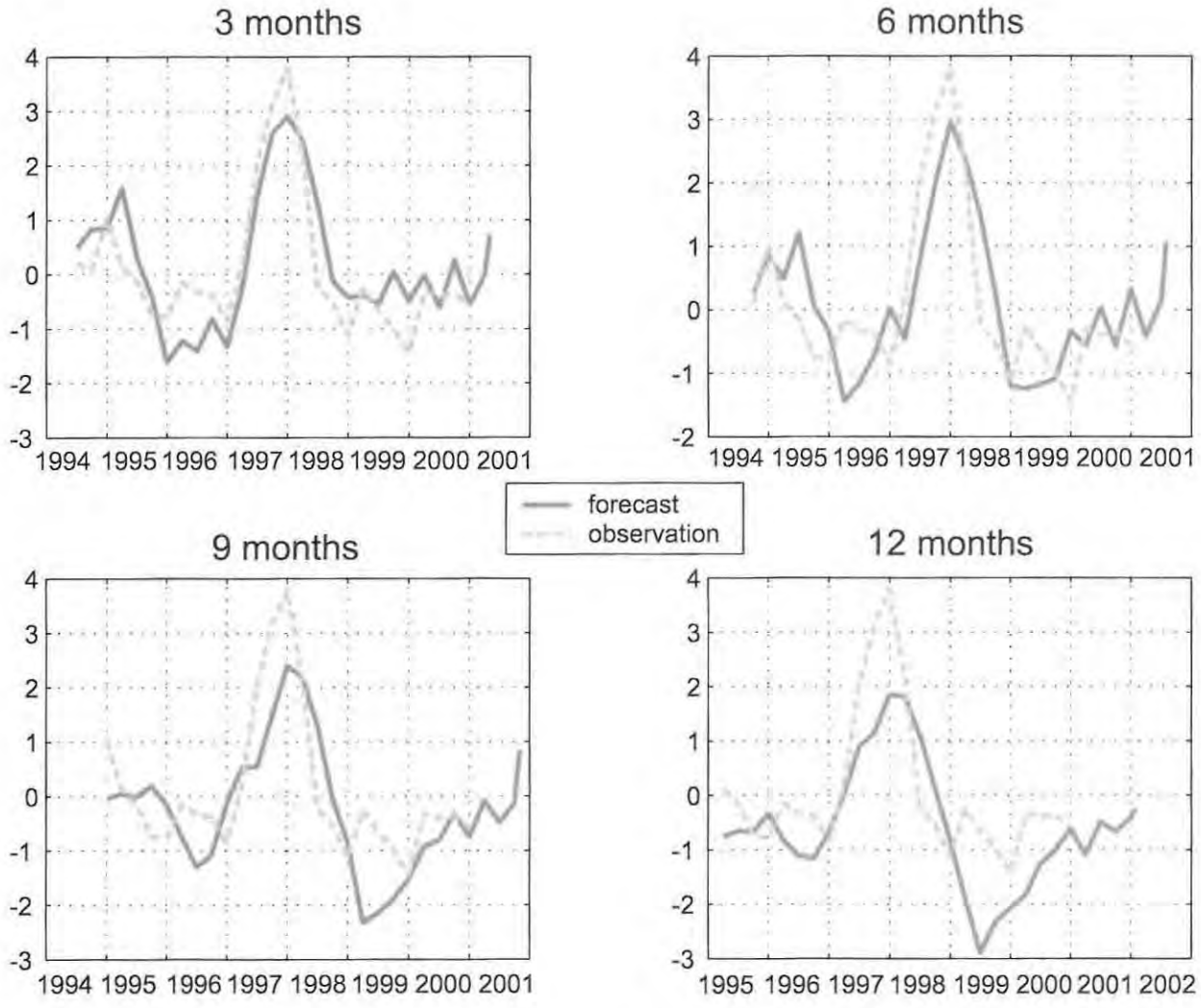

Fig.2 Observed and predicted NINO3 SSTA at lead times of 3, 6, 9 and 12 months

Figure 3 shown in colour on Cover Page illlustrates the predicted SSTA of the tropical Pacific. Contour interval is 0.5 degrees Celcius, with negative anomalies indicated by dashed contours, positive anomalies by solid contours, and zero by thick contours. Shaded areas indicate anomalies of magnitude exceeding one (1) degree.

Students on Ice

by Geoff Green[1]

Résumé: La compagnie "Students on Ice", située à Ottawa, organise en Antarctique et en Arctique des expéditions d'apprentissage pour les étudiants. Leur mandat consiste à fournir, sur tous les continents, des opportunités éducationnelles stimulantes aux étudiants du monde, et ainsi les aider à faire la promotion pour une nouvelle compréhension et le respect de notre planète. Cette compagnie est un membre associé à l'Association internationale des organisateurs de voyages en Antarctique ("International Association of Antarctica Tour Operators - IAATO"), organisation qui a été fondée en 1991 pour préconiser et promouvoir une responsabilité en matière de sécurité et d'environnement lors des voyages du secteur privé en Antarctique. En décembre de l'an 2000, la première expédition de 95 personnes du Canada, formée d'étudiants du secondaire, d'enseignants et de scientifiques spécialistes des régions polaires, ont entrepris un voyage éducatif de deux semaines en Antarctique.

Introduction

Students on Ice is an Ottawa-based company organizing student-learning expeditions to the Antarctic and to the Arctic. Their mandate is to provide students from around the world with inspiring educational opportunities at the ends of the earth, and in doing so, help them foster a new understanding and respect for our planet. They are an associate member of the International Association of Antarctica Tour Operators (IAATO), a member organization founded in 1991 to advocate and practise safe and environmentally responsible private-sector travel to the Antarctic. In December 2000, the first expedition of 95 high-school students, teachers and top polar scientists from all across Canada, headed south on a two-week educational journey to Antarctica.

A New Classroon

Antarctica, the fifth largest continent, lies hidden away at the bottom of the world, still very much a frozen frontier. It is home to 90% of the planet's fresh-water, in which is trapped 70% of the earth's fresh water supply, as well as many of the secrets unlocking our world's past and future. In the Austral summer it is the breeding and feeding ground for one of the planet's greatest concentrations of wildlife. It is a place that defies description, and this author is usually guilty of using too many superlatives in the attempt. As a unique platform for global education, Antarctica inspires and overwhelms its visitors. As a window to our world and its many global challenges, you might say it is the planet's greatest classroom.

Tourism to Antarctica

Since the middle of the 19th century, sealers, whalers and explorers began visiting and discovering Antarctica. At the turn of the century, the famous and sometimes tragic expeditions of Scott, Shackleton, Amundsen and Mawson, began to raise the world's consciousness about this still-mysterious and unknown part of the world. Many international scientific expeditions followed, and continue to this day, and these eventually led to the signing of the Antarctic Treaty in 1959. It was not until the late sixties, that the first Antarctic "tourist" expedition took place. Since then tourism to Antarctica has been slowly on the rise, although it still remains the most unvisited part of the world.

Having led over 50 expeditions to the Antarctic since 1992, I had witnessed how the experience of visiting Antarctica profoundly impacted people. However, it was mostly well heeled, well-travelled, older Americans having this opportunity. Imagine taking a group of students here, and the impact it would have on them? This was a place that begged to be exposed to today's youth, and yet only a handful of students had ever visited. And so Students on Ice was born.

"Students on what?" Was this some sort of figure-skating organization? Once the concept of taking a group of young Canadians to the Antarctic was explained, the interest and support for the project quickly spread across the country. Students and teachers from St. John's Newfoundland to Victoria, British Columbia joined the expedition. Two Inuit students from Labrador were among the many talented young Canadians to participate. In almost every case, the students received financial support from their schools, school boards, communities and corporate sponsors to cover the $8,900 Cdn expedition cost.

Sponsors

The Canadian Committee for Antarctic Research (CCAR), the Canadian Space Agency, Canadian Geographic Magazine and the Canadian Museum of Nature were some of the important groups to initially team with Students on Ice as expedition partners. Bell Canada also joined as the technology partner, and Bell's Sympatico-Lycos hosted the expedition's live expedition website. The support of these organizations from an early stage in the expedition's development through to its successful outcome was invaluable.

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[1] Founder and expedition leader of Students on Ice

Canadian Expedition

Joining the expedition's educational team were some of Canada's finest polar scientists including: Dr. Fred Roots, science advisor emeritus for Environment Canada; Dr. Kathy Conlan, research scientist at the Canadian Museum of Nature; Dr. Warwick Vincent, CCAR chair and professor at Laval University; Dr. Wayne Pollard, professor of geology at McGill University; Dr. Kevin Hall, head of geology department at UNBC; and Dr. Fritz Koerner, Canada's senior glaciologist and Antarctic veteran. Other members of this world-class educational team were Dr. Don Walsh, oceanographer and past president of the Explorer's Club, Alex Boston from the David Suzuki Foundation, and Jonathon Shackleton, polar historian and second cousin of Sir Ernest Shackleton. This impressive group generously and enthusiastically shared their knowledge and passion with the students every step of the journey.

The journey began in Toronto on December 27th, 2000, where the group assembled and flew to Buenos Aires, Argentina via New York City. A few of the students had never been on a plane before, while others had never traveled outside of Canada, or in one case, outside of Labrador. So the excitement and sense of adventure amongst the group was quite palpable. After a day in Buenos Aires, we continued south to Tierra del Fuego and the small city of Ushuaia, Argentina, lying on the windy shores of Beagle Channel. It was here that we boarded our ice-class expedition vessel, the Lyubov Orlova, and set sail for Antarctica.

Exploring the Environment

The expedition was not designed as a vacation trip and there were no 'virtual' experiences involved. The Drake Passage took care of that! All the students participated in an educational program, which began with preparatory study and research prior to the expedition. During the expedition, the education team presented seminars and lectures focused on diverse topics such as the history, geography, geomorphology, flora and fauna, glaciology, the environmental issues and politics of the Antarctic. The ship acted as our expedition base and daily field excursions in Zodiac boats took the group to penguin rookeries, research stations and cruising amongst icebergs. Throughout the expedition, a total of 11 landings were made, including a rare landing on the remote Diego Ramirez Islands, which lie 60 miles southwest of Cape Horn.

Several of the education team members conducted science activities in which the students participated. Kathy Conlan conducted plankton tows in the Zodiacs together with groups of students. Then in the evening, we would examine the many forms of microbial life under a microscope, which Kathy brought all the way from her laboratory in Ottawa. Warwick Vincent and his PhD student Claude Belzile conducted UV penetration experiments on various Zodiac outings with the students, part of an ongoing project Warwick has in the Antarctic. Both Fritz Koerner and Wayne Pollard did some ice coring with the group, demonstrating the way ice-cores are taken and analysed, as well as what can be learned from them. The scientists themselves generously provided all of the scientific equipment needed for these activities.

Another of the planned activities, organized with the Canadian Space Agency (CSA), was to have satellite images taken of the students and ship using RadarSat. At set times and positions during the expedition, we set up radar reflectors provided by CCAR, and waited to have our "picture taken" by RadarSat as it passed overhead. On one of the occasions, the students and staff all lay on the snow in a giant circle during a blizzard smiling up to the stars. Besides the obvious novelty of this project with the CSA, it was a terrific opportunity for the students to learn about RadarSat and its many global applications, including the recently conducted Antarctica Mapping Mission.

What resulted was a learning atmosphere that was dynamic, exciting and effective. Impromptu classes would occur on beaches, glaciers, in the Zodiacs and on the deck of the ship. The small student-to-staff ratio also allowed for close interaction, interpretation and one-on-one discussion. Many of the students commented that this was one of the highlights of their experience. Just being on a first name basis with the education team members in an environment like Antarctica inspired the students about science and about learning in general. One of the many successful outcomes of the expedition was the development of "A Canadian Youth Statement on Antarctica", a document produced by the students, which addresses many Antarctic and global issues and offers several recommendations.

An expedition website allowed thousands of students and adults across Canada and around the world to follow the expedition each day via the Internet. Each day during the expedition we uploaded digital photos, videos, personal journals of the students and staff and expedition updates via an Inmarsat B satellite system to the people at Sympatico-Lycos in Toronto. The site was a great success and served as a successful interactive educational resource allowing thousands of young and old virtual travelers to share the experience and learn about the Antarctic.

Media Coverage

The expedition received tremendous media coverage from coast to coast. National television programs such as CBC Morning and CTV's Canada AM did stories before and after the expedition. Articles in Maclean's, the Globe and Mail, the Toronto Star, the Montreal Gazette, the Vancouver

Province, Canadian Geographic, and dozens of other newspapers and radio stations all across Canada covered different elements of the story. A recent Media Coverage Report showed that an audience of over 15,000,000 people was reached through television, radio and print media. An additional audience of over 10,000,000 people were reached through the Students on Ice expedition website and various other websites that had Students on Ice related content.

Conclusion

On February 22, 2001, Mr. Peter Adams (M.P.) presented the following in the House of Commons:

"*Mr. Speaker, early this year scores of young Canadians visited Antarctica with the Students on Ice Expedition. Students and teachers from all across Canada participated in this remarkable experience (...). These students are now ambassadors for Antarctica in Canada. Their Statement on Antarctica calls on Canada to become a full member of the Antarctic Treaty and to ratify the Treaty's Environmental Protocol. To learn more about these students visit www.studentsonice.com. Let us take the advice of these wonderful young Canadians. As a great polar nation, we have a moral responsibility to participate fully in the protection and appropriate use of Antarctica.*"

It is realistic to believe the Students on Ice expedition, and its associated national media exposure, may have helped to raise public awareness about Antarctica and its related issues. It may have also served as a vehicle to teach Canadians about Canada's role in the Antarctic, as well as about the importance of a bi-polar perspective. Undoubtedly, it had a significant impact on the lives of many young Canadians - an experience that is certain to help define the course these future voters and leaders in Canada will follow.

The Canadian polar science community, together with schools, parents, companies, corporations and many other groups from coast to coast are responsible for the success of this initiative and should be proud. In 2001-02, the first Students on Ice expedition to the Canadian Arctic (Aug.15–26) is planned, as well as the second annual Antarctic expedition (Dec.27-Jan.10).

