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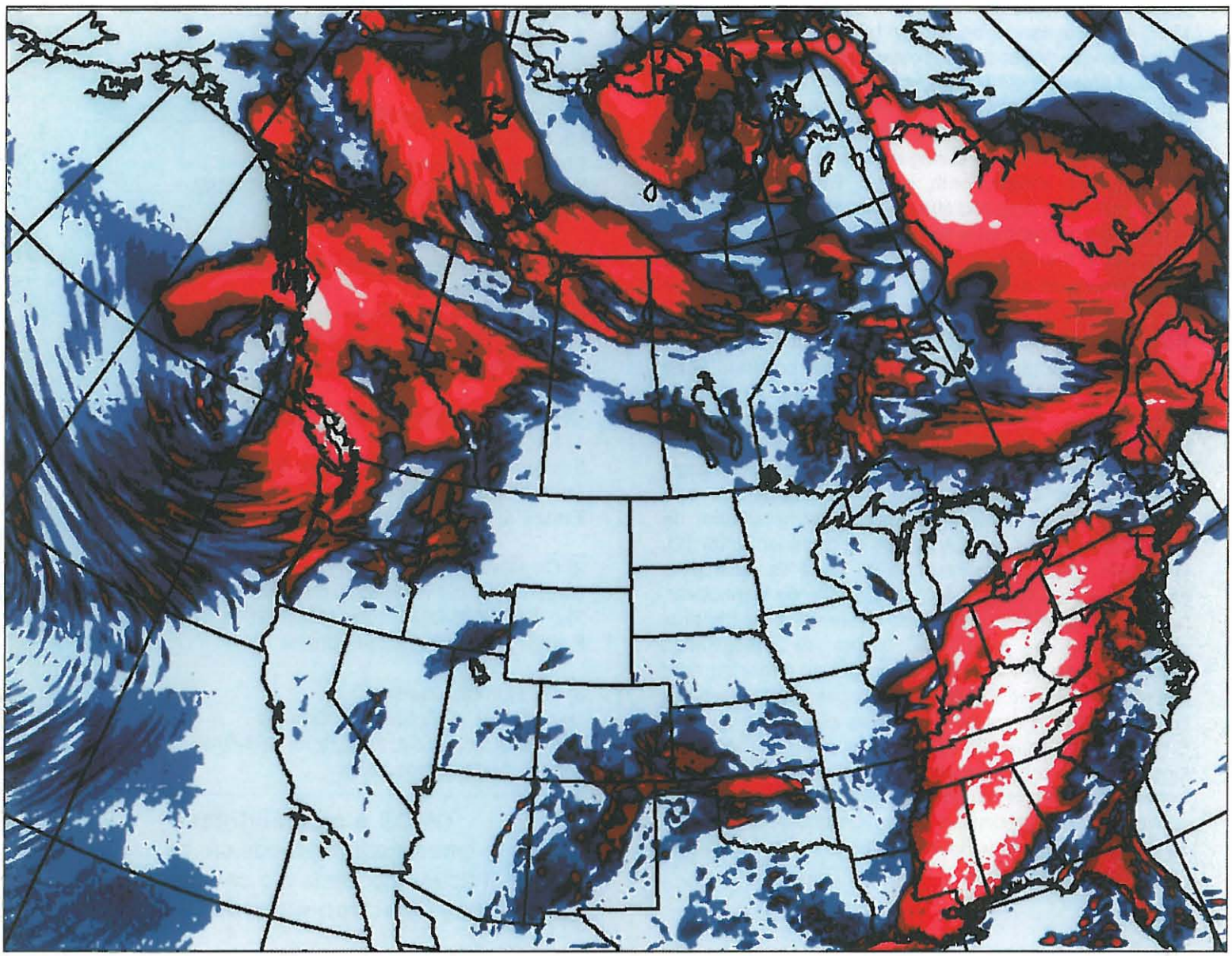

CMOS Bulletin SCMO
"at the service of its members
au service de ses membres"

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Cover page: History was made on June 27 1997 as a first real-time mesoscale forecast at 10 km resolution covering all of North America was computed using the Massively Parallel computer recently acquired by Environment Canada. See article News Flash, p. 102. Cover picture is not a satellite view but the 24-hour total precipitation forecast terminating at 00 UTC 27 June 1997. There is almost one model gridpoint for every pixel on the image. West of Vancouver Island, the fingerprint of cloud streets post-frontal convective rain is amazing, with also a precipitation tongue moving out to sea in the return flow North of the Queen Charlotte Islands. Severe convection has bubbled during the afternoon over the hot US Southern Plains, with squall lines activity over Oklahoma. The long red streak from the Sudbury region across central Quebec is due to fast-moving convection. From South Carolina to Cap Canaveral, the sea-breeze front appears as a narrow red line.

Page couverture: Le 27 juin 1997 a fait histoire, alors que la première prévision de mésoéchelle couvrant toute l'Amérique du Nord à une résolution de 10 Km fut intégrée, au moyen de l'ordinateur à structure massivement parallèle acquis récemment par Environnement Canada (voir l'article News Flash en page 102). L'image sur la couverture n'est pas une vue satellitaire, mais plutôt la prévision d'accumulation de pluie pour la période de 24 heures se terminant à 00 TU, le 27 juin 1997. Il y a presque un point de grille pour chaque pixel de l'image! À l'ouest de l'île de Vancouver, l'empreinte des allées de nuages convectifs post-frontaux est surprenante, avec une langue de précipitation s'étendant vers la mer dans le courant de retour au nord des iles de la Reine Charlotte. De la convection sévère a bouillonné durant l'après-midi sur les plaines du sud des É.U., avec des lignes de bourrasques sur l'Oklahoma. La longue traînée rouge s'étendant de la région de Sudbury à travers le centre du Québec est causée par de la convection en déplacement rapide. De la Caroline du Sud au Cap Canaveral, le front de brise de mer apparaît comme une ligne rouge.

Canadian Meteorological and Oceanographic Society (CMOS)

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Tour Speaker

Many members were disappointed that we missed the normal spring speaker tour this year, but good things are worth waiting for and I'm pleased that we have now been able to arrange a fall tour. Dr. William Hsieh, who is Associate Professor in the Department of Earth and Ocean Sciences at the University of British Columbia, will speak on "Neural Networks for Short-term Climate Prediction". The tour is being done in two parts to accommodate William's teaching commitments. The eastern swing, which includes Halifax, Montréal, Ottawa and Toronto will take place in October. William hopes to cover the western centres in December. We have been able to arrange co-sponsorship of this tour with the Canadian Institute for Climate Studies and look forward to welcoming some of their members to the presentations.

Pour nos membres de Québec et de Rimouski, nous avons organisé une présentation par le Dr. Louis Lefaivre, chef de la division des prévisions numériques du temps, au CMC. Les présentations se tiendront vers la fin du mois d'octobre. Il présentera les méthodes dynamiques qu'on utilise au CMC pour les prévisions à longue échéance. De plus, il présentera un court résumé de l'atelier du groupe de travail sur les prévisions à longue échéance reliées à l'agriculture qui aura eu lieu du 20 au 22 octobre au CMC.

If you are interested in participating in the workshop on long range forecasting and agriculture mentioned above, please contact Louis at Louis.Lefaivre@ec.gc.ca.

The Ottawa Scene

As many of us anticipated, the Alternative Service Delivery study is running behind the original schedule. Lots of analyses are under way but nothing in the way of hard information is being released. Joanne Lancaster (on secondment from DOE Atlantic Region) is managing the communications aspects from the project offices in Hull. She tells me that a general mailing to stakeholders is scheduled for the first or second week of September. The mailing will include an announcement of the study, a brief explanation, an invitation to provide the study with comments, concerns or submissions, and a request if the stakeholder wishes to be part of a consultation process to

begin after mid-November. I have recommended that they share some of the analysis at that time. If you want to be on the stakeholder list, contact Joanne by telephone at (819) 994-9292 or email to: Joanne.Lancaster@ec.gc.ca. Employees of Environment Canada are already identified for consultation.

Meanwhile, the Deputy Minister of Environment Canada has announced that staff level reductions in the department will now be greater than originally expected in order to meet the $17.2 million budget reduction in 1998-99 which was part of the 1996 budget. He stated "We had expected that these reductions could be achieved through additional revenue-generation, cost-recovery and other modest changes in program delivery. Consequently, we had anticipated fewer than fifty (50) positions to be affected and minimal impact on departmental programs. Unfortunately, these (financial) projections are not materializing."

Announcements about programs and individuals to be "affected" (the Public Service euphemism) are scheduled for the first week of September. There are undoubtedly some who welcome the opportunity to leave government with an incentive package. But it seems an odd juxtaposition to be looking to a new ASD organization, without having set on a model, while at the same time precluding options by making cuts to programs and staff! The need for national public good weather services, and research and development to address issues of atmospheric variability and change, has never been greater.

NSERC

The results of the 1997 Research Grants Competition have been published. Overall, out of a total of 4,260 applications for R&D grants, 79 percent were funded. Including installments from applications approved in previous years 7,258 projects are now approved for a total of $192,078M. Environmental Earth Sciences (EES), where most CMOS university members find their funding, awarded 335 grants for a total of $7.791M, about 4% of the total. In round figures, about 100 of these, 1.4 percent, are in the fields of meteorology and oceanography; the boundary is hard to define.

As most university faculty will know, there is presently a quadrennial reallocation exercise going on for NSERC funding. Grant selection committees stand to lose up to 10% of their funding unless they can make a convincing case to the Reallocation Committee. The solid and environmental earth sciences are presenting a combined case; a draft document is available at: http://earth.geo.ucalgary.ca/nserc/wwwboard/wwwboard.html.

CMOS has nominated Han-Ru Cho(cho@rossby.physics.utoronto.ca) and Brad de Young (bdeyoung@crosby.physics.mun.ca) to represent our disciplines on the selection committee drafting team. They have more work to do yet because the Reallocation Committee, which met in July, has now put a premium on enunciating a vision for the discipline in Canada, presented in an international context. If you have any concern about the size of the NSERC allocation from which you are seeking research support, it behooves you to take an interest in the reallocation exercise and make your views known to our representatives.

New University of Ottawa Chair

On April 15, the University of Ottawa inaugurated a new NSERC Industrial Research Chair in Earth Systems to investigate mechanism of global warming. NSERC, and its industrial partners Noranda Ltd. and Hatch & Associates Ltd., will invest over $1 million in the Chair over the next five years. Chairholder Dr. Jan Veizer and his colleagues will examine the dynamics of carbon dioxide.

Dr. Veizer and his group will attempt to gauge the amount and the fate of carbon that circulated through the water and the atmosphere in the past and compare the pattern to today's. This comparison will enable us to better estimate the impact of changes in the world's fuel burning patterns and the degree of global warming.

The University of Ottawa dedicated the "G.G. Hatch Isotope Laboratories" at the inauguration in honour of Dr. Hatch, the founder of Hatch & Associates Ltd., whose efforts helped in making the research chair a reality. The laboratories will analyse geological samples to provide clues on the chemical composition of ancient seawater as well as an understanding of biochemical processes in present-day rivers and lakes.

John Reid,
President / Président

Efficient experimental design strategy for numerical ocean modelling

by William A. Gough[1] and William J. Welch[2]

Résumé: Dans ce bref article, nous démontrons l'efficacité d'utiliser des techniques statistiques dans le concept d'une série d'expériences numériques lors d'une analyse de sensibilité d'un modèle de circulation générale d'eaux océaniques. Par exemple, les données d'un sonar passif sont étudiées et correlées avec le comportement de certains résultats du modèle d'écoulement des masses d'eaux océaniques. Les données dépendent grandement de la dispersion verticale du modèle en accord avec le renversement méridional des eaux. Il a été constaté que la tension du vent joue un rôle limité et que celui-ci diminue avec le temps. Nous avons détecté une contradiction entre les données et la dépendance de la fonction de flux au renversement sur la dispersion horizontale. Ceci rend donc possible la suggestion que le diagnostic utilisé pour la puissance du renversement des eaux n'est pas le meilleur.