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Note from the Editor: CMOS Bulletin SCMO wishes to thank Olav Oken who has suggested and coordinated this article. Mr. Oken is Secretary of the Canadian Committee for Antarctic Research.

Open-water Evaporation: The Swift Current Water Balance Study

by G.S. Strong[1] and C. Hrynkiw[2]

Résumé: Les estimations du bilan hydrique de l'évaporation de deux étangs artificiels, munis d'un revêtement intérieur imperméable, ont été utilisées pour évaluer et mettre au point les méthodes opérationnelles semi-empiriques pour l'estimation de l'évaporation à ciel ouvert au-dessus de petites nappes d'eau. Les deux étangs artificiels, fournis par l'administration du rétablissement agricole des Prairies ("Prairie Farm Rehabilitation Administration - PFRA"), possèdent chacun les dimensions suivantes : 30 m par 55 m par 4 m de profondeur. Au cours de l'année 1994, les deux étangs artificiels ont été à la fois équipés d'instruments pour fournir des données météorologiques semi-horaires détaillées, ainsi que sur les précipitations, les niveaux d'eau, les températures de l'eau, et les données du bac d'évaporation de classe A.

Les estimations de l'évaporation obtenues à partir du bilan hydrique ont été comparées avec les estimations des données du bac et de la méthode de transfert de masse de Meyer. Une fuite non identifiée dans un des étangs artificiels, suivie d'une défectuosité du limnigraphe au cours de l'été, puis un démantèlement impromptu du site en raison d'une expansion urbaine au début de l'année 1995, ont causé de sérieuses restrictions aux efforts mis dans les analyses et ont contribué aux délais dans la transmission de ces résultats. Des mesures optiques du niveau d'eau, prises périodiquement en sus au cours de l'année 1994, ont été une façon de mettre au point les données du niveau d'eau. On discute des coefficients empiriques des équations d'évaporation du bac et de Meyer, déduits de l'évaporation saisonnière de chaque méthode qui est comparée avec l'évaporation totale obtenue des données du niveau d'eau.

Introduction

Evaporation can be defined as "*the phenomenon by which a substance is converted from the liquid or solid state into vapor*" (Brutsaert, 1982). An understanding of evaporation dates back to Greek antiquity, as demonstrated by Aristotle in his work, *Meteorologica* (Lee, 1962). Aristotle stated that "*moisture about [the earth] is evaporated by the sun's rays and the other heat from above and rises upwards...and turns from air into water: and having become water falls again onto the earth. The exhalation from water is vapour; the formation of water from air produces cloud.*"

A number of techniques exist to estimate open-water evaporation, including:

1. Water Balance Method - provides a direct, areal, time-integrated value based on the actual water budget of the body of water; usually determined as the residual in the balance of surface and ground water inflows and outflows, precipitation, and evaporation.

2. Atmospheric Moisture Budgets – radiosonde data are used to measure changes in atmospheric moisture from evapotranspiration (evaporation, sublimation, and transpiration) over large areas, without regard to source. Great care must be taken to carefully account for horizontal and vertical fluxes into and out of the region (advection, convection, subsidence), and cannot be considered accurate for small areas.

3. Eddy Correlation Method - provides a direct point estimate of evaporation through estimates of the vertical turbulent flux of water vapour, using fast response measures of vertical velocity and absolute humidity. This technique demands stringent conditions on the instrumentation, including a fast response time and very precise placement and orientation of velocity sensors. It is therefore an excellent research tool, but less useful for operational conditions.

4. Estimates using Class A Evaporation Pans - a smaller controlled version of the water balance method, pans provide a direct point measure of the time-integrated total evaporation *from the pan.* However, it is not usually truly representative of conditions over the larger surface being approximated, and generally over-estimates evaporation in such cases. Various formulae for correcting pan data have been developed, the simplest, and often most accurate, being simply a multiplicative factor ranging from 0.7 to 1.0, depending on the area, surface characteristics, and other factors.

5. Energy Budget Methods - provide areal or point estimates, based on the principle of conservation of energy, where the amount of evaporation accounts for the thermal budget of the water. The most widely used method in this category is the *Bowen Ratio* (Bowen, 1926).

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6. Mass Transfer Method - provides areal estimates of evaporation in which most methods are derived from Dalton's equation (see above).

7. Empirical combination formulae - provide areal estimates of evaporation based on a combination of energy balance, mass transfer, and standard meteorological observations. Such methods, including *Morton's complementary relationship* (Morton, 1979; 1986), are often poorly justified by theory.

The last four of these methods are semi-empirical; that is, they involve one or more field-derived coefficients for a particular application. Some of these methods, for example, eddy correlation, provide accurate estimates of the evaporation at a point. However, most operational applications require evaporation estimates integrated over areas ranging from small reservoirs (of 10s of metres across) to large bodies of water such as the Great Lakes. Vaughan (1986) listed reliable evaporation estimates as one of the meteorological science issues of 1950 still outstanding. This remains so in 2001, so that evaporation (evapotranspiration) over large water bodies (areas) are generally estimated either using the semi-empirical techniques (such as Woodvine, 1994), or as a residual term either in a surface water balance (such as McKay, 1962) or in an atmospheric moisture budget (Strong, 1997). In theory, the water balance method should be more accurate than any semi-empirical method since it responds directly to all natural changes, while most other techniques respond only to the variables inherent in the computation. On the other hand, it is difficult to maintain all the controls needed for the water balance approach, groundwater discharge/recharge being but one of the problems.

More than 2000 years after Aristotle, Dalton (1801) provided a mathematical formulation of the process of evaporation. He theorized that an increase in the temperature of a liquid and a decrease in humidity in the atmosphere would result in greater evaporation, the *advection* factor, which is often overlooked today by those attempting to relate daily radiation measures to evapotranspiration using semi-empirical operational techniques. Dalton also recognized the relationship between evaporation and wind speed, the *ventilation* factor, and derived a simple mass-transfer equation for evaporation, expressed as:

$$E = f_D(u)\,(e_s^* - e_a) \quad (1)$$

where **E** is evaporation, $f_D(u)$ is a function of wind velocity, e_s^* is the saturation vapour pressure over the water surface, and e_a is the vapour pressure of the air. The wind function is normally derived empirically. Meyer (1915, 1942) developed an operational version of Dalton's Law for estimating *monthly* evaporation from lakes and reservoirs in Minnesota. His version of Equation 1 is:

$$E_M = C_M\,(e_s^* - e_a)\,(1 + W/10) \quad (2)$$

where the saturated vapour pressure, e_s^* is determined using the monthly mean surface water temperature, e_a is determined from monthly mean air temperature, W is the monthly mean wind speed in mi hr^{-1}, and C_M = the Meyer constant. C_M = 15 for fully exposed pans or small puddles of water, = 11 for larger lakes when the vapour pressures are determined from the average daily maximum/minimum temperatures and mean of morning and evening relative humidity, and = 10 when the vapour pressures are determined from hourly average values. To account for the effect of barometric pressure, the computed evaporation was then increased by 1% for every 1000 ft increase in elevation.

On the Canadian prairies, where water is an extremely important economic issue, Martin (1989) and Woodvine (1994) used a modified version of Equation 2. This includes an empirical relationship to estimate surface water temperature from ambient air temperature, to provide routine monthly estimates of open-water evaporation for synoptic meteorological sites in Saskatchewan and Manitoba. These estimates are still in official use by PFRA and other agencies for water supply potential planning, including hydro-electric power generation, irrigation uses, and for determining water apportionment estimates to neighbouring provinces and states.

During early-1988, the Prairie Provinces Water Board (PPWB) requested that the National Hydrology Research Centre (NHRC) carry out research to evaluate current operational techniques for estimating evaporation, and if possible, to develop a cost-effective technique which would satisfy most operational purposes. This resulted in a proposal for a Prairie Evaporation Study (PES) involving the construction and instrumentation of a large lined reservoir of 400-m diameter (Strong et al., 1989) in order to carry out accurate water balance estimates of evaporation for a wide range of water body sizes and scenarios. This size was deemed necessary in order to avoid reservoir edge effects, and to ensure evaporation equilibrium over a portion of the reservoir in varying temperature, wind, and stability conditions. Unfortunately, the necessary funding to carry out PES was not available, so that the large reservoir concept was postponed indefinitely. However, during 1993 PFRA constructed two small lined dugouts at the Agriculture Canada field research site in Swift Current, Saskatchewan. This provided the opportunity to carry out limited studies on dugouts similar in size to those used for domestic and livestock use on many prairie farms.

Swift Current Field Site

PFRA had constructed the Swift Current dugouts specifically to investigate algae growth in farm dugouts and to test operational methods used to estimate evaporation. It was recognized that evaporation results for these dugouts would not be valid for large water bodies, but these tests would be a start in the right direction. During 1993, one of the dugouts included a floating cover for the

algae tests being carried out by PFRA, while NHRC installed meteorological sensors for testing over the second dugout. It was planned to conduct two summers of evaporation tests using the two side-by-side dugouts, commencing in 1994, with the duplication of dugouts and instrumentation providing backup data in case one or the other failed through seepage or other problems. Unplanned dismantling of the dugouts in early-1995 to make way for city expansion ended the tests prematurely.

The Swift Current study compares three methods of open-water evaporation measurement - the water balance method, evaporation pan data, and Meyer's mass transfer method (1915, 1942) applied to daily values of evaporation. Swift Current is located in the southwest part of Saskatchewan where the average mean annual gross (open-water) evaporation of 1019 mm (Woodvine, 1994) greatly exceeds the mean annual precipitation of 367 mm (Environment Canada, 1993). While the ratio of open water area to dry land over this part of the Canadian prairies is very low (~10% or less), open-water evaporation still plays a significant role in the water balance, affecting hydro-electricity, mining, agriculture, irrigation, human consumption, livestock operations, recreation, and wildlife. For example, Pentland and Kulshreshtha (1989) estimated that a 5% improvement in evaporation data would result in an annual benefit of $2.5 million in capital costs (1989 dollars), where water-related developments typically compensate for current unreliable estimates of evaporation through over-design. Furthermore, it is known that local evapotranspiration (combining both open-water evaporation and transpiration from vegetation) is a major factor in the generation of convective storms on the prairies (Strong, 1997; Raddatz, 1998). Convective storms, in turn, are an essential component of the water budget of the prairies, especially for agriculture, maintaining a continuous redistribution of moisture throughout the prairies during summer months. Figure 1 depicts a typical large convective storm developing northwest of the Swift Current site in this study during July, 1994, a storm which yielded much-needed heavy rainfall throughout a large region of southern Saskatchewan, and even produced a small tornado.

Figure 1: A large thunderstorm developing northwest of the Swift Current evaporation site on 10 July, 1994, which produced heavy rainfalls and a small tornado (photo by G. Strong). Also shown in colour on back cover page.

Description of Lined Dugouts and Data Collection -

The two lined dugouts were constructed within 10 m of each other near Swift Current, Saskatchewan. The dugouts were of almost identical dimensions, approximately 30 m by 55 m by 4 m deep, and each was lined with a polyester tarpaulin type of material. The purpose of lining these water bodies was to eliminate uncertainty that the inflow and outflow of groundwater adds to evaporation estimates. Figure 2 is a schematic diagram of the dugouts, while Figure 3 provides a wide-angle view of the excellent exposure of the two dugouts. The main 10-m meteorological tower was sited between the two dugouts at their west end, while a second fully instrumented 3-m meteorological tripod was added 50 m east of the 10-m tower, along with a nearby semi-automated Class A evaporation pan and additional sensors. Both dugouts contained water level recorders and water temperature profilers, along with various other backup sensors, all recorded on the two tower dataloggers. The accumulation period for daily estimates of precipitation and evaporation were assigned to be from 1201 UTC (06:01 local time) until 1200 UTC the following morning.

In order to convert actual precipitation measurements (P) into *effective* precipitation (P_e, for water balance estimates), it was also necessary to make periodic estimates of the precipitation collection area and water surface area of both dugouts in Figure 2. P_e is simply the depth of water added to the dugout water level adjusted for the precipitation collection area defined by the lip of the dugout, neglecting small amounts of evaporation on the banks of the dugout. As backup to the water level recorders, optical measurements of both water levels were also made at these times. The latter measurements turned out to be quite important, as these have been used to salvage otherwise erroneous water level measures for a sizable portion of the data collection period.

Figure 4 shows the floating water temperature profiler for the north dugout, anchored and tethered to each side of the dugout. Water level fluctuations and meteorological variables were monitored from early-July to shortly before winter freeze-up in October, 1994. Meteorological variables measured included atmospheric pressure, air temperature, humidity, total solar radiation, water temperature at three depths (1 cm, 50 cm, and 2 m), wind (at 10 m, 2.5 m, and 25 cm), and precipitation.

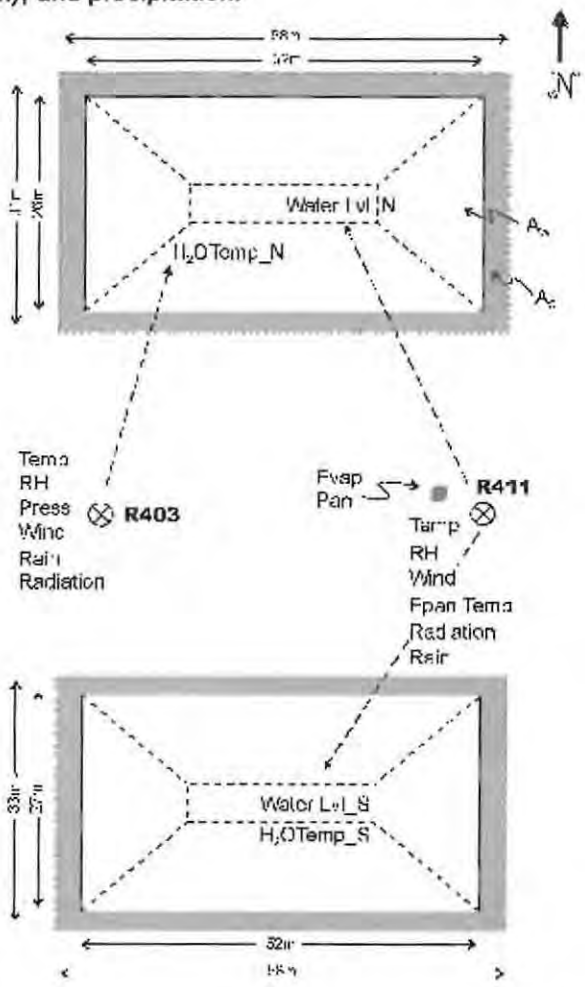

Figure 2: Schematic of lined dugouts used for water balance estimates of evaporation at Swift Current, Saskatchewan. Distances, including separation between dugouts, are scaled approximately correct.

A Class-A evaporation pan, constructed of galvanized steel, 122 cm in diameter and 25 cm deep, was deployed near the east side between the two dugouts, as shown in Figure 2 and depicted in Figure 5. The pan included a wind speed indicator (at 25 cm) and water temperature recorded on the 3-m tower (R411) data.

Daily readings for two manual precipitation gauges (at R403 and R411 in Figure 2) were carried out at 08:00 AM CST, as double backup to the two automatic raingauges.

Data Treatment

Raw Data Comparisons -

Every effort was made to ensure comparability between the two dugouts and reproducibility of data from the two towers. Figure 6 shows comparisons of air temperature, relative humidity, wind speed, and precipitation over the 90-day period, 22 July to 20 October 1994. The envelope of differences for temperature is approximately ±1.0°C with most differences within ±0.5°C. RH differences are generally less than ±2%, with a few outlier differences of up to 10%. The water temperatures shown are a function of depth, while cumulative manual and auto-tipping bucket values compared favourably, except when the north dugout gauge ceased functioning in late-September, further justifying the doubling up of sensors.

The average difference between the temperature/RH sensors at both towers confirmed that both were well within the manufacturer's specifications for accuracy. The mean deviation for temperature was 0.07°C, and for relative humidity, 0.63%, while the accuracy was on average, ±0.2°C for temperature and ±1% for RH. Differences between water temperature at varying depths in the north dugout showed a mean difference of -0.1 °C for surface (1-cm) to 50-cm depth, and -0.3°C for surface to 2-m depth, obviating the concern to measure surface water temperatures (as opposed to several cm depth) on small dugouts, as they rapidly attain a near-isothermal temperature profile. Total accumulated precipitation values for the manual standard and automatic tipping bucket raingauges (TBRG) used, with the manual gauge reading only 0.2 mm higher than the TBRG on the summer total. Also, manual measurements at the North dugout compared well with the tipping bucket and manual measurements at the South site, with all total accumulations being within 1.6 mm.

Figure 3: Panoramic view east showing 10-m meteorological tower (R403) between the two lined dugouts, each ~30 m by 55 m by 4 m deep, used in the Swift Current evaporation study; 3-m tower and evaporation pan were added later (photos by G. Strong). Also shown in colour on back cover page.

Figure 4: North dugout with floating water temperature profiler, anchored and tethered to both sides of dugout (photo by G. Strong).

Figure 5: Class-A evaporation pan between the two lined dugouts at Swift Current; the 10-m meteorological tower is visible to the west of the pan (photo by G. Strong).

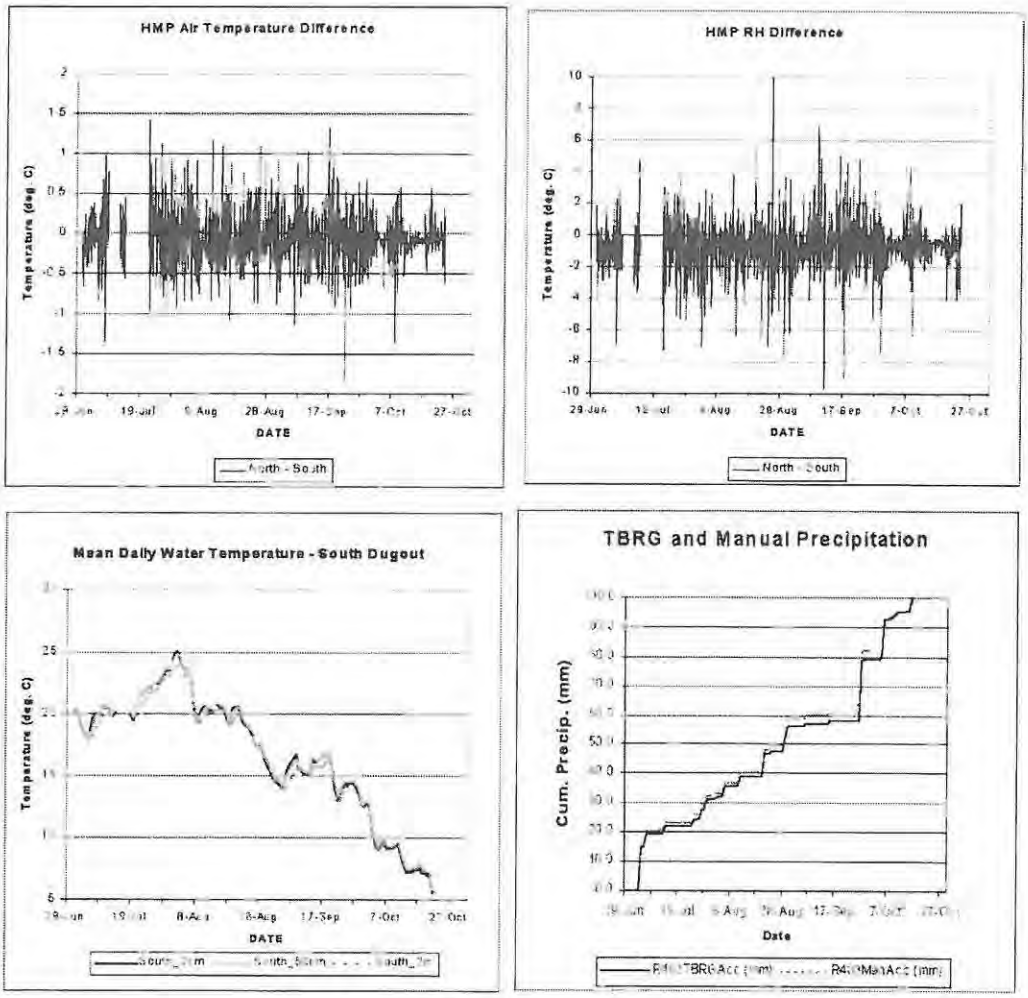

Figure 6: Sensor comparisons between 10-m and 3-m towers (aproximately 50 m apart) at Swift Current twin dugout site for 90-day period, 22 July through 20 October, 1994. Shown are differences between 10-m and 3-m (a) air temperature and (b) relative humidity, (c) surface (1-cm), 50-cm, and 2-m water temperature in north dugout, and (d) cumulative precipitation from autostation tipping bucket and manual gauge readings.

4. Results

Treatment of Water Level Data -

Two rather serious problems arose with the measurement of water level depth in the lined dugouts over the course of the field experiment. First, an unusually rapid decrease in water level height in the south dugout, which could not be explained by evaporation alone, strongly suggested a leak, probably caused by one or more tears in the liner. This alone precluded any use of water level data from the south dugout, since there was no means of estimating the magnitude of the seepage. Secondly, the water level recorder for the north dugout started to indicate erroneous rising water levels on 24 August due to an error in the pressure transducer sensor, which was determined to result from a plugged vent tube. Fortunately, optical theodolite measurements of the water levels of both dugouts during seven site visits throughout the field period ensured the salvage of at least the seasonal data. Moreover, daily fluctuations in the errant water level data appeared to be somewhat realistic in terms of frequency, if not magnitude of the fluctuations, suggesting a possible means to salvage the daily water level data (after 24 August).

Figure 7. shows the water level trends before and after adjustment using the optical water level measurements. While confidence is high for the general trend, the daily fluctuations after 24 August do not appear to be reliable after all, the magnitude of fluctuations being considerably larger than what was recorded prior to the pressure transducer problem. However, the optical measures of water level, after accounting for effective precipitation over the dugout, should ensure the validity of the seasonal totals.

The cumulative daily values of manual and automatic gauge precipitation, net evaporation pan water loss (E_{PL}), Meyer estimates of evaporation (E_M, using C_M value of 10 for initial computations), and the water level estimates of evaporation (E_{WL}) are shown in Figure 8. The large daily fluctuations in water level computations of evaporation after 24 August (after which optical corrections were applied), and especially after 07 September, may be erroneous (as much as ±25 mm in one day). It is possible

that some of the large daily fluctuation may have resulted from larger variations in temperature and humidity, or from slopping due to stronger winds at that time of year; i.e., on cool, dry days, the evaporation may be driven by large-scale dynamics and the heat storage in the dugout rather than surface radiation, much as happens over large water bodies during fall such as the Great Lakes (Aubert and Richards, 1981) or Great Slave Lake (Rouse et al., 2000). This is investigated further below.

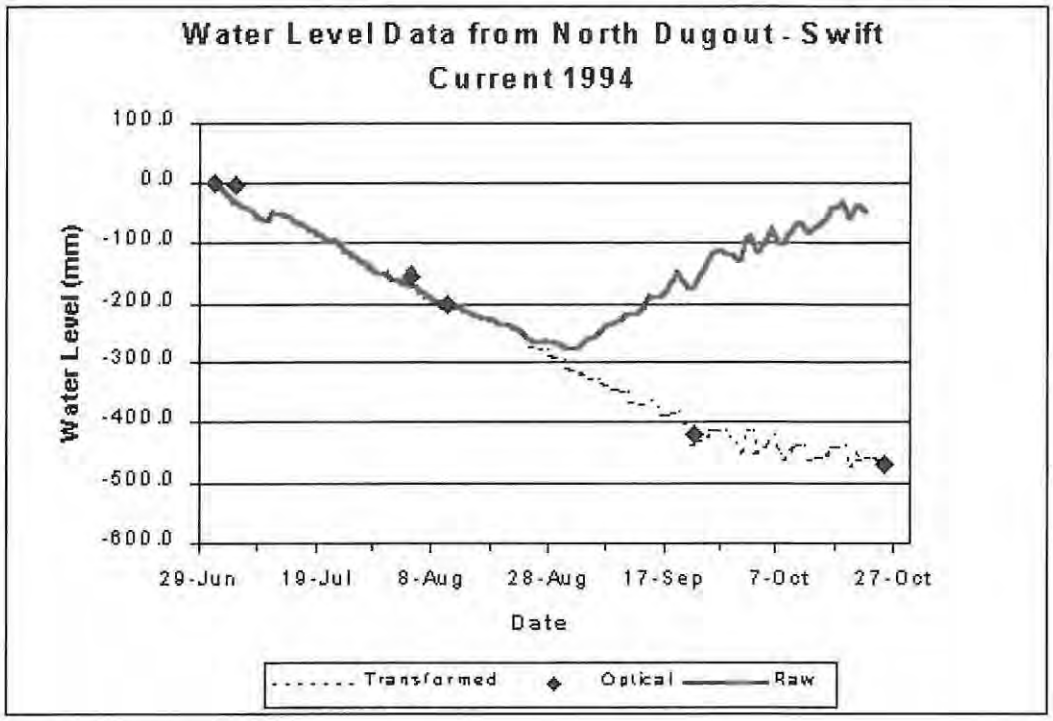

Figure 7: Water level data trends before and after transformation using optical theodolite measurements of water levels.

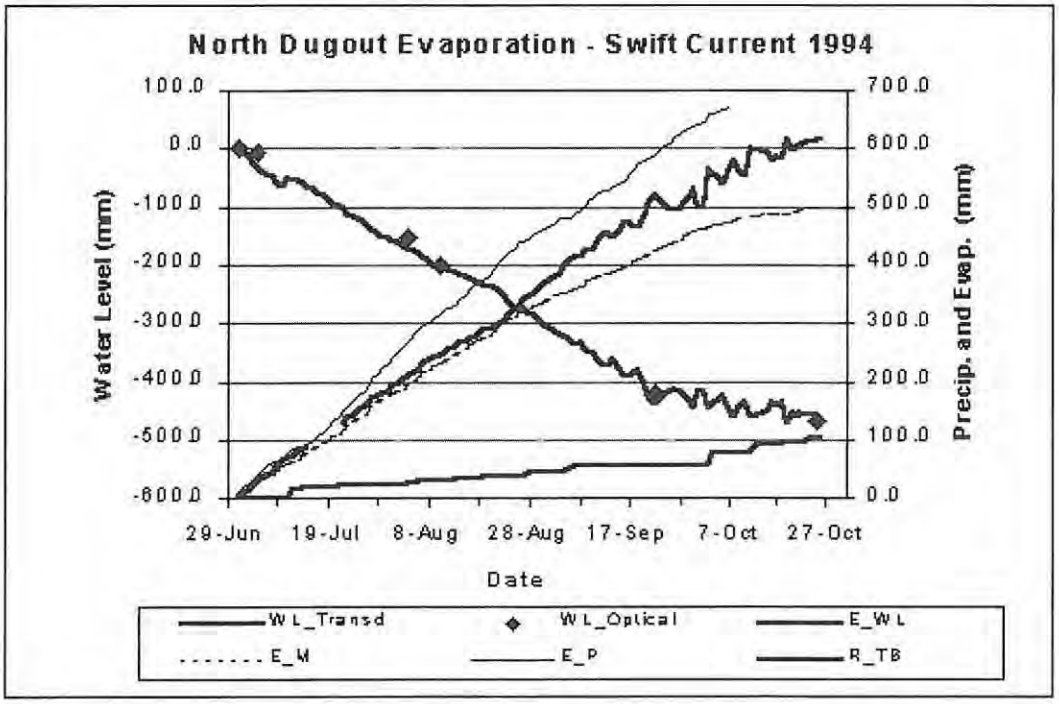

Figure 8: Cumulative daily values of corrected water levels, point optical theodolite values of water levels used for corrections, tipping bucket rainfall, pan water loss, Meyer estimates of evaporation (initially using C_M=10), and water-level determined evaporation for north dugout, Swift Current, 01 July – 27 October, 1994.