Abstract: In this brief note we illustrate the efficacy of using statistical techniques in the design of a series of numerical experiments in a sensitivity analysis of an ocean general circulation model. As an example, the uptake of a passive tracer is examined and correlated to the behaviour of some ocean model flow diagnostics. The uptake is found to be highly dependent on the vertical diffusivity of the model consistent with the behaviour of the meridional overturning. It is found that the wind stress plays a small role which diminishes with time. A discrepancy between the uptake and overturning streamfunction dependency on the horizontal diffusivity is detected. This adds credence to the suggestion that the diagnostic used for the strength of overturning may not be the best.

1. Introduction

A common exercise for the developers and users of numerical models is to perform a sensitivity analysis. This is typically done by examining the model's response to variations in internal tunable parameters and variations in forcing. For ocean modelling, the internal tunable parameters include, among other things, diffusion coefficients used in temperature, salinity and passive tracer equations and viscosity coefficients used in the momentum equations. Typically, variations in forcing include the strength of surface wind stress and buoyancy.

The traditional approach to assess model sensitivity is to vary one parameter while holding all others constant. Even with a small sampling of each parameter, the required number of experiments quickly escalates. For example, if a model has five tunable parameters of interest and each are sampled thrice, 3^5 (243) experiments are needed, 729 for six parameters and 2187 for seven parameters. If we increase the sampling to five values each, the number of experiments increases to 3125, 15625 and 78125 respectively. Clearly these are impractical numbers of experiments for even coarse resolution ocean general circulation models. In practice, the numbers are reduced by using modelling "intuition", i.e. the vertical viscosity coefficient, within the range of numerical stability, has little impact on typical oceanic measures of the flow.

Employing statistical sophistry, another approach to experimental design for multi-parameter models has been demonstrated. A Latin hypercube design is used to sample an n dimensional parameter space. The statistical details are outlined elsewhere (McKay et al, 1979; Sacks et al., 1989; Johnson et al., 1990; Welch et al., 1992; Gough and Welch, 1994). Optimization insures that the design points are spread apart, enabling a good representation of the n dimensional space. Using model outputs, statistical approximating functions can be calculated, i.e. the creation of a statistical model of the dynamic model. The approximating functions can then be used to determine the importance of the input parameters on the model output.

In Gough and Welch (1994) this methodology was used with an ocean general circulation that used isopycnal mixing (along constant density surfaces). Seven input parameters were examined. Six of them were internal model parameters, diapycnal and isopycnal mixing coefficients, vertical and horizontal viscosity coefficients, horizontal background diffusivity, and the peak allowable isopycnal slope. The last two parameters were included as numerical overhead to enable isopycnal mixing in the model. The final parameter examined was the strength of the wind stress. A total of 51 experiments were run, considerably less than the 2187 required for the more traditional approach. It was found that the resulting

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oceanic flow depended highly on the diapycnal diffusivity (as expected from Bryan, 1987), wind stress, horizontal background diffusivity and the peak allowable isopycnal slope. This technique, for example, identified that the number of convective points was directly proportional to the horizontal background diffusivity and inversely proportional to the peak allowable isopycnal slope. This observation has led to more recent work (Gough, 1997).

In this work, we show another example that illustrates the efficacy of this approach. A series of experiments are run that explore a five-dimensional parameter space of a basin ocean general circulation model roughly representing the North Atlantic. We report here on the equilibrium flow under restoring boundary conditions for temperature and salinity, although the experiments have other motivations not included here. The uptake of passive tracer, released after equilibrium has been achieved, is the main diagnostic of interest. The uptake of tracer is dependent on such physical mechanisms as convection, dynamic overturning, vertical diffusion, and Ekman pumping due to wind stress.

In the next section, the model and experiments are briefly described. This is followed by the results and discussion of the statistical modelling.

2. Model description

The model used in this work is the widely distributed Bryan-Cox ocean general circulation model. It is based on the pioneering work of Bryan (1969). A detailed description of the model can be found elsewhere (Cox, 1984; Pacanowski et al., 1991).

The horizontal momentum, at the upper surface, is forced by the atmospheric winds. This is accomplished by using idealized wind stresses (τ_λ,τ_ϕ) given by an analytic representation. This choice is designed to produce a two gyre circulation in the North Atlantic, the approximate region of the model domain. The model has a 2° x 2° horizontal resolution extending from 20°N to 70°N and from 0 - 60°W. There are ten vertical levels of increasing thickness, emphasizing the more active thermocline region.

Restoring boundary conditions are used for both temperature and salinity (Haney, 1971). The restoring values are taken from the Levitus (1982) data set. The diffusion constant is constant spatially and temporally, and corresponds to a restoring timescale of 50 days for a 50 m upper layer. Tracer is introduced into the model after the 2000 year spin-up is complete. A restoring condition is placed on the tracer with a surface value of 10.0 tracer units. The ocean is then allowed to "fill" with tracer. This is, of course, a simple representation of tracer uptake in the ocean. A more realistic simulation would have a more sophisticated boundary condition.

Five input parameters are examined, the vertical and horizontal eddy diffusivities (A_V,A_H), the vertical and horizontal eddy viscosities (A_{MV},A_{MH}), and the peak value of the wind stress (τ_m). Table 1 contains the ranges of values for the five input parameters. These ranges should be kept in mind when interpreting the results; sensitivity with respect to a parameter would tend to increase if a wider range is chosen.

Four outputs are used. The first two characterize the ocean flow, the overturning streamfunction (MMT) and the number of statically unstable points (CONV). The final two outputs are measures of the sequestering efficiency of the model, the time it takes for the model ocean to be 50% "full" (i.e. an average value of 5.0 for tracer concentration) and 95% "full" (an average tracer value of 9.5).

3. Results and Discussion

Twenty-six runs of the circulation model are made. The range for each input parameter is covered by a grid with spacings of 1/25 of the range. Four of the 26 simulations failed to reach a satisfactory equilibrium and thus are discarded.

The output data from the 22 simulations reaching an equilibrium are modelled using an approach described in Sacks et al. (1989) and Welch et al. (1992). Details may be found in these references.

i) cross validation

To insure that the statistical approximating functions are working well, a cross validation is performed. A data point is removed from the set. The approximating functions are then calculated with the remaining points. These functions are then used to "predict" the missing point. This is successively performed on all points in the data set. Figure 1 depicts a plot of actual (ordinate) versus predicted (abscissa) for the meridional overturning streamfunction (MMT), number of convective points (CONV), 50% full and 95% full tracer diagnostics. The approximating functions do a reasonable job of reproducing model output.

Table 1. Input parameters range

		Minimum	Maximum
Vertical eddy diffusivity (cm^2/s)	A_V	0.25	20.00
Horizontal eddy difffusivity ($10^7 cm^2/s$)	A_H	0.1	5.00
Vertical eddy viscosity (cm^2/s)	A_{MV}	0.25	20.00
Horizontal eddy viscosity ($10^8 cm^2/s$)	A_{MH}	0.25	5.00
Peak wind stress ($dynes/cm^2/s$)	τ_m	0.0	1.8

ii) model flow

The first two outputs (MMT and CONV) are used as diagnostics that characterize the ocean flow and are potentially important for the uptake of passive tracer. The approximating functions enable us to determine the relative importance of the model inputs for these outputs as shown in Fig. 2. Clearly the vertical diffusivity dominates accounting for 95% of the variation of the streamfunction.

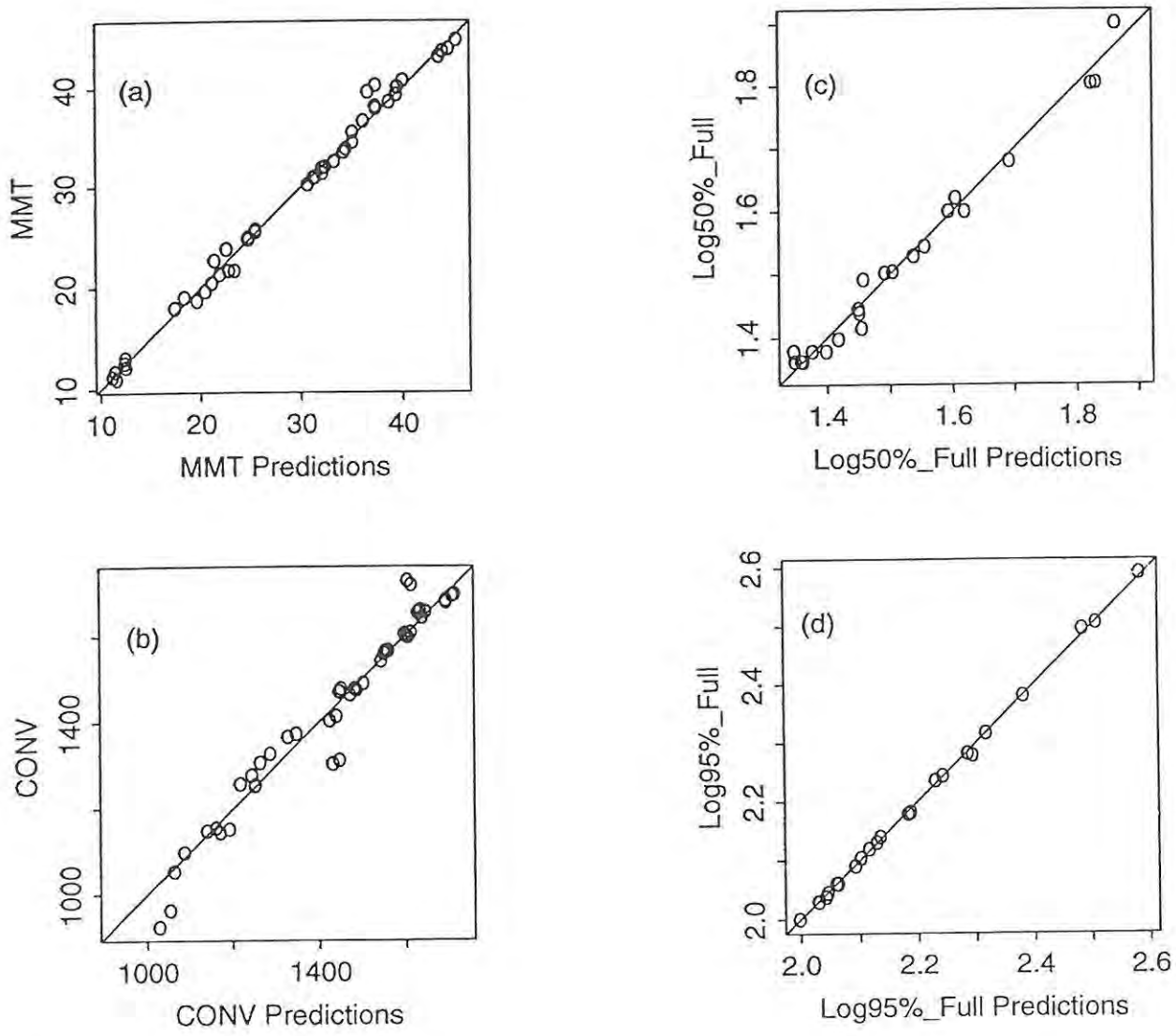

Figure 1. Ocean model values versus statistical-model cross-validated predictions: a) the meridional overturning streamfunction (MMT), b) the number of statically unstable points (CONV), c) time for average tracer value to reach 5.0 (50% full), d) time for average tracer to reach 9.5 (95% full).