Regardless of process, the cumulative total of water balance evaporation is believed to be accurate at least to within this ±25 mm (±4% of the total) in this instance, since the optical measures of water level, precipitation, and corrections for effective precipitation, were taken with great precision, as well as duplication. Given that the cumulative water balance evaporation total is correct, then the seasonal totals on 07 October, the last date for evaporation pan measures, are: (1) water balance evaporation, E_{WL} = 567.2 mm; (2) Meyer evaporation estimate (using C_M of 10), E_M = 472.8 mm; and (3) net Class A pan water loss, E_{PL} = 670.2 mm. As an added comparison, (4) PFRA the total Meyer estimates of evaporation using monthly Swift Current synoptic data were approximately 615 mm for this period (Woodvine, personal communication).

Accepting the water balance evaporation totals for the period 01 July through 07 October, the last date of pan measurements, these results yield an adjusted pan coefficient of 0.85 ($=E_{WL}/E_{PL}$), and Meyer coefficient, C = $E_{WL}/10E_M$ = 12.0, in order to force these to the water balance result of 567.2 mm. The pan coefficient is typical of values found in the literature for small ponds. McKay and Stichling (1961) derived values of 0.94 (August) and 0.96 (September) for Weyburn Reservoir, but later discovered that seepage had been occurring, which would have reduced those coefficients correspondingly. The Meyer coefficient fits within the range of Meyer's own estimates of 15 for small puddles and 10 for larger lakes.

An attempt was made to filter out the large daily fluctuations in the water balance estimates of evaporation resulting from the faulty pressure transducer after 24 August, and to consider other possible causes for the fluctuations. The 9-day centred running means shown in Figure 9 suggest that large-scale forcing, involving cooler, drier air masses over the relatively warm water surface may have been partly responsible for the peak period of water balance evaporation (E_{WL}) in late-August. The opposite effect, warmer and moister air over a then cooler water surface, may have contributed to the dip in E_{WL} during mid-September. Wind effect, causing the dugout water to 'slop', is also a possible contributor to the large fluctuations in E_{WL}. However, while a few points and the seasonal total of E_{WL} could be adjusted using available optical theodolite water level measurements, the fluctuations undoubtedly resulted mostly from the poor water level data after mid-August, especially since similar fluctuations were not apparent in the Meyer and pan estimates.

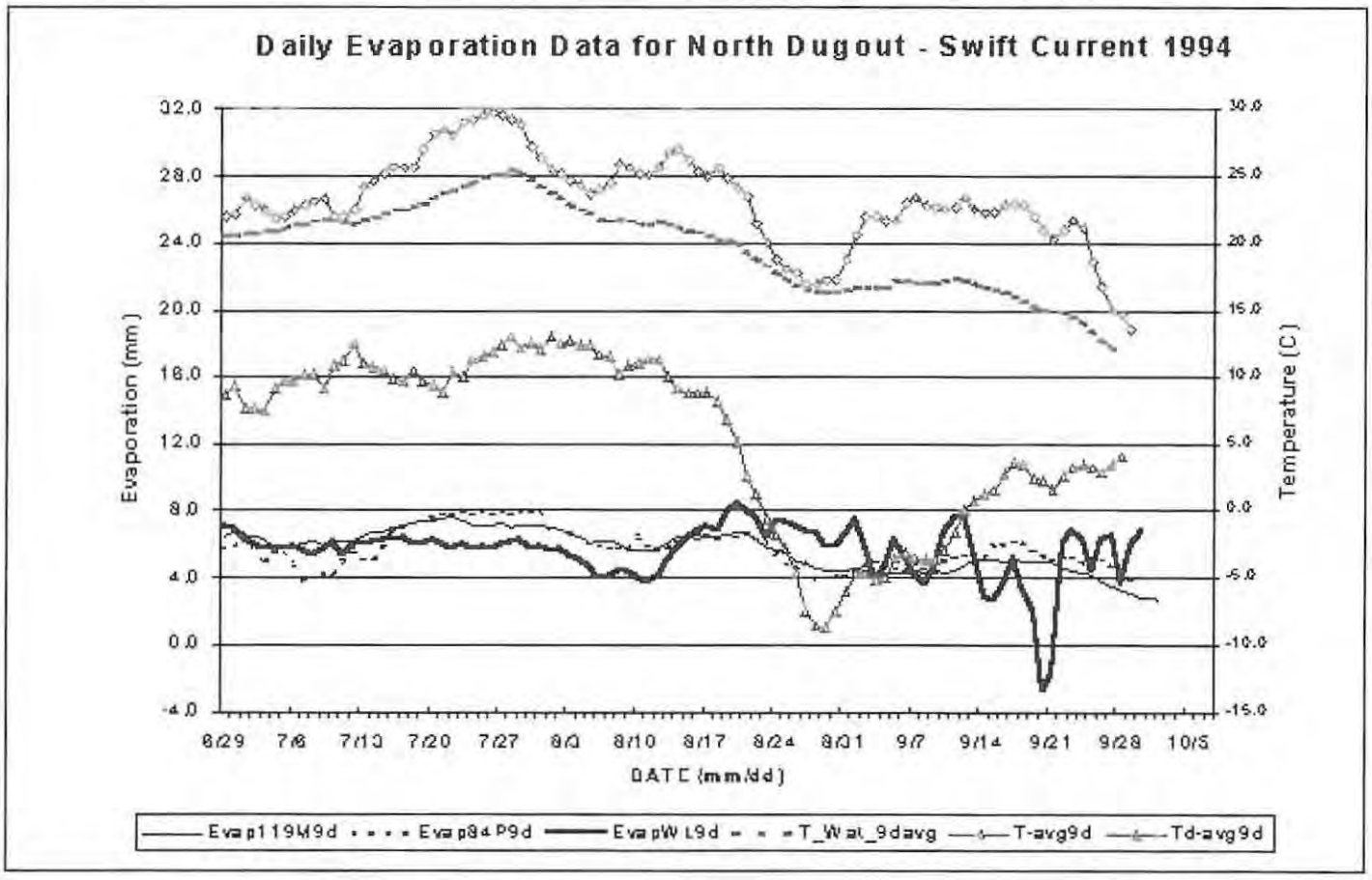

Figure 9: Nine-day centred running means of air temperature (T), surface water temperature (Tw), and dew point (Td) (top grey lines and RHS axis), and daily totals of water balance (heavy solid), Meyer (medium solid), and evaporation pan X 0.85 (broken) estimates of evaporation (bottom lines and LHS axis) for the north lined dugout at Swift Current, 29 June – 02 October, 1994. T and Td are 2400 UTC values, Tw is a daily average.

5. Discussion

The Swift Current water balance study, using two lined dugouts of a size used by the farming community, yielded empirical values for Class A pan coefficient of 0.85, and Meyer constant of 12.0. These values cannot be assumed to be valid for larger lakes. Problems with seepage on one dugout and a problem water level pressure transducer on the other cast some doubt on the validity of daily values in this study after late-August. However, the seasonal estimates are believed to be accurate to within ±4% (of 567 mm). The experiment and results could not be reproduced for a second year due to the take-over of the site by the city of Swift Current.

Further water balance tests using lined reservoirs of various size are necessary to validate these results for other locations, conditions and water body sizes. Extreme care must be taken to ensure that such lined reservoirs are leak-proof, and that all sensors are monitored daily to ensure quality control. Duplication of sensors is also important. Field tests using several such reservoirs of varying sizes would make a reasonable compromise to the original PES plan (Strong et al., 1989).

6. Acknowledgements

This study was undertaken while the lead author was employed by Atmospheric Environment Service (AES, now Meteorological Service of Canada) in Saskatoon. AES and the National Water Research Institute at NHRC, Saskatoon, provided funding and instrumentation for the field study. PFRA provided the lined dugouts, on-site pumps and water to fill the dugouts, equipment for clearing weeds, and other field assistance. Mr. Dan Matthews and Mr. Bruce Cole of AES carried out most of the field technical work.

7. References

Aubert, E.J., and T.L. Richards, eds., 1981: Summary of accomplishments, *IFYGL, the International Field Year for the Great Lakes.* NOAA rep., Ann Arbor, MI, March, 1981, 367-384.

Bowen, I.S., 1926: The ratio of heat losses by conduction and by evaporation from any water surface. *Phys. Rev.*, 27, 779-787

Brutsaert, W.H., 1982: *Evaporation into the Atmosphere.* D. Reidel Publishing Co., Boston, 299 pp.

Dalton, J., 1801: New theory of the constitution of mixed aeriform fluids, and particularly of the atmosphere. *J. Nat. Philos.*, Chemistry and the Arts, 5, 241-244.

Environment Canada, 1993. *Canadian Climate Normals 1961-90 Prairie Provinces.* Minister of Supply and Services Canada.

Lee, H.D.P., 1962. *Aristotle – Meteorologica.* Harvard University Press translation, Cambridge, Massachusetts.

Martin, F.R.J., 1989. *Gross Evaporation for the 30-Year Period 1951-80 in the Canadian Prairies*, PFRA Hydrology Report #121, 58 pp.

McKay, G.A., 1962. *Evaporation from Weyburn Reservoir Progress Report 1960-1961.* Meteor. Br., Dept. Trans., Mar. 1962, 36 pp.

McKay, G.A. and Stichling,W., 1961. *Evaporation Computations for Prairie Reservoirs.* Second Canadian Hydrology Symposium, March 1 and 2, 1961, Toronto.

Meyer, A. F., 1915. Computing Run-off From Rainfall and Other Physical Data. Paper No. 1348 in the *Procs. Amer. Soc. Civil Engineers*, meeting of April 21, 1915.

Meyer, A. F., 1942. *Evaporation From Lakes and Reservoirs.* Minnesota Resources Commission, St. Paul, Minn.

Morton, F.I., 1979: Climatological estimates of lake evaporation. *Water Resources Res.*, 15, 64-76.

Morton, F.I., 1986: Practical estimates of lake evaporation. *J. Clim. and Appl. Meteor.*, 25, 371-387.

Pentland, R.S., and S.N. Kulshreshtha, 1989: *Benefits of evaporation data. Final report to Nat. Hydrol. Res. Cen.,* Water Resource Consultants Ltd., Regina, Sask., Mar., 1989, 64 pp.

Raddatz, R.L., 1998: Anthropogenic vegetation transformation and the potential for deep convection on the Canadian prairies. *Can. J. Soil Sci.*, 78, 657-666.

Rouse, W.R., P.D. Blanken, A.K. Eaton, and C. Spence, 2000: Energy and water balance of high latitudes. *Procs. 5th MAGS Workshop*, Edmonton, Alta., Nov., 1989, 80-86.

Strong, G.S., 1997: Atmospheric moisture budget estimates of regional evapotranspiration from RES-91. *Atmosphere-Ocean*, 35, 29-63.

Strong, G., R. Boals, D. Gray, R. Hopkinson, B. Kenney, R. Lawford, F. Martin, W. Nicholaichuk, and S. Shewchuk, 1989: *Vers. 4.0, Scientific/Technical Objectives and Field Research Proposal for the Prairie Evaporation Study*, 31 March, 1989. National Hydrology Research Centre, Saskatoon, 45 pp.

Vaughan, W.W., 1986: *Compendium of Meteorology Scientific Issues of 1950 Still Outstanding.* NASA Ref. Pub. 1167, 55 pp.

Woodvine, R.J., 1994. *Gross Evaporation for the 30-Year Period 1961-90 in the Canadian Prairies*, PFRA Hydrology Report #133, 105 pp.

Natural "Heat Vent" in Pacific Cloud Cover Could Diminish Greenhouse Warming[1]

The tropical Pacific Ocean may be able to open a "vent" in its heat-trapping cirrus cloud cover and release enough energy into space to significantly diminish the projected climate warming caused by a buildup of greenhouse gases in the atmosphere.

If confirmed by further research, this newly discovered effect - which is not seen in current climate prediction models - could significantly reduce estimates of future climate warming. Scientists from NASA's Goddard Space Flight Center in Greenbelt, Md., and the Massachusetts Institute of Technology present their findings in the March 2001 issue of the Bulletin of the American Meteorological Society.

"High clouds over the western tropical Pacific Ocean seem to systematically decrease when sea surface temperatures are higher," says Arthur Y. Hou of Goddard's Data Assimilation Office. Hou and co-authors Ming-Dah Chou of Goddard's Climate and Radiation Branch and Richard S. Lindzen of MIT analyzed satellite observations over the vast ocean region, which stretches from Australia and Japan nearly to the Hawaiian Islands. The researchers compare this inverse relationship to the eye's iris, which opens and closes to counter changes in light intensity. The "adaptive infrared iris" of cirrus clouds opens and closes to permit the release of infrared energy, thus resisting warmer tropical sea surface temperatures, which occur naturally and are predicted to increase as the result of climate warming.

The study compares detailed daily observations of cloud cover from Japan's GMS-5 Geostationary Meteorological Satellite with sea surface temperature data from the U. S. National Weather Service's National Centers for Environmental Prediction over a 20-month period (January 1998 to August 1999). The researchers found that cumulus cloud towers produced less cirrus clouds when they moved over warmer ocean regions. For each degree Celsius rise in ocean surface temperature, the ratio of cirrus cloud area to cumulus cloud area over the ocean dropped 17-27 percent. The observed range of surface temperatures beneath the clouds varied by 6.3 degrees Fahrenheit (3.5 degees C).

The authors propose that higher ocean surface temperatures directly cause the decline in cirrus clouds by changing the dynamics of cloud formation and rainfall. Cirrus clouds - high-altitude clouds of ice crystals - typically form as a byproduct of the life cycle of cumulus towers created by rising updrafts of heated, moist air. As these cumulus convective clouds grow taller, cloud water droplets collide and combine into raindrops and fall out of the cloud or continue to rise until they freeze into ice crystals and form cirrus clouds.