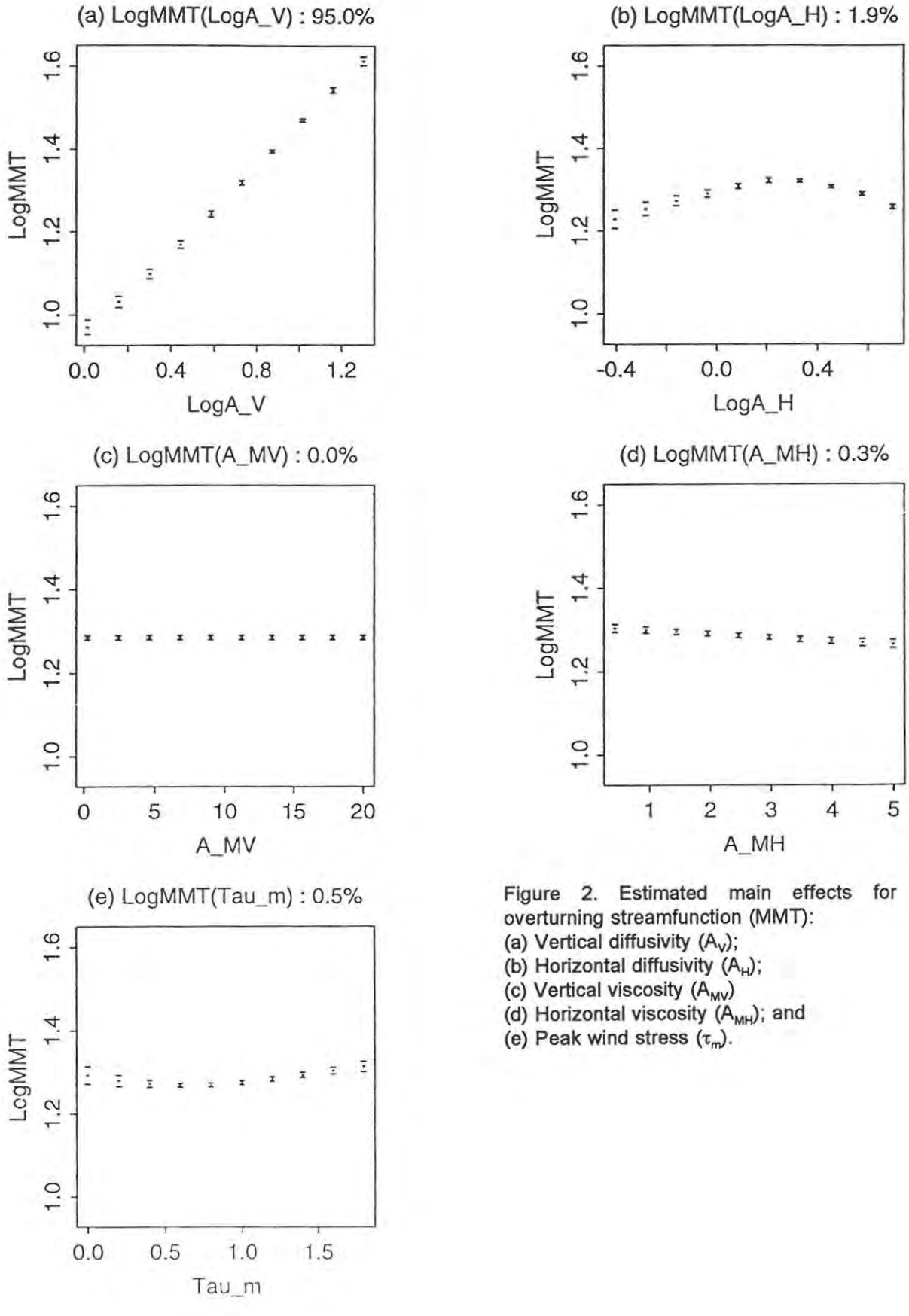

Figure 2. Estimated main effects for meridional overturning streamfunction (MMT):
(a) Vertical diffusivity (A_V);
(b) Horizontal diffusivity (A_H);
(c) Vertical viscosity (A_{MV})
(d) Horizontal viscosity (A_{MH}); and
(e) Peak wind stress (τ_m).

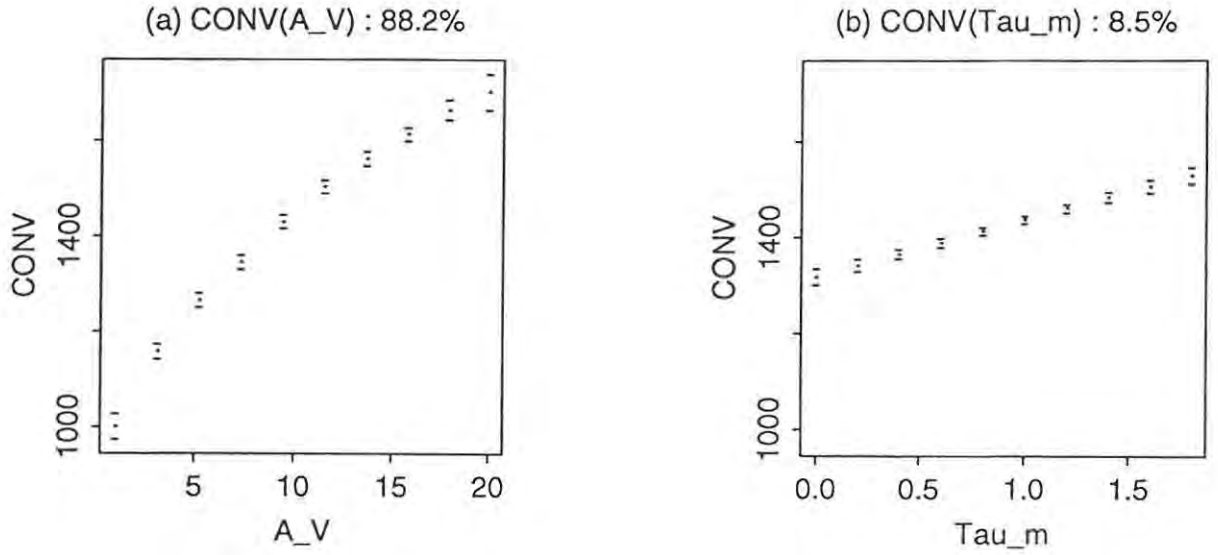

Figure 3. Estimated main effects for the number of statically unstable points (CONV): (a) Vertical diffusivity (A_V) and (b) Peak wind stress (τ_m).

The dependency on the vertical diffusivity (A_V) comes as no surprise and is consistent with Bryan (1987) and Winton (1996). Bryan found that the overturning streamfunction had a $A_V^{1/3}$ dependence, differing from a $A_V^{2/3}$ dependence expected from scaling. A log log analysis of the current results shows a dependence ranging from 1/3 for low A_V to 1/2 for larger A_V values. Horizontal diffusivity and wind stress play marginal roles and the viscosity coefficients can be ignored. The dependence on the horizontal diffusivity has been noted before (Gough and Allakhverdova, 1997). The reduction of overturning for large values of horizontal diffusivity may be spurious and an artifact of the diagnostic used for assessing overturning strength rather than an actual reduction in overturning strength. In Figure 3, a similar plot is presented for the number of convective points. Vertical diffusivity dominates (88.2%). The only other input of significance is wind stress (8.3%).

iii) tracer diagnostics

The two tracer diagnostics are presented in Figs. 4 and 5. The time taken to reach an average tracer value of 5.0 and 9.5 is recorded for each model run. Log values are used in the figures to easily facilitate power relationship calculations. For the first diagnostic (5.0, Fig. 4), three inputs are worthy of consideration. The vertical diffusivity dominates, i.e. the uptake time decreases as the diffusivity increases. This is true also for the horizontal diffusivity and wind stress but to a much smaller degree. The two viscosities have negligible impact. Note that the dependence on horizontal diffusivity does not match that of overturning streamfunction. Fig. 5 depicts a similar set of plots for the 9.5 tracer time. The role of the wind stress is less important in this instance.

For both diagnostics the power scaling is approximately -1/2, especially for higher values of the vertical diffusivity. The result is consistent with the power scaling found for the overturning streamfunction. Although the number of convective points depended on the wind stress, this input appears to have only a minor impact on the tracer distribution. It is likely then that the increase in convective points occurs near the surface and thus has little impact on tracer penetration to the deep ocean and hence reduced importance for the 9.5 tracer time diagnostic.

4. Conclusions

The results presented in this brief article illustrate the utility of employing statistical techniques in the design of numerical experiments. The examples presented are straightforward model outputs in which we had reasonable expectations of the outcome.

The overturning streamfunction and the number of convective points are found to largely depend on the vertical diffusivity as we had expected from previous work. The tracer uptake also depended strongly on the vertical diffusivity. The dependency on the horizontal diffusivity differs between the overturning streamfunction and the tracer uptake. This adds credence to the suggestion that the peak value of the overturning streamfunction may not be the best measure of the strength of the overturning (Winton, 1996; Gough and Allakhverdova, 1997). The experiments also show the relative unimportance of the viscosity coefficients.

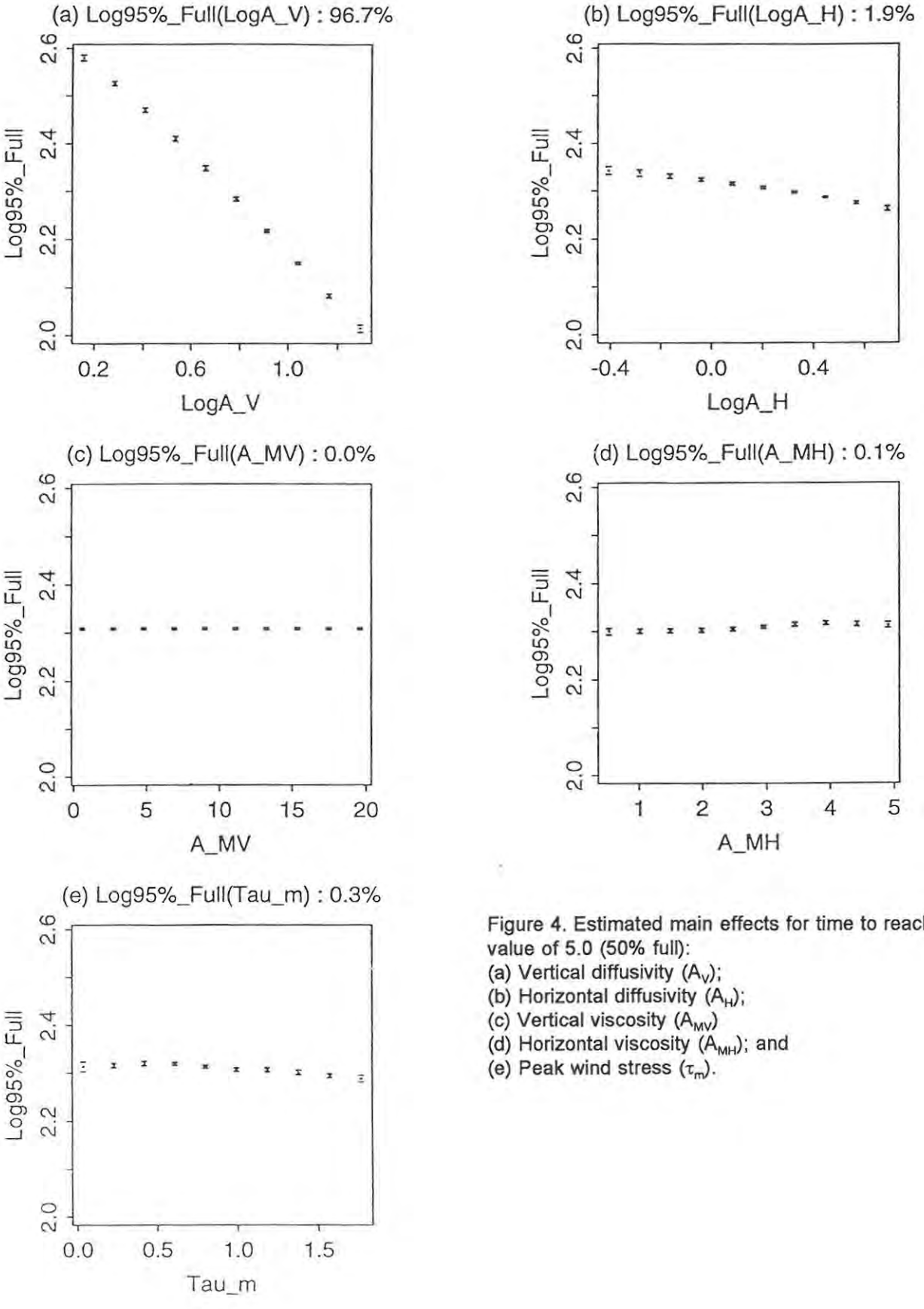

Figure 4. Estimated main effects for time to reach tracer value of 5.0 (50% full):
(a) Vertical diffusivity (A_V);
(b) Horizontal diffusivity (A_H);
(c) Vertical viscosity (A_{MV})
(d) Horizontal viscosity (A_{MH}); and
(e) Peak wind stress (τ_m).

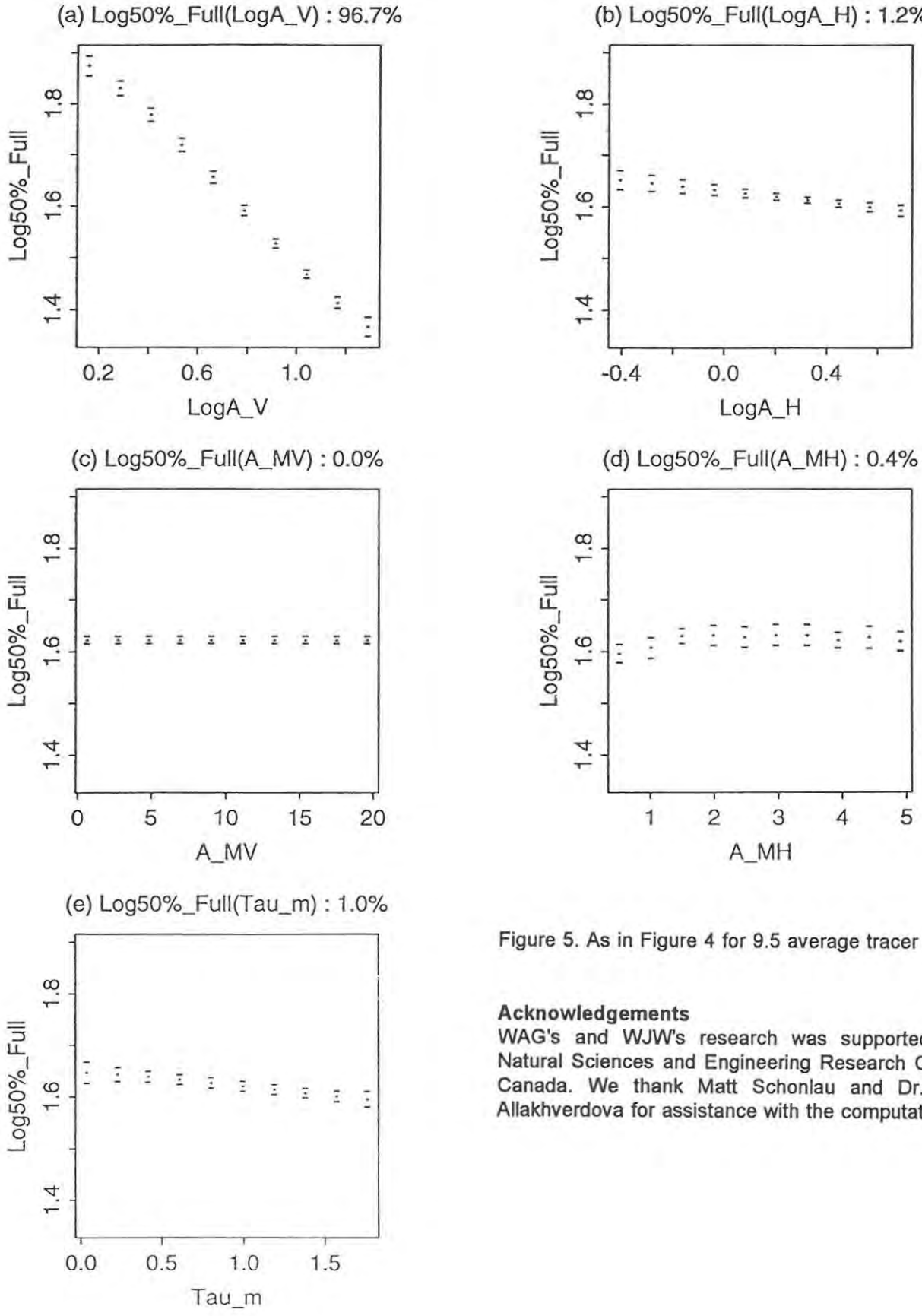

Figure 5. As in Figure 4 for 9.5 average tracer value.

Acknowledgements
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References

Bryan, F., 1987. Parameter sensitivity of primitive equation ocean general circulation models. *J. Phys. Oceanogr., 17, 970-985.*

Bryan, K., 1969. A numerical method for the study of the circulation of the world ocean. *J. Comput. Phys., 4, 347-376.*

Cox, M., 1984. A primitive equation, three dimensional model of the ocean. *GFDL Ocean Tech. Report No. 1. Princeton, New Jersey.*

Gough, W. and W. Welch, 1994. Parameter space exploration of an ocean general circulation model using an isopycnal mixing parameterization. *J. Mar. Res., 52, 773-796.*

Gough, W., 1997: Convective adjustment in an isopycnal ocean general circulation model., *Atmosphere-Ocean (in revision).*

Gough, W. and T. Allahkverdova, 1997: Sensitivity of a coarse resolution ocean general circulation model under climate change forcing. *(submitted to Tellus).*

Haney, R., 1971. Surface thermal boundary conditions for ocean circulation models. *J. Phys. Oceanogr., 1, 241-248.*

Johnson, M.E., Moore, L.M., and D. Ylvisaker, 1990. Minimax and maximin distance designs. *J. Stat. Plan. Inf., 26, 131-148.*

Levitus, S., 1982. Climatological Atlas of the world oceans. *NOAA Prof. Paper 13, Washington, D.C.*

McKay, M., W. Conover, and R. Beckman, 1979. A comparison of three methods for selecting values of input variables in the analysis of output from computer code. *Technometrics, 21, 239-245.*

Pacanowski, R., K. Dixon and A. Rosati, 1991. The GFDL modular ocean model user guide, *GFDL Group Technical Report #2, 44p.*

Sacks, J., B. Schiller, and W. Welch, 1989. Designs for computer experiments. *Technometrics, 31, 41-47.*

Winton, M., 1996: The role of horizontal boundaries in parameter sensitivity and decadal-scale variability of coarse-resolution ocean general circulation models. *J. Phys. Oceanogr., 26, 289-304.*

Welch, W., R. Buck, J. Sacks, H. Wynn, T. Mitchell and M. Morris, 1992. Screening, predicting, and computer experiments. *Technometrics, 34, 15-25.*

News Flash

by Dr. Steve Thomas[1], Dr. Robert Benoit and Michel Desgagné
Recherche en prévision numérique (RPN)
Environnement Canada

On Friday June 27, 1997 the first 24 hour forecast over North America (continental USA and Canada) at 10 km resolution was produced in real-time using the adiabatic kernel of the non-hydrostatic Mesoscale Compressible Community (MC2) model combined with the full RPN physical parameterization package on a 753 x 510 x 31 grid. The forecast required 40 minutes of wall-clock time on the new NEC SX-4/32 supercomputer at the Canadian Meteorological Centre in Montréal.

These results will be presented to the air traffic controllers association and the FAA in the United States by NCAR as proof that a 10 km real-time forecast is now possible. This technology would permit aircraft `free-flight' navigation using GPS satellites and high-resolution forecasts including severe weather warnings, clear-air turbulence predictions and wind shear. In fact, the US weather service plans to achieve a continuous 10 km resolution forecast by the year 2000. Canada has the capability to do it now ! (see the front cover).

Background

The Messcale Compressible Community (MC2) model is a limited-area weather forecast model used in Canadian Universities and Environment Canada for mesoscale and microscale atmospheric research. The model is an extension of a fully compressible limited area model developed by Tanguay, Robert and Laprise in the mid-1980's at Recherche en prévision numérique (RPN) and l'Université du Québec à Montréal (UQAM). The MC2 model dynamics and physics code libraries along with related support software are maintained by RPN for the Cooperative Center for Research in Mesometeorology (CCRM). The small-scale prediction capabilities of the model have also been tested as part of the Comparison of Mesoscale Predictions and Research Experiments (COMPARE) and the Mesoscale Alpine Programme (MAP) in Europe. A distributed-memory parallel version of MC2 was constructed not only as a proof of concept for the Canadian atmospheric modeling community, but also to satisfy the increased computational demands of high-resolution studies in atmospheric turbulence and the development of new planetary boundary layer parameterization schemes. Over the past year the model has been benchmarked on the Cray T3E MPP and most recently on a NEC SX-4/32 symmetric multi-processor (SMP) at the Canadian Meteorological Centre in Montréal and a SX-4/16M2 SMP cluster (2 x SX-4/8 SMP nodes) in Fuchu Japan.

Dynamics

The MC2 model dynamics are based on a centered-in-time semi-implicit, semi-Lagrangian time discretisation and finite differences in space. The model dynamics have been optimized over the past two years for maximum computer performance. Major algorithms have been modified or completely replaced during this period. Work continues on all major components of the dynamical core of the model to improve numerical accuracy and increase computational speed. In particular, a new formulation of the model which is better able to handle steep mountainous terrain is currently being tested.

Physics

The MC2 model was coupled with version 3.5 of the RPN physics package including a planetary boundary layer scheme based on turbulent kinetic energy, a surface layer scheme based on similarity theory, solar and infrared radiation, large-scale precipitation, convective precipitation, and gravity wave drag. The physics interface was modified to support multiple physics "spill" files for memory requirements above the current 8 Gbyte MMU limit on the NEC SX-4/32 "hiru".

Performance

NEC SX-4/32 SMP, 800 Mflops/s per processor or 24 Gflops/s in total. 24 hr prog = 480 time steps x 180 secs on 30 processors. Performance scales linearly and we expect to run at well over 60 Gflops/s on a cluster in Fuchu Japan consisting of two SX-4/32 nodes connected via a NEC IXS crossbar network in the fall of 1997 or early 1998. A cluster of 4 x SX-4/32 nodes will also be available for testing in Japan sometime in 1998.

Software

The distributed-memory message-passing version 4.0 of MC2 employs the MSG toolkit developed by Andrei Malevsky at CERCA. This state-of-the-art Application Programmer Interface (API) makes use of several advanced features of the Message-Passing Interface (MPI) international standard (http://www.cerca.umontreal.ca/~malevsky).

The distributed-memory MC2 based on the Message-Passing Interface (MPI) standard is run or "launched" on 32 processors of the newly installed NEC SX-4/32 at CMC using the following command:

```
% mpisx -p 32 -e ./mc2.Abs
```

Exactly the same code can be executed across a "multi-node" configuration of NEC SX-4 shared-memory symmetric multi-processor (SMP) nodes connected by a low-latency, high-bandwidth IXS crossbar network. For example, on an SX-4/16M2 configuration consisting of two SX-4/8 nodes (ixs0 and ixs1) connected via the IXS crossbar, the model is launched using 8 processors on node ixs0 and 8 processors on node ixs1. The command and associated "mpi.hosts" file specifying the node configuration is given below:

```
% mpisx -f mpi.hosts

# mpi.hosts files contains SMP cluster configuration
-p 8 ixs0 ./mc2.Abs
-p 8 ixs1 ./mc2.Abs
```

Note that 16 identical copies of the model are launched, where each copy computes on a different "partition" of the underlying computational grid. This is known as a Single Program Multiple Data (SPMD) model of parallel computation.

Real-time Forecasting Capability

The real-time performance of the distributed-memory MC2 MESO-LAM at high resolution is best characterised by the time to complete a time step:

- 4 seconds per time step + 1.5 secs parallel I/O in physics = 5.5 secs.

With additional SSRAM memory the physics will execute "in-core" and in this case the model will run at 4 seconds per time step requiring 1,920 seconds or 32 minutes of wall-clock time including I/O.

"Scalable" distributed-memory computing implies increasing the problem size with the number of processors. Memory requirements for a real-time forecast over North America are truly impressive:

- 8 Gbytes total Main Memory Unit (MMU) available consisting of high density synchronous static random access memory (SSRAM) chips. Approximately 240 MegaBytes per UNIX SPMD process requiring 7.2 Gbytes. Physics "spill-over" onto 16 Gbyte eXtended Memory Unit XMU:

- 40 Megabytes per process or 1.2 Gbytes total read/write to RAM disk every time step (requires 1.5 secs per time step).

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SHEBA and JOIS: the PURSUIT of ARCTIC SCIENCE in 1997 and 1998

by Martin Bergmann[1] and Ed Carmack[2]

Préambule: Au cours des derniers mois, le Canada et les États-Unis se sont unis dans un programme de recherche du climat atmosphérique/océanographique en Arctique. En octobre 1998, lorsque les conditions deviendront de plus en plus difficiles pour le travail extérieur dans le nord, une équipe de scientifiques de l'Amérique du Nord tout entière commenceront à installer leur série de détecteurs très perfectionnés et à surveiller et mesurer une myriade de données environnementales afin de perfectionner les calculs des paramètres climatiques. Lorsque la température chutera sous le point de congélation et que les heures d'ensoleillement continueront à diminuer de 20 minutes par jour, la science débutera.