"With warmer sea surface temperatures beneath the cloud, the coalescence process that produces precipitation becomes more efficient," explains Lindzen. "More of the cloud droplets form raindrops and fewer are left in the cloud to form ice crystals. As a result, the area of cirrus cloud is reduced."

Clouds play a critical and complicated role in regulating the temperature of the Earth. Thick, bright, watery clouds like cumulus shield the atmosphere from incoming solar radiation by reflecting much of it back into space. Thin, icy cirrus clouds are poor sunshields but very efficient insulators that trap energy rising from the Earth's warmed surface. A decrease in cirrus cloud area would have a cooling effect by allowing more heat energy, or infrared radiation, to leave the planet.

If this "iris effect" is found to be a general process active in tropical oceans around the world, the Earth may be much less sensitive to the warming effects of such influences as rising greenhouse gas concentrations in the atmosphere. The researchers estimate that this effect could cut by two-thirds the projected increase in global temperatures initiated by a doubling of carbon dioxide in the atmosphere.

1: Source: American Meteorological Society Website (http://www.ametsoc.org/AMS).

J. Reginald H. Noble

1911-2001

Reg Noble, head of the federal government's meteorological service from 1964 to 1976, died in Toronto on March 19, 2001. He appeared to have been in excellent health before he died from a heart attack.

John Reginald H. Noble was born on December 15, 1911, on a farm near Clinton, Ontario. He graduated with a B.A. in Honours Mathematics and Physics from the University of Toronto in 1934 and then took a graduate degree (M.A.) in physics (meteorology). With the Depression there were no positions available in meteorology in 1935 so he went to the Ontario College of Education to train as a teacher. But, in February 1936, when the Meteorological Service began hiring meteorologists, Reg applied and was hired that month.

After working at Meteorological headquarters in Toronto for more than a year, Reg's first posting, in July 1937, was to Botwood, Newfoundland, where Pat McTaggart-Cowan was about to begin forecasting for British and American experimental transatlantic flying boat flights. The weather forecasts proved to be most useful, two more meteorologists arrived and, a year later, Reg was brought back from Newfoundland and posted to Montréal. There he became officer-in-charge of a new District Aviation Forecast Office at St. Hubert airport where Trans-Canada Airline (now Air Canada) had established a terminal and was about to begin a transcontinental air service.

But Reg was moved again the following year. When war broke out on Labour Day weekend 1939, he was called to Ottawa on the holiday and given instructions by the Deputy Minister and John Patterson, then head of the new Meteorological Division, to proceed to Halifax at once and establish a weather forecast office to provide services for the Royal Canadian Air Force the Royal Navy and the Royal Canadian Navy. As he related years later it was a daunting task for a young meteorologist to deal with the Armed Forces, the Department of Public Works and other government and private organizations when all he had was a piece of paper as authority. But with the help of teletype operators, meteorological technicians, and meteorologists sent from Montréal and Toronto, he obtained the necessary telecommunications, furniture and space at the Halifax RCAF headquarters and the office began issuing forecasts before the end of September.

In the spring of 1940 Reg was presented with another challenge. A few months earlier, Patterson, with the support of his Department of Transport, had concluded an agreement with the Department of National Defence under which the Meteorological Division would provide full meteorological support for the RCAF. Besides providing weather reports and forecasts, this meant seconding meteorologists to the RCAF bases. At first it was thought that only a few would be required but then, with the British Commonwealth Air Training Plan beginning, it was estimated that thirty or so meteorologists would be needed. Most would go to flying training bases but a senior meteorologist would be needed as a liaison officer at RCAF headquarters in Ottawa. Reg Noble was selected for this position and went to Ottawa in April. As air force needs for meteorologists grew, nearly 400 new meteorologists had been trained and posted to RCAF stations. For nearly six years Reg was the pivot point in all dealings between RCAF headquarters and John Patterson and other meteorological officials in Toronto. Since he was central to all meteorological requirements from Eastern and Western Air Commands as well as from the Training Commands, Reg was appointed Meteorological Advisor to the RCAF Chief of Air Staff.

After the war Reg moved to Toronto meteorological headquarters early in 1946 as the Chief of the Planning and Administration Section. Here he had responsibility for finance, personnel, and all the other support services necessary to operate the national service with offices in every part of the country and more than 2,000 employees. The next 20 years were growth years in meteorology. The Service expanded to meet the needs of Canadians for weather services and Reg was the one behind Andrew Thomson and then Pat McTaggart-Cowan in handling the administration, especially the financial matters. In 1959, Reg was appointed Deputy Controller (the official name for the director of the service was Controller to fit the Department of Transport's nomenclature system at that time) and in 1964 he succeeded Pat McTaggart-Cowan as Controller of what was by then the Meteorological Branch.

The Meteorological Branch continued to expand during the late 1960s with Reg at the head. Plans for the long-awaited new headquarters were finally approved and construction began on the new Downsview building. Reg was highly regarded in Ottawa and when a major reorganization of the department was deemed necessary he was named Project Manager of the Intertrans Team. This team met for six months or so in 1970 to study and make recommendations concerning the introduction of a ministry system in Transport. In the new system meteorology was taken from Air Services and became the Canadian Meteorological Service with Reg as the Administrator. But this nomenclature was not to last as the government soon announced the formation of a new Department of the Environment with meteorology a part of it. Accordingly the new department and the Atmospheric Environment Service came into being in 1971 with Reg as an Assistant Deputy Minister responsible for AES.

In October 1971 the Downsview headquarters were opened and the Service celebrated its 100th anniversary. The new Service became responsible for more than meteorology -

air quality observations and research at first and then expanding into such fields as acid rain, ozone layer and global warming studies. The 1970s proved to be somewhat competitive days in the new Environment Canada. Several Services had been brought together in the department and other new Services launched. Most wanted more resources, even at the expense of the established Services. AES was considered a source of man-years since the other research scientists and administrators could not grasp the fact that AES needed hundreds of employees across the country to man operational offices twenty-four hours a day, seven days a week. But Reg defended the AES turf well and it was fortunate that sufficient resources were available to allow AES expansion to handle the added responsibilities until after he retired at 65 years of age in December 1976.

Reg enjoyed taking part in World Meteorological Organization activities: this was a part of his professional life that few Canadians saw. He had not participated in the work of the technical commissions but once he became head of the Service he took very seriously the responsibilities of being Canada's Permanent Representative with WMO. As such, he was Canada's Principal Delegate at the month-long WMO Congress Sessions in Geneva in 1967, 1971 and 1975. Since he was usually elected to the Executive Committee (now Executive Council) or was president of Regional Association IV, he attended weeklong annual meetings in Geneva from 1967 to 1973 and again in 1975 and 1976. As regional president he led the Canadian delegation to Asheville, USA, in 1966, Geneva in 1971 and Guatemala City in 1973. By no means a radical at international meetings, Reg's quiet commonsense was appreciated by the representatives of other national meteorological services.

The Canadian Meteorological and Oceanographic Society was important to Reg Noble. In 1940 he had been a charter member of the Society's predecessor, the Canadian Branch of the Royal Meteorological Society and a member of its first executive. Later, in administrative positions, he insisted that support be given to the Society by having the Service look after such things as printing and mailing, by authorizing attendance at meetings in office hours, by supporting travel to annual meetings and congresses. Later, when the Society had a secretariat, he always made sure the Service's annual financial estimates included provision for a grant to the Society. He was a life member of the Society and after he retired he told his friends that he planned to go to the annual meetings and stay for days, something he had never been able to do before.

Reg did not undertake any meteorological work after retirement from government service but he retained a keen interest in the Service and was a regular attendant at Downsview retirement parties and other celebrations. He became very active in the affairs of his church and was well versed in its administration, especially its finances. His wife Muriel predeceased Reg: they were married September 1940 when he was at RCAF headquarters in Ottawa. Reg leaves a son, Jim, and grandchildren.

Submitted by Morley Thomas
March 2001.

Barry Saltzman

1931-2001

Barry Saltzman, professor of Geology and Geophysics at Yale University, passed away on Monday, February the 5th, after a year-long battle with cancer. His condition had been worsening rapidly since earlier this year. His loss, especially to me, is a difficult one.

Barry guided me to a Ph.D. at Yale with grace and great knowledge. Over the years he has always been there to lend advice and counsel. He was the quintessential professor - always learning, always teaching, always loving his work and always caring personally for his pupils. I will not forget him. To his other colleagues and students, he will also be remembered as a gentleman and a great scientist.

Barry was a pioneer in the study of global scale atmospheric processes and circulations and in the development of dynamic climatology. While developing a numerical model of atmospheric convection, described in a paper published in 1962 (Journal of Atmospheric Sciences) he noticed that the solutions to his model showed unusual sensitivity to initial conditions. This observation led Ed Lorenz (his long-time friend and collaborator at MIT) to investigate the specific cause of this unusual behavior in a simpler version of Barry's model. So, although the oft-quoted 1963 paper of Lorenz (Journal of Atmospheric Sciences) was the first to describe the distinct characteristics of what is now known as chaos, his work was prompted by Barry's initial observations.

Meteorologists and climatologists have much for which to be grateful to Professor Saltzman. A symposium to honour his memory and his work is being considered.

Submitted by Lionel Pandolfo
University of British Columbia
18 February 2001.

Storm Warning
Gambling with the Climate of our Planet
par Lydia Dotto

Critique faite par André April[1]

édition paperback 2000, 332 pp.
Édition canadienne pour Doubleday

Lydia Dotto est une écrivaine scientifique et auteure de plusieurs livres d'actualité scientifique en plus d'avoir été journaliste au Globe and Mail.

Le volume présente de façon journalistique un compte rendu des connaissances actuelles sur le thème des changements climatiques. À l'aide de l'avis de spécialistes elle répond aux principales questions que le public se pose et celles que les principaux décideurs de notre société devraient connaître. Elle débute par un exposé des évènements climatiques extrêmes des 20 dernières années avec la conviction que le réchauffement climatique en est en partie responsable.

Dans le premier chapitre, elle mentionne principalement la problématique de la preuve relative au changement climatique et les difficultés rencontrées pour la faire. Le second chapitre présente les évènements extrêmes avec un contenu canadien et mondial. Le troisième met en évidence le réchauffement global de la planète.

Le chapitre quatre explique clairement le lien entre le réchauffement planétaire et la condition de temps extrême. À partir du phénomène El Niño-La Niña, l'exposé de l'auteure nous permet de comprendre ce que veut dire variabilité climatique et la relation avec la moyenne et les extrêmes de température, précipitation, sécheresse, inondation et tempête en spécifiant leurs impacts socio-économiques.

Le chapitre cinq débute en répondant à la question suivante : Comment et dans quelle proportion l'émission humaine de gaz à effet de serre peut-elle contribuer au réchauffement planétaire ?

Le chapitre six étudie les impacts plausibles causés par le changement climatique sur les écosystèmes naturels et la société. On fait donc intervenir les activités comme l'agriculture, la foret, les pêcheries, la production d'énergie et les réserves en eaux.

Le chapitre sept discute de l'accroissement des maladies infectieuses possible dans le cas d'un réchauffement climatique. On note celles transportées par les moustiques pouvant se trouver dans les régions nordiques normalement hors de portée. De plus l'auteure présente l'aspect de la mortalité relié aux vagues de chaleur principalement pour les citoyens canadiens et américains.

Le chapitre huit tient compte des traumatismes psychologiques qu'ont subi les personnes victimes de désastres majeurs et ceux qui pourraient survenir lors d'événements météorologiques extrêmes. Un sujet intéressant souvent oublié par les victimes elles-mêmes.

Le chapitre neuf relate le débat entre environnementalistes et scientifiques d'une part et les sceptiques d'autre part. L'auteure poursuit sur des méthodes pour réduire l'émission de gaz à effet de serre telles que les énergies renouvelables et l'utilisation de l'énergie de façon plus efficace.

Le chapitre dix mentionne les débats et les difficultés rencontrés depuis le sommet de Rio en 1992 dans le but d'un accord sur le pourcentage de réduction d'émission des gaz à effets de serre par les pays développés et ceux en voie de développement.

Le chapitre onze énonce le concept d'adaptation vu comme façon de faire par les gouvernements et le secteur privé à défaut de pouvoir résoudre le problème radicalement comme souhaité.

Enfin l'auteure conclut en soulignant le fait que le débat est mal compris s'il est nécessaire de faire uniquement la preuve du changement climatique sans qu'intervienne la notion de risque que cela peut comporter pour la planète dans un avenir pas très lointain.

C'est un ouvrage très bien documenté, populaire et qui donne un très bon aperçu de la problématique. Parfois on tend à donner le coût relié à beaucoup d'interventions ce qui est difficilement vérifiable pour le lecteur mais le livre reste toujours convaincant et très compréhensible.

Note du Rédacteur : Une revue de ce livre a déjà paru dans le *CMOS Bulletin SCMO* dans le numéro du mois d'août 2000 (CMOS Bulletin SCMO, Vol.28, No.4, p.117) mais en anglais. Cette revue faite en français complète donc bien la revue déjà faite de ce livre.

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Thirty-six Canadian scientists and scholars win Killam Research Fellowships

Ottawa, 7 March 2001 - Thirty-six outstanding Canadian researchers have been awarded a total of $2.5 million in the 33rd annual competition for Killam Research Fellowships, administered by the Canada Council for the Arts.

Among Canada's most distinguished research awards, the Canada Council for the Arts Killam Research Fellowships are made possible by a bequest of Mrs. Dorothy J. Killam and a gift she made before her death in 1965. The awards support scholars engaged in research projects of outstanding merit in the humanities, social sciences, natural sciences, health sciences, engineering and interdisciplinary studies within these fields.

Killam Research Fellowships enable Canada's best scientists and scholars to devote two years to full-time research and writing. The recipients are chosen by the Killam Selection Committee, which comprises 15 eminent scientists and scholars representing a broad range of disciplines.