Foreword: Over the past few months Canada has become involved with the United States in a joint atmosphere/oceanographic climate research program in the Arctic. In October of 1997, just when conditions will become increasingly difficult for outdoor work in the north, a team of scientists from across North America will begin to set up their extensive set of finely tuned sensors and begin monitoring and measuring a myriad of environmental parameters in order to refine estimates of climate parameters. As the temperatures dip well below freezing and the daylight hours continue to decline by 20 minutes per day, the science will begin.

Introduction

SHEBA (**S**urface **HE**at **B**udget of the **A**rctic) is the name of this program to understand, for climate modeling purposes, air/sea/ice albedo feedback mechanisms. SHEBA is predominantly a U.S. program, but includes international participants (Canada, Japan and The Netherlands). In support of this program and by making the most effective use of the vessel platforms provided to carry out the operational requirements of the program, the JOIS (**J**oint **O**cean **I**ce **S**tudies) program was born and represents a joint U.S./Canada effort to build ancillary science programs in climate, contaminant transport and biology.

At the first Joint U.S./Canada Workshop for SHEBA/JOIS in April, 1997, in Winnipeg, Manitoba, Captain Ray Pierce, Regional Director General, Central and Arctic Region, Department of Fisheries and Oceans Canada, expressed his commitment to the SHEBA/JOIS program, and to the development of a strong, broadly-based Arctic research program. In concurrence, Dr. Scott Parsons, Assistant Deputy Minister, Science, endorsed the need for a long-term commitment to Arctic research in support of the Canada Oceans Act (COA), an integrated approach to oceans management.

These commitments by senior management recognize that Canada borders three oceans, including the Arctic, and that responsibilities for stewardship, sovereignty, fisheries, human health, and scientific inquiry are clearly expressed in the COA. It is the stated goal of DFO to provide data, analysis and advice to describe the marine environment in support of sustainable development.

Objectives

Climate-related processes, contaminant disposition and living resources are central issues driving present-day research on the Arctic Ocean; accordingly, the primary objectives of the Canadian component of JOIS are to: (1) carry out physical and geochemical tracer measurements of the Arctic Archipelago through-flow (e.g. transports of mass, salt, heat, nutrients, contaminants and tracers) into the North Atlantic; and (2) investigate the relationships among physical, chemical and biological processes in the North Water Polynya (NOW Program), the Canadian Arctic Archipelago (SHEBA Transit) and Canada Basin (SHEBA Drift). The scientific basis SHEBA/JOIS is supported by national and international panels such as the **A**rctic **C**limate **SY**stems **S**tudy (ACSYS) and the **A**rctic **M**arine **A**ssessment **P**rogram (AMAP). JOIS includes oceanographic work in the Atlantic/Arctic straits and passages, North Water Polynya, Canadian Arctic Archipelago, Canada Basin, and at the SHEBA drifting station.

The combined SHEBA/JOIS programs constitute the most complex and broadly-based ocean study ever undertaken in the Arctic. Work involves three ships, over 50 universities and laboratories and approximately 100 principal investigators; field work spans a full year.

Benefits

The SHEBA/JOIS program offers a *two-way* street of mutual benefit between Canadian policymakers and the scientific community. Canadian participation in SHEBA/JOIS will greatly expand the scientific database and predictive capabilities required for sound management and stewardship of Canada's Arctic region. At the same time, the scientific questions posed by

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SHEBA/JOIS offer Canadian researchers the benefits of international collaborations, and a vital role in the discovery of new knowledge. These two incentives, together, form a substantial base for a long-term Arctic research program. For DFO, this mission represents a cooperative effort between Coast Guard staff from the Central & Arctic, Laurentian, Maritimes and Pacific regions, and Science Sector staff from the Freshwater Institute, Institute of Oceans Sciences, and Bedford Institute of Oceanography.

Global stewardship is increasingly dependent on the development of reliable predictive models which, in turn, require an observationally-based advance in our understanding of the complex and interrelated processes impacting climate, contaminant disposition, and the habitats of living resources. This urgent requirement forms the motivation for the joint U.S./Canada SHEBA/JOIS program.

Rationale

During the past decade two central ideas have dominated discussions on the role of polar oceans in climate change; both convey the notion that small changes in high-latitudes are amplified within the global climate system. One is the so-called *albedo feedback* effect, wherein warming melts ice which reduces albedo which leads to further warming (Rind et al., 1995; Washington et al., 1996). Because the Arctic ocean exists for much of the year at temperatures just below the freezing point of water, even a small increase in surface temperature could potentially have a large impact on the geographic extent of Arctic sea ice. The primary goal of SHEBA, then, is to understand and properly parameterize for modeling purposes, the albedo feedback mechanism, including the additional effects of clouds and aerosols on the earth's radiation budget. The other idea concerns the so-called *thermohaline loop* wherein the export of freshwater from the Arctic Ocean impacts on ocean circulation (Aagaard and Carmack, 1989; Hakkinen, 1993; Manabe et al., 1994; Weaver and Sarachik, 1994; Delworth et al., 1997). A major but poorly understood source of freshwater to the North Atlantic is via the Canadian Archipelago through-flow. An important goal of JOIS, then, is to measure and develop a conceptual model of material fluxes through the Canadian Archipelago.

Another realization that has come about in the past decade is that the Arctic is not the pristine environment once believed. Instead, we now recognize the combined threats of pollution, especially by organochlorines, radionuclides, and heavy metals; this issue is of particular concern to Canada's northern people. Semi-volatile organochlorine compounds, mainly derived from industrial and agricultural use in southern latitudes, are carried preferentially to the Arctic via the so-called *cold condensation* phenomenon (Wania and Mackay, 1993). Once in Arctic waters, fat-soluble organochlorine compounds are biologically focused and stored in the lipid-rich Arctic food chain (cf. Barrie et al., 1997). Artificial radionuclides have been introduced to the Arctic by nuclear weapons testing, industrial disposal, particularly by the release of effluent from European reprocessing plants and the dumping of radioactive wastes by the former Soviet Union, and through accidents such as Chernobyl and the sinking of nuclear vessels. While current levels present no serious health risk, their widespread distribution confirms a rapidly circulating Arctic Ocean (Smith et al., 1997). Finally, the toxic effects of a variety of heavy metals warrants continued monitoring (Boden et al., 1993).

Living resources in all three oceans surrounding Canada are coupled to the global climate system, and perturbations to ocean conditions are linked to changes in distribution, growth and recruitment of Canadian fish stocks. One example concerns widespread changes observed in the early 1990s: in the Atlantic a cooling trend seriously depressed the production of all Atlantic fish stocks (cf. Flanders et al., 1997); in the Pacific a regime shift in ocean conditions is now thought to have caused major changes in the survival and growth of Pacific salmon (R. Beamish, pers. comm.); in the Arctic a basin-wide change in temperature and the distribution of water masses of Atlantic and Pacific origin was observed (McLaughlin et al., 1996; Carmack et al., 1997). All three shifts *may* be tied to a dramatic alteration in atmospheric pressure observed over the Arctic Ocean beginning in 1989 (Welch et. al., 1996). Changes to ocean conditions are also linked to changes in distribution, growth and recruitment of Arctic fish stocks and marine mammals. Within the Archipelago the distribution of marine life is extraordinarily variable in space and time. For example, biological "hotspots" are known and used by native hunters as an important source of country foods, but the physical and geochemical causes for such phenomena are unknown. Also, the timing of biological events is of key importance; for example, "swarming" has been observed to concentrate locally the populations of polar cod to over 1,000 fish per m^2 for short periods of time. These events suggest that the Arctic is not isolated, but is closely coupled to ocean conditions in the Atlantic and Pacific.

Specific Studies

Four major SHEBA/JOIS program areas which are also tied to components of the Canada Oceans Act are:

- Oceanic Carbon Cycling - It is not yet possible to say if the impact of climate change will be positive or negative for marine species but among critical issues are the response of the ocean biological pump and resulting change in the rate of CO_2 cycling, drawdown of atmospheric CO_2, and the oceanic production of sulphate

aerosols. This program element is addressed by the carbon cycle work planned during the year-long SHEBA Drift to investigate the cycling or (biological) pumping of nutrients and gases between the atmosphere, the ice, the water, the biota, and sediments and how it responds to and influences climate.

- Ocean Circulation - There is growing evidence of linkage between the Atlantic and Pacific Oceans through the atmosphere and the Arctic Ocean that needs to be better understood by fisheries management. In the continental margins, physical and biogeochemical processes vary strongly on regional scales and they together with the influence of the Arctic must be understood in order to determine possible global effects. This program element is addressed through the JOIS Transit work; 1) on understanding the effects of Arctic throughflow; 2) on the large scale ocean circulation well enough to allow development of quantitative ocean climate models.

- Ocean Monitoring - Ocean climate research, coastal zone monitoring and fisheries management require diversified data collections and data analysis. Any modeling of physical, chemical and biological processes requires a major input of archived historical data. Mooring actives during SHEBA/JOIS will allow continuation of monitoring of the ice and ocean climates of the Arctic carried out in the Beaufort Sea by IOS since the late-1970s. Collaboration with U.S. investigators will greatly expand the basis for interpretation of this data, and make them easily accessible to climate modelers and other users.

- Ocean Database Management - At the 16th Annual Arctic Ocean Sciences Board Meeting held in Sopot, Poland in February, 1997 the board members recommended that all new information generated as part of Arctic oceans programs need to address the lack of an integrated inventory of arctic oceans data. A priority for the U.S. and Canadian projects proposed as part of SHEBA/JOIS is to develop a strong database program which integrates all aspects of the data collected. The importance of defensible data management was also recently underscored by a report produced by the Data and Information Systems Panel of the Canadian Global Change Program (Data Policy and Barriers to Data Access in Canada: Issues for Global Change Research, 1996).

Conclusion

Climate change and variability are therefore global environmental science issues which have risen in prominence over the last decade. All of the major international and intergovernmental climate meetings of the 1990s have identified the oceans as being one of the weak links in our ability to understand, describe and predict climate change and climate variability (*From the DFO Oceans Science Strategic report, 1996).* Models of climate change generally predict an ultimate high latitude (including the Arctic) warming and a decreased sea ice cover which may have a detrimental effect on the important high latitude ecosystems, such as polynyas, in the Arctic Ocean and the Canadian Archipelago. Joint programs in biological and physical oceanography are essential in order to understand the processes that determine the flow of energy from plankton into other components of the ecosystem, including fish, shellfish and marine mammal populations (From the DFO Science Strategic Plan document on Ocean Climate, 1997).

References:

Aagaard, K. and E. C. Carmack, 1989. The role of sea ice and other fresh water in the Arctic circulation. *J. Geophys. Res.* 94: 485-498.

Barrie L., R.W. Macdonald, T. Bidleman, M. Diamond, D. Gregor, R. Semkin, W. Strachan, S. Backus, M. Bewers, C. Halsall, C. Gobeil, J. Hoff, A. Li, L. Lockhart, D. Mackay, J. Pudykiewicz, K. Reimer, J. Smith, G. Stern, W. Schroeder, R. Wagemann, F. Wania, and M. Yunker. 1997. Sources, occurrence and pathways. In *Canadian Arctic Contaminants Assessment Report*, J. Jensen, K. Adare, and R. Shearer, editors, Department of Indian and Northern Affairs, Ottawa, pp. 25-182.

Boden T. A., D. P. Kaiser, R. J. Sepanski, and F. W. Stoss, 1993. Trends '93: A compendium of data on global change, Vol. ORNL/CDIAC-65, ESD Publication No. 4195, 984 pp.

Carmack E. C., K. Aagaard, J. H. Swift, R. W. Macdonald, F. A. McLaughlin, E. P. Jones, R. G. Perkin, J. N. Smith, K. M. Elliss, L. R. Killius. 1997. Changes in temperature and tracer distributions within the Arctic Ocean: Results from the 1994 Arctic Ocean Section. *Deep-Sea Res.* In press.

Delworth T. L., S. Manabe, and R. J. Stouffer. 1997. Multidecadal climate variability in the Greenland Sea and surrounding regions: a coupled model simulation. *Geophys. Res. Lett.* **24**, 257-260.

Flanders, N. P., L. Hamilton and C. M. Duncan. North Atlantic Fisheries: Large-scale processes and human communities. Submitted.

Häkkinen S. 1993. An Arctic source for the great salinity anomaly: a simulation of the Arctic ice-ocean system for 1955-1975. *J. Geophys. Res.* **98**, 16,397-16,410.

McLaughlin, F.A., E. C. Carmack, R.W. Macdonald, and J.K.B. Bishop. 1996. Physical and geochemical properties across the Atlantic/Pacific water mass front in the

southern Canadian Basin. *J. Geophys. Res.* 101: 1183-1197.

Manabe, S., R.J. Stouffer, and M.J. Spelman. 1994. Response of a coupled ocean-atmosphere model to increasing atmospheric carbon dioxide. *Ambio* 23: 44-49.

Rind, D. R., R. Healy, C. Parkinson, and D. Martinson. 1995. The role of sea ice in 2 X CO_2 climate modeling sensitivity, I. The total influence of sea ice thickness and extent. *J. Climate*, 8, 449-463.

Smith J.N., K.M. Ellis, and L.R. Kilius. 1997. 29I and 137Cs tracer measurements in the Arctic Ocean. *Deep-Sea Res.*, In press.

Wania, F. and D. Mackay. 1993. Global fractionation and cold condensation of low volatility organochlorine compounds in polar regions. *Ambio* **22**, 10-18.

Washington, W. A., and G. A. Meehl. 1996. High-latitude climate change in a global coupled ocean-atmosphere-ice model with increased atmospheric CO_2. *J. Geophys. Res.*, 101, 12795-12801.

Weaver, A. J. and E. S. Sarachik. 1994. Rapid interglacial climate fluctuations driven by North Atlantic ocean circulation. *Nature*, 367, 447-450.

Welch. J. E., W. L. Chapman and T. L. Shy. 1996. Recent decrease of Sea Level Pressure in the Central Arctic. *J. Climate*, 9, 480-486.

Benefits of Providing the AES Marine Weather Services in Atlantic Canada Far Outweigh Costs

by Joseph Shaykewich
Manager, Program Evaluation, AES,
Department of Environment.

The AES sponsored a Masters thesis, at Dalhousie University, on the Economic Aspects of Meteorological Information in Marine Applications. The study, undertaken by Masters in Development Economics candidate Glenn Purves, examined the relevance, effectiveness and efficiency of the Atmospheric and Environment Services marine weather program in Atlantic Canada. It concluded that the benefits of providing the AES marine weather services in Atlantic Canada substantially outweigh the costs of producing the services.

The benefits of the AES marine weather services in Atlantic Canada were estimated using two approaches: a Willingness to Pay (WTP) approach (exploring the active-use value using the Contingent Valuation Method), and a With-Without approach (measuring the existence value). The costs are similarly estimated using two approaches: the first examines solely the costs of producing the marine weather service component; the other adds the cost estimate of the Canadian Meteorological Centre's (CMC) weather model.

Using the WTP approach, the AES marine weather service program was estimated to generate a benefit-cost ratio of 4.6:1. Over a period of ten years (discounted at an annual 6% rate), the gross benefits are estimated at $52.4 million and the gross costs at $11.4 million. By including the additional cost of the Canadian Meteorological Centre (CMC) weather model, $2 million (per year), the gross cost figure increased to $26.1 million over a ten year time span (discounted at an annual 6% rate). The benefit to cost ratio was consequently decreased, yet even then the benefits still exceeded the costs by a comfortable margin of 2:1.

Using the With-Without approach to determine the existence value, the cost savings to government and society for providing marine weather services in Atlantic Canada were as follows: (1) potentially avoided costs for a single marine accident with seven fatalities range from $23 million up to $42 million, and (2) avoided cleanup costs of oil spills can range from $0.5 million (for multiple small-scale oil spills), to $4 billion (for an isolated large-scale oil spill). Although the precise accuracy of such estimates is unlikely to be perfect, the resulting range in values does offer quite reasonable cost saving parameters.

As the federal government is seeking ways to conserve resources, and trends towards privatization continue to be favoured, more government programs are being considered as less efficient under the umbrella of the public sector.

The study suggested that this is not appropriate in the case of Environment Canada's provision of marine weather services in Atlantic Canada. The costs attributed to providing a marine weather program without the CMC weather model, including the extra costs of monitoring the dissemination of this information and the collecting of user fees, would be significantly too high for a 100% private sector interest. With the service under the auspices of Environment Canada, environmental, societal, and public costs would appear to be far more effectively contained.

The study did offer some suggestions to the AES for the maintaining of a relevant, effective and efficient marine weather service with regard to access (mediums, user-pay), visibility, accounting practices and international cooperation. For further information on this study, please contact Joseph Shaykewich by telephone at (416) 739-4978, by fax at (416) 739-4380, or by e-mail at Joseph.Shaykewich@ec.gc.ca.

CLIMATE CHANGE 1995

Impacts, Adaptations and Mitigation of Climate Change
Scientific-Technical Analyses

Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)

R.T. Watson, M.C. Zinyowera, R.H. Moss and D.J. Dokken (Editors)
Cambridge University Press
(on behalf of IPCC), 1996, 878 p.

Book reviewed by Madhav Khandekar,
Climate Research Branch
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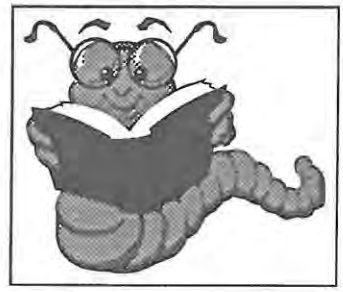
The IPCC was jointly established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP). IPCC is now recognized as the prime source of scientific and technical information on climate change and its environmental and socioeconomic impact. IPCC completed its first assessment report in 1990.

The second assessment on climate change was made by the Working Groups I, II and III of the IPCC, leading to the publication of three reports in 1996. The first report (Climate Change 1995, The Science of Climate Change) prepared by the Working Group I was reviewed in the February 1997 (Vol. 25, No. 1) issue of the *CMOS Bulletin SCMO*. The present report prepared by the Working Group II of the IPCC focuses on potential impacts of climate change, adaptive responses, and measures that could mitigate future emissions. The report consists of twenty-five chapters covering a wide range of ecological systems and socioeconomic sectors and activities. It also includes three technical appendices - two sets of guidelines or methodologies for assessing the potential efficacy of adaptation and mitigation strategies, and an inventory of technology databases and information. In addition, there are five general appendices giving a list of expert reviewers, a glossary of terms, a list of acronyms and symbols, a list of units, plus a summary for policymakers and about forty pages of introductory material on terrestrial ecosystems and the global energy system. This comprehensive report cites over 3,000 references and has over 100 diagrams and several dozen tables.



The primary objective of the second assessment on climate change was to review the state of knowledge concerning the impact of climate change on physical and ecological systems, human health and socioeconomic sectors and to further evaluate adaptation and mitigation options that could be used in progressing towards the ultimate objective of the United Nations Framework Convention on Climate Change (UNFCC). The ultimate objective of the UNFCC can be briefly stated as *"... stabilization of greenhouse gas concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner"*. Within this framework, the present report makes a detailed examination of the climate change impact on key areas like agriculture, forestry, hydrology and freshwater ecology, land degradation and desertification, oceans and water resource management. The report also examines the climate change impact on related areas like energy, industrial process and human settlement emissions, human infrastructure and human health, lakes, wetlands and coastal zones. The impact is assessed by analyzing a large number of modelling studies (regional and/or global) which attempt to simulate the climate change by doubling the present concentration of greenhouse gases (GHG), in particular by doubling the concentration of carbon dioxide (CO_2), the most important of the GHG and which has contributed about 65% of the combined radiative effects of the long-lived gases over the past one hundred years. Considering the limitations and uncertainties associated with various modelling studies, numerous climate-change impact statements are provided in the summary section as well as in various chapters of the report with appropriate caveats.

Some of the important findings of the report on climate change impact are: **1**. Global agricultural production could be maintained relative to baseline production in the face of climate change induced by doubling the concentration of CO_2. **2.** Boreal forests of the middle latitudes will experience maximum impact of climate change, with increased fire frequency and pest outbreak. **3**. Deserts are likely to become more extreme - hotter but not significantly wetter. **4.** Global hydrological cycle will be intensified with increased frequency of intense rainfall leading to increased runoff and increased risk of flooding;

and **5.** Increasing sea level leading to increased risk of flooding of coastal areas (e.g. a rise of 50 cm in sea level in future will put about 92 million people at risk of flooding due to storm surges; at present, about 46 million people are estimated to be at risk of flooding every year). These and many other findings of the report are assessed to have a high degree of confidence in terms of their occurrence. However, unambiguous detection of these climate-induced changes, according to the report, will prove extremely difficult in the coming decades because of the complexity of various physical and ecological systems and their many nonlinear feedbacks. Thus, any estimate on the timing of occurrence of these climate-induced changes has a low degree of confidence at this time and the issue of detection and timing of occurence of climate-induced changes is likely to remain unresolved in the foreseeable future.

The report contains introductory material on a terrestrial ecosystem which provides useful background information on a number of interdisciplinary topics like climate-driving forces, precipitation and soil water, carbon and soil nitrogen dynamics, ecosystems and biomes. The chapter entitled Energy Primer provides a very readable account of global energy systems, energy use, energy resources and global energy-related CO_2 emissions. The eighteen chapters that follow the introductory material provide a comprehensive discussion on climate-change impact on various areas like agriculture, forestry, mountain ranges, coastal zones, etc. Four of the eighteen chapters discuss climate-change impacts and mitigation measures on socioeconomic issues like industry, energy and transportation, human settlement, financial services and human population health. These eighteen chapters form the bulk of the report (almost 500 of the total 878 pages) and provide good (though rather long) reading material on various climate-change related issues.

The report is produced in a soft cover format and uses a typeset which is attractive and easy to read and the text is almost free of errors. The report can be a valuable source of reference for researchers as well as for policymakers and politicians. The report would be a welcome addition to reference libraries and research organizations dealing with climate change science.

Under the Whirlwind

If you haven't seen it, get hold of a copy of "Under the Whirlwind" by Arjen and Jerrine Verkaik. They were guest speakers at our recent Saskatoon Congress and enthralled the audience with their amazing slides of severe storms. The book is a smorgasboard of information on the human as well as the physical aspects of the tornado. A worthwhile gift for anyone with an interest in weather, you can order a copy by calling 1-888-4-SKYART. Tell them you heard of it through CMOS. We'll try for a full book review in a coming issue.

Atlas des courants de marées, Estuaire du Saint-Laurent du cap de Bon-désir à Trois-Rivières Pêches et Océans Canada Saint-Laurent, Vision 2000

Publication revue par André April, Département des Sciences de la Terre Direction Science de l'atmosphère, Université du Québec à Montréal

Cette Atlas remplace le document publié en 1939 par le Service hydrographique du Canada, "Tidal Currents Charts, St-Lawrence Estuary". De nombreuses observations ainsi que l'utilisation de modèles numériques ont permis de présenter une plus grande quantité d'information.

L'Atlas des courants de marée est produit à l'aide de modèles numériques hydrodynamiques tridimensionnels utilisant une grille ayant 400 m de résolution latérale et 20 couches dans la verticale. Les résultats de ces modèles numériques ont été comparés à de nombreuses mesures de niveaux d'eau et de courants. La méthode retenue pour synthétiser l'information requise pour produire l'Atlas fut de reproduire un cycle de marée semi-diurne typique de la saison estivale soit de juin à septembre.

Durant les étés 1994 et 1995, des courants de surface furent mesurés à l'aide de bouées dérivantes équipées de recepteur GPS, mais la reproduction dans l'Atlas de ce graphique laisse à désirer. D'autres figures représentent les ondes internes pouvant avoir lieu dans la zone. L'influence des vents n'a pas été prise en compte dans l'Atlas.

Enfin, c'est une publication que plusieurs attendaient avec impatience.