After considering 110 applications, the Killam Selection Committee chose 17 researchers as new Killam Research Fellows for 2001 among which one is a CMOS member:

Garry K.C. Clarke
University of British Columbia
Earth and Ocean Sciences-Glaciology
Ice-Climate Coupling

General Information

The Canada Council for the Arts, in addition to its principal role of promoting and fostering the arts in Canada, administers and awards a number of distinguished prizes in the arts, humanities, social sciences, natural sciences, health sciences and engineering. Among these are the Canada Council for the Arts Molson Prizes, the John G. Diefenbaker Awards, the Governor General's Literary Awards, the Governor General's Awards in Visual and Media Arts and the Walter Carsen Prizes for Excellence in the Performing Arts.

For more information about these awards and prizes, including nomination procedures, contact Carol Bream, Director of Endowments and Prizes, at (613) 566-4414, or 1 800 263-5588, ext. 5041. E-mail: carol.bream@canadacouncil.ca.

Cambridge University Press Honoured by AMS

Cambridge University Press has won this year's American Meteorological Society's award for Outstanding Service to Meteorology by a Corporation.

The award recognized Cambridge University Press for its "support of research and teaching in the atmospheric and related sciences through the publication of important monographs and texts." AMS President James Kimpel presented the award at the AMS 81st Annual Meeting in Albuquerque, New Mexico.

Cambridge University Press is the world's oldest printer and publisher. Founded on a royal charter granted by University of Cambridge by King Henry VIII in 1534, Cambridge University Press has a staff of over one thousand employees worldwide, with offices at the University of Cambridge in the UK as well as in the US, South America, Asia and Australia. Cambridge publishes over one thousand new books annually and maintains a backlist of many thousands of titles published over the last century.

Recent noteworthy Cambridge publications in meteorology include *The Cambridge Guide to Weather* by Ross Reynolds and *Currents of Change: Impacts of El Niño and La Niña on Climate and Society*, by Michael H. Glantz, which Cambridge will be reissuing in a new, revised edition in 2001. Cambridge University Press is the second publisher to receive the AMS Award for Outstanding Services to Meteorology by a Corporation.

CMOS Bulletin SCMO Next Issue - Prochain Numéro

Next issue of the *CMOS Bulletin SCMO* will be published in June 2001. Please send your articles, notes, workshop reports or news items at the earliest to the address given on page ii. We have an **URGENT** need for your articles.

Le prochain numéro du *CMOS Bulletin SCMO* paraîtra en juin 2001. Prière de nous faire parvenir au plus tôt vos articles, notes, rapports d'atelier ou nouvelles à l'adresse indiquée à la page ii. Nous avons un besoin **URGENT** d'articles.

Frequently Asked Questions about Membership Fee Increases

What are the benefits of being a member of CMOS?

There is no other comparable society or organization in Canada that offers meteorological and oceanographic sciences and services to its members and the public at large. If CMOS did not exist, it would have to be invented.

CMOS is a charitable organization that receives donations for the promotion of school or university education and remits income tax receipts for these donations.

CMOS provides a link and a forum to exchange ideas among all members of the meteorological and oceanographic community in Canada.

CMOS provides "Employment" to numerous retired meteorologists and oceanographers in extending their professional careers while providing services to the rest of the community at a very minimum cost.

CMOS is a national organization and operates in Canada's two official languages.

CMOS issues position papers on matters of importance to Canadians such as climate change.

CMOS organizes an Annual Congress for the promotion of meteorological and oceanographic sciences. It is organized and hosted by its members on themes that are of local, regional or global importance.

CMOS publishes a scientific journal "Atmosphere-Ocean" that compares well with other international meteorological and oceanographic journals.

CMOS publishes timely, current and historical papers of direct interest to members in the *CMOS Bulletin SCMO*, six times a year, at a cost in excess of $26,000 a year, or $32.50 per member.

CMOS provides free advertising on the Web and in the Bulletin to members seeking a professional position. The Bulletin is an excellent publication to advertise positions available; the Homepage even offers free listings of positions available.

CMOS carries announcements of upcoming conferences and workshops for its members.

CMOS financially supports conferences and workshops to a total of $2,000 a year.

The CMOS Web site provides a venue for use by members and contains information on Consultant Accreditation, Weathercaster Endorsement, educational information for teachers and students and links to similar societies and subjects worldwide.

CMOS has fourteen Centres and Chapters across the country which are subsidized annually by grants and matching funds for School Science Fairs. These Centres offer conferences and workshops of interest to members, and organize other activities, such as visits, school speakers and science fairs.

CMOS organizes an annual speaker's tour to all Centres across Canada.

CMOS:

i) represents the concerns of members in lobbying government to enhance research in atmospheric and oceanic sciences through letters to Ministers and the Partnership Group for Science and Engineering (PAGSE);
ii) establishes guidelines and criteria for public announcements of natural disaster alerts;
iii) certifies consultants in meteorology and oceanography;
iv) endorses radio and television weathercasters.

As an example of the effectiveness of the lobbying, CMOS received sixty million dollars for the creation of the Canadian Foundation for Climate and Atmospheric Sciences. Council members of CMOS are the members of this Foundation.

What does CMOS do for the Private Sector?

Provides an active link between the private sector and the government, and helps to resolve conflicts.

Organizes meetings of the private sector.

Maintains a list of private sector companies in Canada.

Refers enquiries from the Canadian and international public to appropriate sources for information or answers questions directly.

What does CMOS do for Students?

CMOS is a principal contributor and advocate of supporting student interest and involvement in meteorological and oceanographic sciences by supporting:

i) two, two-year graduate student scholarships valued at $5,000 each per year;
ii) two undergraduate scholarships per year of $500 each;
iii) ten student travel bursaries for students attending and giving papers at a CMOS Congress for a total of $5,000;
iv) a teacher travel bursary to the AMS-NOAA "Project Atmosphere" in Kansas City, Missouri, at a level of $400 - $500 annually.

CMOS provides advice and information to guidance counsellors and students on meteorological and oceanographic career development.

CMOS participates, financially and professionally, in the development of scientific modules for the teaching of meteorology and oceanography in primary and secondary schools.

Recognition of Members' Achievements

CMOS recognizes outstanding contributions and services to meteorology and oceanography with the appointment of Fellows to the Society.

CMOS recognizes scientific and operational achievements of its members by means of its Prizes and Awards program.

CMOS also recognizes achievements of others serving the public through the provision of environmental information related to the fields of interest of the Society.

School and Public Education
A New Look for CMOS

by Eldon Oja
Chair, CMOS School and Public Education Committee

As we begin the 21st century, CMOS has begun a transformation as it becomes engaged in new and proactive endeavours to promote, encourage and foster an interest in meteorology and oceanography amongst young people through educational initiatives in the primary and secondary schools across Canada, and to promote a better informed public through the development of information programs in meteorology and oceanography.

The School and Public Education Committee (SPEC) / Comité d'Education Publique et Scolaire (CEPS) is a new entity within CMOS. The committee has been tasked to develop, implement and maintain an educational role for the Society, through appropriate strategies, priorities, programs, partnerships, and activities related to meteorology and oceanography for youth at the primary and secondary school levels across the K-12 curriculum, and the public at large.

You may recall that CMOS has been sponsoring along with the Canadian Council for Geographic Education (CCGE), Canadian teachers to attend the American Meteorological Society's Project Atmosphere teacher training sessions in Kansas City. Feedback from participating teachers indicated a need for more Canadian content in the material to take into the classroom. To this end, the SPEC committee has been working on *Project Atmosphere Canada,* a collaborative initiative of CMOS and the Meteorological Service of Canada (MSC), designed to adapt and introduce a Canadian version of the Project Atmosphere program into Canadian schools.

This transition into an educational role demands a renewed commitment by CMOS members to become much more involved at the both committee level and in the delivery of programs and related activities at the local Centre level.

In my discussions on outreach and education, I often quote Edward D. Eddy, Jr. who once said, "*Youth is a time of ferment, not cement. On the college campus we should disturb at every turn the cementing process, and encourage in every way the right kind of fermenting activity*". How has CMOS disturbed the cementing process to make young Canadians aware of the atmospheric and oceanographic sciences?

You may recall the English philosopher John Locke who spoke of a child as a *tabula rasa*, or a blank slate (tablet). By participating in school and public education activities such as Project Atmosphere Canada, CMOS members can help write the words METEOROLOGY and OCEANOGRAPHY on that blank slate.

Welcome to our future.

Entendu sur les ondes radiophoniques de Radio-Canada

Dieu a créé les météorologistes pour mieux faire paraître les économistes!

Questions les plus fréquemment demandées au sujet de l'augmentation des frais d'adhésion

Quels sont les avantages d'être un membre de la SCMO ?

Il n'y a aucune autre société ou organisation semblable au Canada qui se voue aux sciences météorologiques et océanographiques et qui offre des services à ses membres et au grand public. Si la SCMO n'existait pas, on devrait l'inventer.

La SCMO est un organisme sans but lucratif qui reçoit des contributions volontaires afin d'encourager les programmes éducationnels à l'université et à l'école. Des reçus pour fins d'impôt sont remis aux donateurs.

La SCMO sert de lien et contribue à un forum d'échanges d'idées pour tous les membres de la communauté météorologique et océanographique au Canada.

La SCMO foumit une liste d'offres d'emploi aux nombreux météorologistes et océanographes à la retraite qui désirent prolonger leur carrière professionnelle. Pour les autres membres de la communauté, elle offre des services à un coût très minime.

La SCMO est un organisme pancanadien fonctionnant dans les deux langues officielles.

La SCMO organise un Congrès annuel afin d'encourager les sciences météorologiques et océanographiques. Un centre local ou une section en est l'hôte et il organise le congrès sur des thèmes d'intérêt soit local, régional ou mondial.

La SCMO publie la revue scientifique "ATMOSPHERE-OCEAN" et elle a très bonne réputation parmi les autres revues internationales météorologiques et océanographiques.

La SCMO publie au moment opportun, dans le *"CMOS BULLETIN SCMO"*, des articles historiques et d'actualité qui sont d'intérêt pour les membres. Le bulletin, publié six fois l'an, coûte un peu plus de 26 000 $ ou 32,50 $ par membre.

La SCMO met à la disposition des ses membres, cherchant du travail, de l'espace publicitaire gratuit sur le site internet de la société et dans le Bulletin. Celui-ci est une excellente publication pour annoncer des postes vacants ; la page d'accueil du site affiche même une liste de postes vacants, et c'est gratuit.

La SCMO transmet à ses membres des messages concernant les conférences et les ateliers de travail à venir.

La SCMO subventionne des conférences et des ateliers de travail pour un montant total annuel de 2 000 $.

Le site internet de la SCMO fournie un lien unique d'accès pour ses membres et il les renseigne sur l'accréditation des consultants, l'approbation des présentateurs météo, les programmes éducationnels pour les professeurs et les étudiants. De plus, le site fournit des renvois électroniques à d'autres sociétés et sujets similaires à l'échelle mondiale.

La SCMO comprend quatorze centres locaux et sections à travers le pays. Chaque centre local et section sont subventionnés et des fonds additionnels peuvent être accordés pour la tenue d'une exposition scientifique d'une école. Ces centres locaux et sections offrent des conférences et des ateliers d'intérêt pour ses membres Ils organisent aussi d'autres activités telles que des visites, des conférences dans les écoles et des expositions scientifiques.

La SCMO organise annuellement la tournée d'un conférencier itinérant dans chaque centre local et chaque section.

La SCMO :

i) représente les intérêts de ses membres en faisant pression auprès du gouvernement pour mettre en valeur la recherche en sciences atmosphériques et océanographiques par l'envoi de lettres aux ministres et au Partenariat en Faveur des Science et de la Technologie (PFST) ;
ii) prépare des directives et des critères à être diffusés au public lors d'alertes sur les catastrophes naturelles ;
iii) accrédite des experts-conseils en météorologie et en océanographie ;
iv) approuve des présentateurs météo en radio et télévision.

L'exemple le plus frappant où la SCMO a été efficace comme groupe de pression, c'est bien lors de l'obtention de soixante millions de dollars pour la création de la Fondation canadienne pour les sciences climatiques et atmosphériques. Les membres du conseil d'administration de la SCMO sont membres de cette fondation.

Que fait la SCMO pour le secteur privé?

Elle fournit un lien actif entre le secteur privé et le gouvernement, et aide à résoudre les conflits.

Elle organise des réunions du secteur privé.

Elle maintient une liste des compagnies canadiennes du secteur privé.

Elle soumet les demandes de renseignements, provenant du public canadien et international, vers des sources compétentes, ou bien la SCMO répond directement aux questions.

Que fait la SCMO pour les étudiants?

La SCMO est le principal bailleur de fonds et défend les intérêts des étudiants et de son implication dans les sciences météorologiques et océanographiques en subventionnant :

i) deux étudiants pour des bourses d'études de second cycle, sur une période de deux années à raison de 5 000 $ par année et par étudiant ;
ii) deux bourses d'études de premier cycle, octroyées annuellement au montant de 500 $ chacune ;
iii) des bourses de voyage à dix étudiants pour assister et présenter des articles au Congrès annuel de la SCMO pour un total de 5 000 $;
iv) une bourse annuelle de voyage, d'un montant d'environ 400 à 500 $, à un enseignant d'école secondaire pour participer à l'atelier "Project Atmosphere" de l'AMS/NOAA à Kansas City au Missouri.

La SCMO fournit des conseils et de l'information aux orienteurs et aux étudiants pour la promotion de la carrière en météorologie et en océanographie.

La SCMO participe, financièrement et professionnellement, à la préparation de modules scientifiques pour l'enseignement de la météorologie et de l'océanographie dans les écoles primaires et secondaires.

Reconnaissance du mérite de ses membres

La SCMO récompense les contributions et les services exceptionnels à la météorologie et à l'océanographie en accordant le titre de Membre émérite.

La SCMO reconnaît les réalisations scientifiques et opérationnelles de ses membres avec son programme de prix et de récompenses.

La SCMO reconnaît aussi les réalisations de personnes au service du public transmettant de l'information environnementale reliée dans les domaines d'intérêt de la société.

Report on Special Session on the Socio-Economic Value of Weather Information and Services

On May 30th, 2000, at the Annual Congress of the Canadian Meteorological and Oceanographic Society in Victoria, British Columbia, the MSC hosted a special session on the social and economic value of weather information and services. The popular session was standing room only, with lively question and answer sessions.

Background

Public and media interest in significant and extreme weather events has been growing. Questions are being raised about the social and economic ***costs*** of weather, climate change and global warming, and the related issues of the economic and societal ***value*** of weather, climate and environmental information and services.

As a public agency facing continual resource pressures, the MSC is under pressure to justify the economic and social benefits of the products and services it provides. While MSC has commissioned some contracted studies and sponsored graduate work to study aspects of the value of weather information, the topic is too vast and resources too limited to enable a proper response to such requests.

From the CMOS perspective, one of Dr. Rutherford's priorities as President of the Society was to focus on the value of atmospheric information to society.

Members of the CMOS executive and the Meteorological Service of Canada met in the fall of 1999 to discuss possible joint activities they could undertake on this issue. They agreed that an important step would be to host this half-day session at the annual Congress to initiate the discussion with the broader meteorological community.

Objectives

The objectives of the half-day session were to:

- stimulate interest in this topic among the meteorological community;
- share ideas and knowledge and identify key players to advance the body of knowledge;
- identify opportunities for future work and research.

Agenda/Structure of Session

Four speakers gave presentations on a variety of aspects of the economic and social value of weather, followed by a panel discussion which provided an opportunity for those attending the session to ask questions and state their views on this important topic.

Session Schedule

Session Chair: Brian O'Donnell, Regional Director, MSC, Pacific and Yukon Region.

13:50 - 14:45	**Keynote Address**: *Societal Aspect of Weather: Implications for Research and Policy* Roger A. Pielke, Jr., NCAR
14:45 - 15:15	*The Value of Weather and Climate Products* Valerie Sexton, Economist, Environmental Economics Branch, Environment Canada
15:15 - 15:30	**Health Break**
15:30 - 16:00	*Weather Prophets: The Private Industry Perspective* Ron Bianchi, V.P. of Meteorology, The Weather Network/MétéoMédia
16:00 - 16:30	*The Economic Context of Weather Information Generation and Dissemination* Dr. Kim Rollins and Jeremy S. Brown, University of Guelph
16:30 - 17:30	Panel Discussion **Moderator**: Richard Berry, Meteorological Service of Canada **Panel members**: Roger Pielke Jr., Valerie Sexton, Ron Bianchi, and Kim Rollins
17:30 - 17:40	**Session Wrap Up** Richard Berry

Atmosphere-Ocean Vol 39-1 Paper Order

OC-201 Vorticity Fluxes in Shallow Water Ocean Models by Andrew Peterson and Richard J. Greatbatch

OC-222 Ocean Heat Transport and a Climate Paradox by William A. Gough and Margarita Lozinova

OC-224 Solution of the Linear Thermocline Equations Driven by Wind Stress and Thermohaline Forcing by Adrian Hines and Andrew J. Willmott

AO-209 The Influence of Snow Cover on Northern Hemisphere Climate Variability by Judah Cohen and Dara Entekhabi

99-08 Precipitation data quality and long-term water balances within the Moose River Basin, east-central Canada by Anthony Story and James M. Buttle

These papers can be read on CMOS Website (http://www.cmos.ca).

Ces publications peuveut être lues sur le site Internet de la SCMO (http://www.scmo.ca).

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* Credit must be attributed

An Open Invitation to Attend the 35th CMOS Annual Congress

EXTREME Weather

It is our pleasure to invite you to the 35th CMOS Congress to be held in Winnipeg from May 28th to June 1st, 2001. The theme for this year's congress is Extreme Weather. What better offering of weather extremes than the Canadian prairies, home to summer thunderstorms, winter blizzards, droughts and floods, heat waves and cold snaps. The congress itself will be filled with a stimulating scientific program; as well as social functions where colleagues can come together to learn, share new ideas, renew old friendships and build new ones.

We wish to welcome you to the city at the forks of the Red and Assiniboine Rivers. A vibrant prairie metropolis of 650,000 people, Winnipeg is a city filled with diversity, lush green parks and friendly faces. Aside from the congress itself, we invite you to explore the endless variety of dining and cultural activities, festivals, attractions from sports to the arts, museums and galleries, from the scenic Forks to the bustling downtown.

Jim Slipec, Chair Local Arrangements Committee
Chair Winnipeg Centre

Invitation à participer au 35e Congrès de la SCMO

Météo EXTREME

Nous avons le plaisir de vous souhaiter la bienvenue au 35e congrès de la Société canadienne de météorologie et d'océanographie (SCMO) qui aura lieu à Winnipeg du 28 mai au 1er juin 2001. Le thème du congrès portera sur les Conditions météorologiques exceptionnelles". Les prairies canadiennes seront donc un cadre approprié pour un tel congrès puisqu'on y observe souvent ce type de phénomènes: orages en été, tempêtes de neige en hiver, périodes de sécheresse, inondations, vagues de chaleur et coups de froid. Le congrès offrira un programme scientifique stimulant ainsi que les réunions habituelles au cours desquelles les participants pourront se rencontrer pour échanger, retrouver de vieilles connaissances et en faire de nouvelles. J'espère que ce congrès ira au-delà de vos attentes et soyez certain que nous sommes impatients de vous accueillir très bientôt à Winnipeg.

Jim Slipec, Président du comité local organisateur
Président de l'antenne de la SCMO à Winnipeg

Impacts of Global Environmental and Climate Change: Ozone Depletion, UV Radiation and Health Risk

15 - 18 July 2001
Steamboat Springs, Colorado

UV Instrumentation at Storm Peak Lab

This workshop is specifically designed to provide field training and instructional materials related to the scientific assessment and increasing risks of ultraviolet (UV) exposure caused by ozone depletion.

COLLECT measurements using UV-A, UV-B, solar and meteorological sensors, including those used by national UV monitoring networks. ACCESS data from regional networks and NASA satellites which provide daily monitoring of UV exposure and ozone. EXAMINE the processes which cause variation in solar and UV fluxes during seasonal cycles. NETWORK your college with the other participating faculty, sharing data applications and analyses related to UV climatology and health risk. INTERACT with public health and recreation groups in your community to obtain and provide new information. ENJOY the beautiful alpine setting of Steamboat Springs, Yampa River Valley and Routt National Forest during this workshop.

This workshop is open to all faculty who are teaching in science, environmental or health-related fields, including meteorology, biology, geography, environmental technology, health sciences, medicine, zoology, chemistry, agriculture and forestry. The workshop will include hands-on use of UV monitoring equipment; lectures on the physical and chemical processes leading to ozone depletion and increased UV radiation; demonstration of CD- and web-based sources of instructional materials on UV climatology, ozone trends, and health effects; and group development of curriculum plans which can be used in a wide range of environmental, health and science courses. The workshop will be held in Steamboat Springs (northwest Colorado) at the Colorado Mountain College campus and the Desert Research Institute's mountaintop Storm Peak Laboratory (www.dri.edu/Projects/SPL). Airline and van shuttle service is available from Denver. The workshop fee is US$50. Food and lodging will be provided. Lodging arrangements for family can also be accommodated. This workshop is sponsored by a Geoscience Education grant from the National Science Foundation.

Workshop Leaders: *Melanie Wetzel* is an Associate Research Professor in the Division of Atmospheric Sciences of the Desert Research Institute (DRI), which is a branch of the University and Community College System of Nevada. She has a Ph.D. degree in Atmospheric Sciences and 20 years of teaching and research experience. Dr. Wetzel is a member of the graduate teaching faculty of University of Nevada, Reno, and has led training workshops on meteorological instrumentation and satellite remote sensing for college instructors. *Rebecca Steffens* is Director of Research for the Science and Public Policy Institute (Washington, DC). She has a Master's degree in Public Health from the University of Michigan, and is a specialist in research related to environmental health risks such as cancer. She has a background in dermatology, as well as the epidemiological and statistical analysis of cancer incidence within different population groups, and experience in training the public regarding health risk intervention strategies.

For more information: please contact Dr. Melanie Wetzel:

by e-mail: wetzel@dri.edu
by phone: (970) 879-8796.

EWOC 2003
Education: Weather, Ocean & Climate

6th International Conference on
Meteorology/Oceanography Education
Universidad Europea CEES
Madrid, Spain
7-11 July 2003

Scientific Program

The conference will be focused on the following topics:

- The Role of Mass Media in Meteorology & Oceanography education;
- Meteorology & Oceanography in National Curricula;
- Meteorology & Oceanography on the Internet;
- Teacher Training in Meteorology & Oceanography;
- Promoting Math & Science Education through Meteorology & Oceanography;
- Weather and Society;
- International Cooperation projects;
- Hands on Work activities.

For all of them, preference will be given to papers based on an international approach.

School Competition

Once again, elementary, middle and high school students will be invited to participate in EWOC-2003 School Competition.

How about the following?

- A 3 to 5 minute **International Weather Forecast** should be video taped /DVD recorded and posted to the local organisers before 1 May 2003;
- The forecast should refer to any region on Planet Earth, except for the student's own country. The language should also be different from the student's mother tongue, preferably English or Spanish;
- Schools can participate with as many groups of students as they wish, indicating in each case the group's category: Elementary (5 to 9 year old students), Middle (10 to 13 year old students) or High (14 to 17 year old students);
- The local organising committee will nominate 5 school forecasts of each category, which will be shown during a conference session for final voting amongst the conference participants;
- Prizes are still to be determined, sponsoring seems the best way.

Languages

We thought a good way to reinforce the international component of the conference could be to officially use another language apart from English. In this sense, **abstracts will be accepted both in English or Spanish**. If authors cannot or do not wish to supply both versions themselves, the Translation Department of this university will translate into Spanish abstracts received in English, and into English those received in Spanish. Translations will be checked by the local organising committee. This way **the abstract booklet will contain the two complete versions, in both languages.**

Papers will also be accepted in both languages, but only the original version will appear on the Conference CD.

Presentations will also be accepted in both languages. Audiovisual support in the other language could be useful (key words on slides or so), this can be strongly recommended, though it will not be possible in all cases. Simultaneous translation would be desirable during presentations, but for the moment it cannot be guaranteed.

Web Page

We now have a conference web page: www.uem.es/facultad/ewoc2003.htm where information will be included and updated.

There is also a conference e-mail address: ewoc2003@fis.cie.uem.es. The local organising committee (Adelaida Portela, Rosa Rodriguez) will be in charge of it.

Fees

For the moment figures are only approximate, and they might change in the future, hopefully for the low:

- Registration fee: 300 Euros?
- Accommodation fee (1 week bed & meals in single rooms): 300 Euros?
- Cultural activities fee: 175 Euros?

Cultural Activities

Cultural activities will take place in the evenings of the conference week. Sightseeing tours to Madrid, Toledo & El Escorial are being planned. We will possibly have a dancing evening at the college residence and a scientific tour on Satuday 12 July 2003.

Note from the Editor: by mid-april, 1 Euro = 1.3871 $Cdn.

Fisheries and Oceans Canada Hosted International Conference Promoting Robotic and Satellite Technology in Monitoring the Ocean's Impact on Climate Change

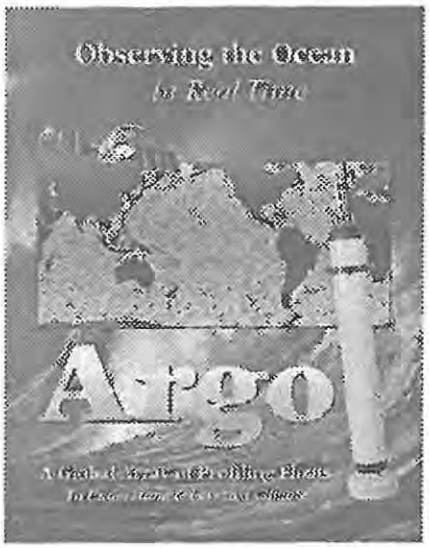
VICTORIA, BC – Fisheries and Oceans Canada was proud to host the International Argo Science Team, a global effort to collect and share information on the temperature, currents, and salinity of the world's oceans. More than 40 delegates representing 14 countries and two international science organizations, North Pacific Marine Science Organization (PICES) and Intergovernmental Oceanographic Commission/World Meteorological Organization (IOC/WMO), attended the conference at the Institute of Ocean Sciences, March 20-22, 2001.

Data collected by a global array of floating robotic devices will be used to better predict the influence of events such as El Niño and La Niña on our seasonal climate. Since weather and climate are linked to the ocean, data from the floating observing systems will help Environment Canada conduct long-term seasonal forecasts.

"Canada is proud to join our international partners in this exciting project," said DFO Minister Dhaliwal. "*This comprehensive observing system, when integrated with our existing marine atmospheric and terrestrial information, will help us to build better climate models to more accurately predict changes that could impact our marine ecosystem.*"

The Argo robotic devices will sample, analyze and provide information on the deep velocities of the ocean, near surface velocities, and temperature and salinity between the deep level and the surface. Once an Argo device is deployed at the ocean surface, it readjusts its buoyancy and sinks to a depth of 2000 metres. After drifting in the deep ocean current for 10 days, the float readjusts, floats to the surface, and takes measurements during its ascent. Once the float surfaces, it begins to transmit data to land-based receiving stations via a tracking satellite for 12 hours. Then it returns to its deep "parking" depth of 2000 metres. Each float has a lifespan of approximately five years.

"*When data collected from the Argo network is integrated with meteorological seasonal forecast models, the results will allow us to forecast in time scales of six months to one year,*" said Dr. Laura Richards, Regional Director of Science for Fisheries and Oceans Canada. "*The benefits of a nine month weather forecast would be immense. Imagine the impact this could have on ski-slope operators or the entire agriculture industry.*"



This coming May, 677 robotic ocean floats will be deployed by ship or aircraft around the world. Project Argo – named in honour of the mythological vessel in which Jason went in search of the golden fleece – will provide for the first time a comprehensive oceans observing system. Canada has committed to providing 52 floats to the Argo network this year – 46 in the Northeast Pacific and six in the Northwest Atlantic. Countries participating in this project include: USA, Japan, France, Germany, Australia, the European community, Brazil, South Africa, India, China, New Zealand, Republic of Korea, and Spain.