Avis de l'Éditeur

Le graphique dont parle André April a été corrigé par un *Avis aux navigateurs* (Édition mensuelle No. 5 du 30 mai 1997). C'est une erreur d'impression qui en était la cause; les lignes indiquant les dérives ne sont malheureusement pas parues lors de l'impression de l'Atlas.

Mini-Conference
The Arctic Buoy Program
Scientific Achievements from the first 20 years
3-4 August, 1998
Seattle, Washington, USA
Sponsored by the International Arctic Buoy Programme and the Data Buoy Co-operation Panel

Perspective

During January/February 1979, the University of Washington deployed the first array of automatic data buoys for the purpose of monitoring fields of sea-ice motion, atmospheric pressure, and surface air temperature throughout the Arctic Basin. The initial program was seen as the initiation of a multi-year monitoring program supporting the Second GARP Objective and as the polar element of the Global Weather Experiment (1978-79). The dual scientific/operational objectives were quickly recognized by Norway and Canada, and the program took on international dimensions. The concept of basin-wide monitoring has endured and evolved into the present International Arctic Buoy Programme (IABP).

The IABP is self supported by its Participants: operational agencies, meteorological and oceanographic institutes, research agencies, and non-governmental agencies with interest in the Arctic Ocean. The buoy array and data management activities are presently operated by a no-cost service to the scientific community and to the operational community.

Objectives

The conference will bring together scientists and Participants of the IABP to review and assess contributions of the arctic buoy programs to the scientific community and to discuss future activities.

- main scientific results of the buoy program will be summarized;
- ongoing and future research will be outlined;
- changes and improvements in the IABP will be recommended.

The contributions of the IABP data to sea ice studies, surface meteorology, oceanography, pollution transport, and remote sensing will be reviewed.

Major Accomplishments

The primary objective of the initial buoy program was to provide the data for a basic understanding of sea ice motion, atmospheric pressure, and surface air temperature throughout the Arctic Basin.

- *sea ice motion* - The basic kinematics and statistics of ice motion are well documented by the existing data set. Daily, monthly, and annual fields of sea ice motion have been prepared since 1979 and define the means and variances for sea ice motion and deformation throughout the Arctic Basin. Variability on the decadal time scale is beginning to be understood.

- *atmospheric pressure* - The basic statistics of surface atmospheric pressure are well defined by the existing data base. New results on decadal scale variability show the Arctic Basin to be a centre of extraordinarily large variability. The high correlation between the surface geostrophic wind and the 10 m wind is well documented. On time-scales of days to years, the linear response of sea ice to the local geostrophic wind explains about 70% of the ice motion variance; thus patterns of surface pressure are akin to the large-scale ice motion in the central Arctic Basin. By subtracting the direct frictionally-driven ice motion, the underlying ocean currents have been inferred.

- *surface air temperature* - The mean monthly fields of 2-m air temperature are reasonably well defined by buoy data, as are some of the statistics of spatial and temporal variability. However, the present data set seems inadequate to measure the high latitude warming due to increased greenhouse gases simulated by many General Circulation Models.

Data from the Arctic Buoy Program are often central to other disciplines. Recently, the data have been extensively used in studies of pollution transport, energy and momentum exchange, and freshwater fluxes. The data also play a key role in forcing and validating mathematical models of the sea-ice/ocean coupled system.

Future

The IABP Principles of Operation make no reference to the duration of the programme. The present consensus is that automatic data buoys are cost-effective and may be the only means for collecting certain data over the ice-covered seas. The IABP is expected to continue for at least another five years before being replaced by higher technology. However, we should expect changing requirements and emphasis. For example, RADARSAT imagery and passive microwave data are now beginning

to supplant buoy trajectories in defining the large-scale fields of ice motion.

The new requirements for the IABP may be in monitoring the upper portion of the Arctic Ocean. Argos buoys equipped with temperature and salinity sensors have successfully operated to depths of 300 m. The scientific requirements for these data and cost-effectiveness of the buoys will be reviewed.

International Programs like the Global Climate Observing System (GCOS) and the Global Ocean Observing System (GOOS) are evolving and defining their requirements for the ice-covered seas. A future role of the IABP may be to serve the climate monitoring community.

Conference Format

Participants are asked to submit brief abstracts in advance of the meeting. The organizers will select and/or solicit keynote presentations, but posters are expected to be the primary medium. At the end of the conference, an open discussion will be held to make recommendations for the future direction of IABP. A conference report containing extended abstracts and major recommendations will be prepared.

Venue and Information

The conference will be held on the campus of the University of Washington in Seattle. The local organizing committee will reserve a block of rooms in one of the Seattle hotels.

Initial inquiries may be directed to:

Roger Colony or Tordis Villinger
e-mail: acsys@npolar.no or tvilling@npolar.no
Tel: +47 22 95 96 05 or +47 22 95 95 73
Fax: +47 22 95 96 01
or to Thomas Thompson
e-mail: thompson@sioc.se
Tel: +47 38 26 96 35 (Mar-Nov)
+47 52 53 41 01 (Dec-Feb)
Fax: same as above.

Further information is available from these two web sites:

http://iabp.apl.washington.edu/
http://www.npolar.no:80/acsys

First Call for Papers

The IABP invites abstracts for poster and oral presentations at this time. A second announcement is scheduled for December 1997. Initial inquiries may be directed to Ms. Tordis Villinger, Thomas Thompson or Roger Colony.

Companion Workshop and Meeting

The workshop on *Sea Ice Charts of the Arctic - Scientific Achievements of the First 400 Years*, will be held at the University of Washington, 5-7 August, 1998.

The IABP will hold its 8th annual business and information meeting during 29-31 July, 1998.

Preliminary Announcement
Workshop on Sea Ice Charts of the Arctic
Scientific Achievements from the first 400 years
5-7 August, 1998
Seattle, Washington, USA
Sponsored by
ACSYS (Arctic Climate System Study)
of the
World Climate Research Programme

Perspective

During the summer of 1596, Willem Barentsz discovered Svalbard and charted the main ice edge between Svalbard and Novaya Zemlya. Within twenty years, an extensive whaling industry was established along the ice edge on the Greenland Sea and on northern Svalbard. Sea-ice information soon became important to the exploitation of whales, safety of navigation, and re-supply of high latitude whaling stations. In the early 1850s, sealing became commercially important, and annual hunts to the Greenland/Barents Seas were organized. Once again, sea-ice information became of operational value.

In the 1930s, the Soviet Union prepared routine ice charts to support shipping along the Northern Sea Route. During World War II and the following cold war period, the ice conditions in the Siberian arctic took on military value. Ship and aircraft reconnaissance was extensively used to prepare sophisticated ice charts.

From the mid 1950s, visual and soon infrared images became routinely available on a daily basis from US and Russian weather satellites. Although weather-dependent, these images greatly improved the quality of the ice charts and, in particular, extended the geographical coverage.

In late 1972, Nimbus 5 was launched with the Electrically Scanning Microwave Radiometer (ESMR), and routine, all-weather information about the ice state and ice edge became available.

Satellite SAR is now available, providing high resolution, all-weather ice information over most of the Arctic.

Objectives

The workshop will bring together scientists and those agencies responsible for the preparation of operational ice charts to review and assess ice chart information to the scientific community. Specific objectives are:

- identify physical processes controlling the seasonal and interannual variability of the ice edge position;
- review current procedures for estimating ice concentration;
- relate the temporal evolution of ice type to mechanical and thermal processes;
- assess the role of ice chart information in the validation of ice/ocean simulations.

Additionally, the meeting will serve to promulgate historical data sets recently available in electronic form and state scientific requirements for further digitizing of arctic sea ice charts.

Ice Charting Centres

From the earliest times, ice information has had economic, public safety, and national defense implications. Preparation of ice charts has primarily been a national operational activity. Within the Arctic, ice charts are presently prepared by:

National Ice Center, USA;
Arctic and Antarctic Research Institute, Russia;
Canadian Ice Service, Canada;
Norwegian Meteorological Institute, Norway; and
Danish Meteorological Institute (Greenland Ice Service).

Since the end of the 1970s, all ice charts have been based on common international codes and sets of symbols developed by WMO. They have been used in the development of the international digitizing code SIGRID. Several series of ice charts have been digitized using SIGRID. USA and Russia maintain data banks now available to the scientific community.

Format of Workshop

Participants are asked to submit brief abstracts in advance of the meeting. The organizers will select and/or solicit keynote presentations of a few topics, but posters are expected to be the primary medium. The participants will be asked to join one of these (tentative) working groups:

- Physical processes at the ice edge;
- Statistical studies of ice chart information;
- Physical processes controlling ice concentration and ice type.

The working groups will report on the level of scientific understanding of these items. The working groups will also recommend future data requirements. A workshop report containing extended abstracts and working group reports will be prepared.

Venue and Information

The conference will be held on the campus of the University of Washington in Seattle. The local organizing committee will reserve a block of rooms in one of the Seattle hotels.

Initial inquiries may be directed to:

Roger Colony or Tordis Villinger
e-mail: acsys@npolar.no or tvilling@npolar.no
Tel: +47 22 95 96 05 or +47 22 95 95 73
Fax: +47 22 95 96 01
or to Thomas Thompson
e-mail: thompson@sioc.se
Tel: +47 38 26 96 35 (Mar-Nov)
+47 52 53 41 01 (Dec-Feb)
Fax: same as above.

Further information is available from these two web sites:
http://iabp.apl.washington.edu/
http://www.npolar.no:80/acsys

First Call for Papers

ACSYS and the US National Ice Center invites abstracts for poster and oral presentations at this time. A second announcement is scheduled for December 1997. Initial inquiries may be directed to Ms. Tordis Villinger, Thomas Thompson or Roger Colony.

Companion Workshop and Meeting

The conference on *The Arctic Buoy Program - Scientific Achievements from the First 20 Years*, will be held at the University of Washington, 3-4 August, 1998.

Coastal Zone Canada '98
First Announcement

August 30 to September 3, 1998
Victoria Conference Centre
Victoria, B.C. Canada

Community-Based Integrated Coastal Zone Management
Sharing our Experience
Building our Knowledge

Coastal Zone Canada '98 will be the third in the Coastal Zone Canada series of international conferences held to advance the field of Integrated Coastal Management throughout the world. The first two conferences, held in Halifax, Nova Scotia in 1994 and Rimouski, Québec, in 1996, were attended by delegates from more than fifty nations. They produced a Call for Action, emphasizing the need for community-based management, and recommendations for practical implementation.

Coastal Zone Canada '98 will build on these two conferences by creating a working forum where a broad cross-section of stakeholders in the coastal zone will not only participate in defining the issues, but will also share experiences and collectively identify the range of alternatives to address at the community level. The format of the meeting will emphasize interactive workshops, round tables and innovative communication sessions. These sessions will be enhanced through presentations of technical papers, poster sessions and training programs.

Coastal Zone Canada '98 hopes to attract representatives from community groups, resource harvesters, First Nations, international agencies, all levels of government, social and natural scientists, landowners, business people, interested citizens and, especially, young people from around the world.

Coastal Zone Canada '98 organizers are endeavouring to secure the financial resources to assist community-based groups, delegates from developing countries and young people, to attend the meeting.

For more information or if you are interested to give a paper, please contact the organizing committee at:

Coastal Zone Canada '98
Conference Management
Division of Continuing Studies
University of Victoria
Box 3030
Victoria, British Columbia
Canada V8W 3N6
Tel: (250) 721-8470
Fax: (250) 721-8774
e-mail: czc98@ios.bc.ca
http://www.ios.bc.ca/ios/czc98

Zone Côtière Canada '98
Première annonce

du 30 août au 3 septembre 1998
Victoria Conference Centre
Victoria, C. B. Canada

Gestion intégrée des zones côtières par les communautés
Partager nos expériences
Bâtir à partir de nos connaissances

Zone côtière Canada '98 sera la troisième d'une série de conférences internationales pour l'avancement de la discipline de la gestion intégrée des zones côtières partout dans le monde. Les deux premières conférences ont eu lieu à Halifax, Nouvelle-Écosse en 1994 et à Rimouski, Québec, en 1996, où les participants sont venus de plus de cinquante pays. Ces participants ont créé un Appel à l'action, mettant l'accent sur le besoin de la gestion de la zone côtière au niveau des communautés, et ont fait des recommandations pour la réalisation de la gestion côtière intégrée.