The Argo team – dubbed Argonauts – have determined 3000 floats are needed for the full global observing array. The goal is to have the entire network of floats drifting and bobbing throughout the world's oceans by 2003. The data will be sent back in real time, making it immediately available to all countries including those currently not represented on the Argo team.

The Canadian contribution to Argo is funded and implemented by Fisheries and Oceans Canada.

For additional information on Argo, visit their Web site: http://www.argo.ucsd.edu/

Ocean Circulation and Climate Observing and Modelling the Global Ocean

Edited by: Gerold Siedler,
John Church and John Gould
Academic Press International
Geophysics Series
(http://www.apnet.com/igs/)

This new book is a remarkable exploration of our understanding of the physics of the global ocean circulation (and particularly its role in climate) at the beginning of the 21st century. The book is not a collection of individual papers and so it contains an integrated reference list (2300 entries) and a very comprehensive index. The book is now at the printers and will appear in bookshops at the end of March.

So if you want to order your copy at the unrepeatable discounted rate of 50% plus postage and packing which is only being offered to attendees of the WOCE Conference in Halifax, Nova Scotia, May 1998, then please send your order form to the WOCE IPO.

If you have already requested a copy be sure you include the order form. Without this form we will not be able to process your order.

The order form was enclosed with the latest issue of the WOCE Newsletter #40, or a pdf version is on the web at, http://www.woce.org.

Au delà des présentateurs Météo[1]

(Le Devoir) - Montréal accueillera, du 24 au 27 mai 2001, le 11e Festival international de météo. L'événement, créé en France, se tiendra pour la deuxième fois seulement hors de ses frontières. Le Festival réunira particulièrement ceux qui donnent de l'information météorologique dans les médias, pour leur permettre de discuter sur leurs différentes façons de travailler. Le Festival se penchera sur les changements climatiques qui affligent la planète et sur les façons de vulgariser le phénomène et de faire des liens avec la présentation quotidienne du bulletin météo. Pour en savoir plus, www.weatherfestivalmeteo.org.

1: Le Devoir, 2 avril 2001, p.B1.

Merger of MARTEC and METOCEAN

Press Release February 5, 2001

MARTEC of Sevres, Cedex, France, and METOCEAN Data Systems Limited of Dartmouth, Nova Scotia, Canada, announce the merger of METOCEAN and MARTEC. The management team at METOCEAN will remain unchanged, and METOCEAN will continue to be located at their manufacturing and engineering facility in Burnside Industrial Park in Dartmouth, Nova Scotia.

MARTEC and METOCEAN have had a strategic alliance since June 1999, and MARTEC has been assisting METOCEAN in the development of their NEPTUNE™ deep diving Argo floats.

MARTEC will continue to manufacture and sell their complete line of PROVOR and MARVOR floats for the French and European markets, and METOCEAN will manufacture the family of PROVOR and MARVOR floats for markets in North America and outside Europe. METOCEAN will also continue the development of their new NEPTUNE™ Model SC float. It is expected that both companies will jointly develop new float products.

MARTEC has been developing floats and other underwater devices for the French scientific community for more than 16 years, and they also act as a manufacturer's representative for many of the leading oceanographic instrumentation companies of the world.

For more than 15 years, METOCEAN has been developing and manufacturing drifting buoys and polar platforms for the operational oceanographic and meteorological communities as well as the scientific markets in these fields.

Oceans Explorations 2001: Learning from our Oceans

Oceans Explorations 2001 is a national discussion series delivered through a partnership between the Oceans Institute of Canada, the CBC Radio Ideas Program and Fisheries and Oceans Canada. The series is designed to encourage dialogue among Canadians about the oceans and their contiguous coastal zone. Three public panel/discussion events will be held:

- Halifax, 7:30 pm, Friday, 6 April, Sobey Building, Saint Mary's University;
- Victoria, 7:30 pm, Thursday, 24 May (provisional);
- Iqaluit, Tuesday, 12 June or 19 June (provisional).

For information, email Mike Butler at mbutler@is.dal.ca

The Government of Canada Announces Climate Change Research and Public Awareness Projects at Northern Summit[1]

March 19, 2001 - WHITEHORSE - Better understanding climate change and its impacts on Canada's unique Northern environment, society and economy is the focus of the Climate Change in the Circumpolar North Summit, which opened today. Ralph Goodale, Minister of Natural Resources Canada, addressed the Summit opening and announced 47 projects that will encourage Canadians to reduce greenhouse gas emissions, increase public knowledge of climate change and shed new light on the Arctic climate system, as well as potential impacts and adaptation strategies. The Government of Canada is investing $1.8 million in these projects.

"We need to understand more clearly the challenges we face" said Minister Goodale. "Then we can focus our efforts on developing strategies to adapt to climate change and reduce greenhouse gas emissions in the future."

"Canada's environment is already feeling the effects of climate change, especially in the North. These projects show the kind of creativity and commitment that Canadians are bringing to the challenge of climate change," said David Anderson, Minister of the Environment. Funding for these projects comes from the Government of Canada's Climate Change Action Fund (CCAF), through its Science, Impacts and Adaptation and Public Education and Outreach (PEO) components. Among the projects are seven dealing specifically with northern issues. This innovative research will give scientists, decision-makers and residents in Canada's North a better understanding of potential impacts by examining permafrost degradation over a wider Arctic area, studying marine mammals, such as the ringed seal, and how to incorporate traditional and scientific knowledge in our research and response.

Some of the PEO projects include creating a "Green Electricity" primer to promote use of green electricity to business and industry, a "Cool Climate Kids" education and action club, and a "Northern Climate Change School Pilot Program" to raise climate change awareness for elementary and secondary school children.

The Government of Canada established the CCAF to take concrete steps to engage Canadians, non-government organizations, businesses, universities, communities and various levels of government in partnerships to promote climate change understanding, action and adaptation. As part of the Government of Canada's renewal of the CCAF and Action Plan 2000 on Climate Change, it will continue its commitment to support research to better identify challenges and opportunities that climate change will present.

The Science, Impacts and Adaptation component of the CCAF supports projects that help improve climate change knowledge, provide better scientific advice, and identify the adaptation responses. The Public Education and Outreach component supports national awareness and communications activities, as well as funds projects that increase public awareness and help provide the information they need to take action.

The Climate Change in the Circumpolar North Summit took place in Whitehorse, Yukon and ran until March 21. It brought together experts and stakeholders to exchange ideas, expertise and knowledge, and promotes various climate change-related technologies, products and services available in the North.

"We know that climate change will be more pronounced in the North," said Yukon MP Larry Bagnell. "This summit is a chance to look at the wide spectrum of issues related to climate change and the steps we can take to deal with them. To meet the climate change challenge, particularly in the North, we have to work together and this summit helps us do that."

Government of Canada funding for CCAF projects was provided for in the February 2000 budget and is therefore built into the existing financial framework.

For more information, please contact:

Pat Breton, Press Secretary
Natural Resources Canada
(613) 996-2007; or

Johanne Beaulieu, Press Secretary
Office of the Minister of the Environment
(819) 953-2101

1: Source: Environment Canada Website

Subaru and American Meteorological Society Announce Partnership to Support Science Education[2]

CHERRY HILL, N.J., March 6, 2000 -- Subaru of America, Inc. (SOA), a pioneer of crossover all-wheel drive vehicles designed for the active lifestyle, today announced a new partnership with the American Meteorological Society (AMS), the nation's leading professional society for scientists in the atmospheric and related oceanic and hydrologic sciences.

The partnership will focus primarily on science education initiatives. Under the agreement, Subaru will provide funding to support the aims and objectives of AMS' education programs such as teacher training, scholarships and fellowships. The two organizations kicked off the partnership at the 81st Annual AMS Meeting in

Albuquerque, New Mexico on January 14-18, 2001.

"We are pleased to welcome Subaru of America, Inc. as the first corporate 'patron' of the AMS," said Ronald D. McPherson, AMS executive director. *"Our shared commitment to science and education makes the pursuit of new opportunities possible for the AMS and will increase the impact of our outreach programs."* The SOA sponsorship will support many AMS educational activities.

"Subaru is proud to support the goals and objectives of AMS through a variety of programs," said Maria Smith, promotions and sponsorship specialist, Subaru of America, Inc. *"Subaru is dedicated to the advancement of science education, and the study of weather in particular, making our partnership with the AMS a natural choice."*

In addition to sponsoring several AMS education programs, Subaru will make a donation to the AMS education and outreach programs in the amount of $150 when an AMS member, family member or friend of a member purchases or leases a Subaru through an authorized Subaru dealership.

2: Source: American Meteorological Society Website (http://www.ametsoc.org/AMS).

Environment and Sustainable Development in Canada

In Section 6 of his end-of-term report, Auditor General Denis Desautels reviews the state of the environment and sustainable development in Canada. He states that "the greening of the Government of Canada might best be characterized as an unfinished journey". The report is available at:
http://www.oag-bvg.gc.ca/domino/other.nsf/html/99menu5e.html

Wild Salmon and Salmon Aquaculture

An article by Bill Doubleday (former Director-General at DFO) in the spring issue of ISUMA, the Canadian Journal of Policy Research, considers the potential impact of salmon aquaculture, as currently practised, on the overall survival of wild salmon in Canada. The article is available at http://www.isuma.net/v02n01/index.htm

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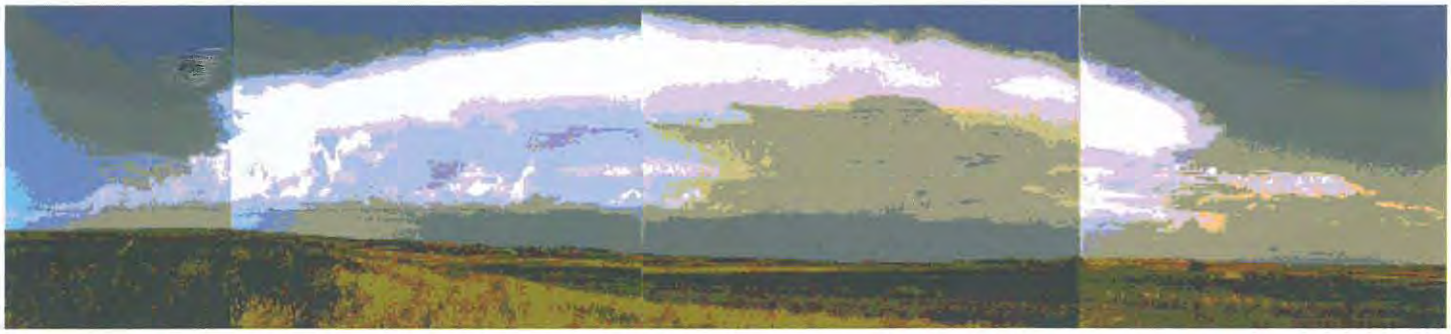

Figure 1, page 42: A large thunderstorm developing northwest of the Swift Current evaporation site on 10 July, 1994, which produced heavy rainfalls and a small tornado (photo by G. Strong). Strong, G.S. and C. Hrynkiw, *Open-water Evaporation: The Swift Current Water Balance Study*, CMOS Bulletin SCMO, Vo.29, No.2, page 40-48.

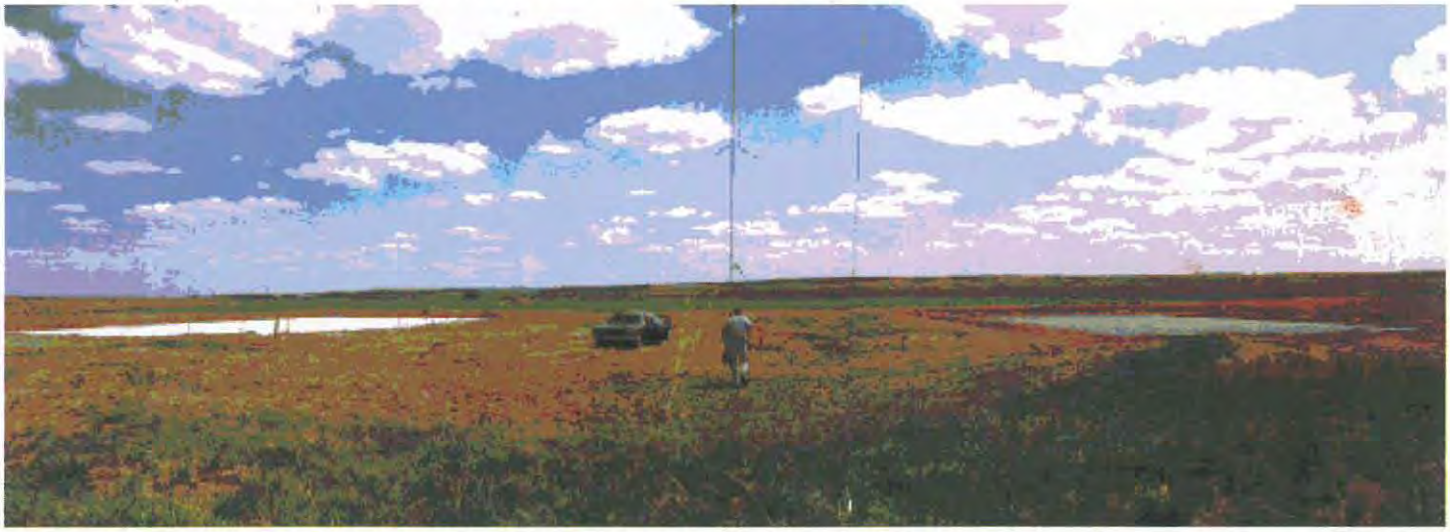

Figure 3, page 44: Panoramic view east showing 10-m meteorological tower (R403) between the two lined dugouts, each ~30 m by 55 m by 4 m deep, used in the Swift Current evaporation study; 3-m tower and evaporation pan were added later (photos by G. Strong). Strong, G.S. and C. Hrynkiw, *Open-water Evaporation: The Swift Current Water Balance Study*, CMOS Bulletin SCMO, Vo.29, No.2, page 40-48.