Zone côtière Canada '98 sera basée sur les résultats et les recommandations des deux premières conférences en créant un forum d'échanges où les gens de tous les secteurs d'intéressant aux problèmes des zones côtières pourront définir les aspects les plus importants. De plus, ils pourront partager des expériences, identifier des solutions qui seront adressées au niveau communautaire. Le format du congrès mettra en valeur les ateliers interactifs, les tables-rondes et les idées innovatrices. Il y aura aussi des présentations orales, des sessions d'affiches et des programmes de formation.

Zone côtière Canada '98 espère attirer les représentants des groupes communautaires, les pêcheurs, les bûcherons, les autochtones, les agences internationales, les différents paliers de gouvernement, les

sociologues, les chercheurs en sciences naturelles, les propriétaires de terrain, les commerçants, les citoyens qui s'intéressent à la gestion côtière et, surtout, les jeunes de tous les coins du monde.

Zone côtière Canada '98 essaie de trouver le financement nécessaire afin de faciliter la participation des groupes communautaires, des représentants des pays en voie de développement et des jeunes.

Pour plus d'information ou si vous désirez présenter une communication, prière de contacter le comité organisateur:

Zone côtière Canada '98
Division of Continuing Studies
University of Victoria
Box 3030
Victoria, British Columbia
Canada V8W 3N6
Tél: (250) 721-8470; Fac: (250) 721-8774
courriel: czc98@ios.bc.ca
http://www.ios.bc.ca/ios/czc98

OCEANS'98

Early Announcement
ACROPOLIS Conference Centre
Nice, FRANCE
28 September - 1 October 1998

Oceans'98 organized by the Oceanic Engineering Society (IEEE/OES) in Nice on the French Riviera celebrates the second venue of the conference in Europe. This oceans' conference will be set under the theme of **Engineering for a sustainable use of the oceans** which is also the main theme for the European Union Marine and Science Technology (MAST) programme.

Included topics are:

1) Underwater Acoustics including detection, Classification and Localization, Tomography, Transducers & Arrays, and Propagation.

2) Oceanographic Instrumentation including Water current measurements, Optical & chemical instruments, Buoys & moorings, Profilers, and Wave & tidal measurements.

3) Underwater Vehicles & Systems including AUV, ROV, Manned submersibles, Towed vehicles, Benthic stations, and Robotics.

4) Positioning, Navigation & Control including Global positioning, Communication, Mission control, and Underwater telemetry.

5) Data Acquisition & Processing including Marine GIS, Modelling & simulation, Data compression & data bases, and World Wide Web.

6) Remote Sensing including Active instruments, Passive instruments, Air/Sea Interactions, and Physics of remote sensing.

7) Signal, Image, Information Processing including Non-Acoustic & Acoustic Image Processing, Sonar signal processing, Neural networks, and Localization & tracking.

8) Coastal Management & Ocean Resources including Coastal monitoring, Coastal circulation, Sediment transport, Polar & severe environments, and Ocean energy.

The technical program will include paper, poster and tutorial sessions.

A large state of the art exhibition in the field of Marine Technology will be held in the Acropolis Conference Centre.

Important deadlines are:

Abstract deadline: February 6, 1998;
Notification of acceptance: April 10, 1998;
Camera ready paper: June 19, 1998.

For more information for Canadian citizens, please contact:

Oceans'98
Thomson Marconi Sonar
525, route des Dolines
BP 157
06903 Sophia-Antipolis
FRANCE
Tel: +33 492 96 44 69
Fax: +33 492 96 39 25
e-mail: g.bienvenu@ieee.org

CMOS Bulletin SCMO
Next Issue - Prochain numéro

The next issue of the ***Bulletin 25 (5)***, October 1997, will go to press by mid-September. We always need your contributions, short articles, notes, presentations, chronicles, book reviews, etc. Forward them to me by early September. Don't miss your chance!

Le prochain numéro du ***Bulletin 25 (5)***, octobre 1997 sera mis sous presse vers la mi-septembre. Vos contributions sont toujours les bienvenues. Veuillez bien me les faire parvenir d'ici le début du mois de septembre. Ne manquez surtout pas votre coup!

Announcement
10th Anniversary Colloquium

The natural and social sciences, policy and technology have each played central roles in the development and implementation of the Montréal Protocol. This Colloquium, planned for Saturday, September 13, 1997, in Montréal, will review their past contributions to this process and lessons for their future role in addressing ozone depletion and other global environmental issues.

This one day event will be one of the key activities marking the tenth anniversary of the signing of the Montréal Protocol. It will involve delegates to the Protocol's Ninth Meeting of Parties, interested members of the academic community, and both governmental and non-governmental policymakers. Environment Canada is the principal Colloquium organizer, with advice from an international committee.

Confirmed participants include:
· Daniel Albritton, NOAA Aeronomy Laboratory, USA;
· Daniel Andersen, US Environmental Protection Agency, USA;
· Duncan Brack, Royal Institute of International Affairs, UK;
· Suely Carvalho, Co-chair - UNEP Technology and Economics Assessment Panel;
· Elizabeth Dowdeswell, Executive Director, UNEP;
· Winfried Lang, Austrian Ambassador to Belgium;
· Jan van der Leun, University Hospital, Utrecht, The Netherlands;
· Mario Molina, Massachusetts Institute of Technology;
· Anne O'Toole, Environment Canada;
· Marvin Soroos, North Carolina State University;
· Manfred Tevini, Karlsruhe University, Germany;
· Mustafa Tolba, International Center for Environment and Development, Egypt.

A statement summarizing the key messages emerging from the presentations and discussions will be prepared for the Ministerial Meeting of the Ninth Meeting of Parties to the Montréal Protocol on September 15th, 1997. Proceedings of selected sessions will also be published.

For more information, contact the 10th Anniversary Colloquium Secretariat, Ms Yarrow McConnell, Canadian Global Change Program, Royal Society of Canada, 225 Metcalfe Street, Suite 308, Ottawa, Ontario, K1M 1Y1 Canada; Tel: (613) 990-9648; Fax: (613) 991-6996;
e-mail: ymcconn@rsc.ca;
Internet: http://www.ec.gc.ca/ozone

Annonce
Colloque du 10e Anniversaire

Les sciences naturelles et sociales, la politique et la technologie ont toutes joué un rôle prépondérant dans l'élaboration et la réalisation du Protocole de Montréal. Ce colloque, qui se tiendra à Montréal le samedi 13 septembre 1997, permettra de passer en revue l'apport respectif de ces éléments au processus et les leçons à tirer pour leur apport futur à la recherche de solutions au problème de l'appauvrissement de la couche d'ozone et à d'autres problèmes touchant à l'environnement global.

Cette rencontre d'une journée sera l'une des principales activités destinées à souligner le dixième anniversaire de la signature du Protocole de Montréal. On y retrouvera des délégués à la neuvième réunion des parties, des membres intéressés des milieux universitaires et des décideurs publics et privés. Environnement Canada est le principal organisateur de l'événement, conseillé en cela par un comité international.

Liste des participants confirmés:
· Daniel Albritton, NOAA Aeronomy Laboratory, États-Unis;
· Daniel Andersen, Environmental Protection Agency, États-Unis;
· Duncan Brack, Royal Institute of International Affairs, R.U.;
· Suely Carvalho, Co-président - Comité de la technologie et de l'évaluation économique, PNUE;
· Elizabeth Dowdeswell, Directeur exécutif, PNUE;
· Winfried Lang, Ambassadeur de l'Autriche en Belgique;
· Jan van der Leun, Hôpital universitaire d'Utrecht, Pays-Bas;
· Mario Molina, Massachusetts Institute of Technology;
· Anne O'Toole, Environnement Canada;
· Marvin Soroos, North Carolina State University;
· Manfred Tevini, Université de Karlsruhe, Allemagne;
· Mustafa Tolba, Centre international de formation en sciences de l'environnement, Egypte.

Une déclaration résumant les principaux messages issus des exposés et des discussions sera préparée pour la réunion ministérielle de la neuvième réunion des parties au Protocole de Montréal, le 15 septembre 1997. Les comptes-rendus de certaines séances seront également publiés.

Pour plus de renseignement, contacter: Secrétariat du Colloque du 10e anniversaire, Mme Yarrow McConnell, Programme canadien des changements à l'échelle du globe, Société royale du Canada, 225 rue Metcalfe, porte 308, Ottawa, Ontario, K1M 1Y1 Canada; téléphone: (613) 990-9648; télécopieur: (613) 991-6996;
courriel: ymcconn@rsc.ca;
Internet: http://www.ec.gc.ca/ozone/indexf.htm

Ocean Beijing '97
Letter of Invitation

1998 was declared the "Year of the Oceans" at the 49th UN General Assembly. In recent years, many countries have achieved great success in the field of multipurpose utilizing and developing ocean resources. With the shortage of land resources, the strategy of developing ocean resources is pressing and is understood by each country. It is predicted that full utilization of ocean resources and rapid improvement of ocean technology will not only have broad development prospects, but will also have lasting influence on the across-the-century global economies.

China has a large sea area with rich resources. The multipurpose utilization and development of ocean resources, as the across-the-century high technology, has greatly attracted the Chinese Government and is now regarded as the state research & development plan of high technology. Since the economic reform and open policy of China, the Chinese Government has put forth great efforts and achieved some results. They will continue to increase R&D capability and set up more extensive international cooperation.

The aims of Ocean Beijing '97 are to further push on the development of the world's ocean economy, promote the extensive international exchanges and co-operation of ocean technology, and draw the common attention of whole society to the career of multipurpose utilizing and developing ocean resources. China cordially welcome all friends to show their new achievements, technology and equipment during this special event.

China will become stronger after Hong Kong's return to China in July of 1997 and Beijing will welcome this international grand meeting on ocean economic development & co-operation. It is hoped that by participation in this event, all friends from the ocean field will strenghten friendship, broaden exchanges and promote joint development together.

Exhibits Categories

Ocean Beijing '97 will be held at the Beijing Exhibition Centre, China, from November 25 to 30, 1997. Categories of exhibits included (both technology and equipment) :

1) Shipbuilding and Navigation; 2) Marine Fishing; 3) Marine Prospecting; 4) Ocean Transportation and Port Construction; 5) Marine Petroleum and Natural Gas Exploitation; 6) Sea Water Desalination and Multipurpose Use; 7) Coastal Zone Development and Aquaculture; 8) Marine Mineral Resources; 9) Marine Communication and Navigation; 10) Marine Biological Product Manufacturing; 11) Ocean Tourism and Recreation; 12) Ocean Chemistry; 13) Development of Marine Engineering, Underwater Operation and Diving; 14) Marine Environment Investigation, Measurement and Survey; 15) Aquatic Products Processing and Multipurpose Use; 16) Marine Medicine and Development of Health Products; 17) Marine Ecology, Resources and Environment Protection; 18) Marine Monitoring, Marine Hydro-Meteorology Research and Calamity Forecasting; 19) Sea Rescue; 20) Marine Engineering.

Activities & Contacts

Chinese leaders will attend the opening ceremony and a special Exhibition. There will be an opening banquet. Technical exchanges and business negotiations will take place. There is a price depending on the size of the exhibit. For more detailed information, please contact:

Ms. Wang Xin or Ms. Bao Jun
Room 412, Building 1
No. 172 Zizhimennei Street
Beijing 100035, P.R. China
Phone: (0086/10)66188713, 66175854, 66175871, 66739929 ext.2412
Fax: (0086/10)66188714
or contact CMOS Bulletin Editor if interested.

CMOS Executive Office Move!

You may not have noticed but CMOS Executive Office has recently moved to the ... SAME location.

During the first week of August, CMOS Executive Office files have been put into several boxes to allow the installation of new modern office furniture and better layout of space. Now, they are proud of their new look and are ready to serve you even better and faster. You may drop in at any time to check them out!

Please note that they have the same telephone and fax numbers and you may reach them with the same Internet address as before.

Déménagement des bureaux de l'Exécutif!

Vous ne vous en êtes peut-être pas rendus compte mais les bureaux de l'Exécutif de la SCMO ont récemment déménagé au ... même endroit.

Pendant le temps d'un week-end au début d'août, les effets des bureaux ont été mis dans plusieurs boites pour permettre l'installation de nouveaux bureaux plus modernes et aussi un aménagement plus fonctionnel. Les membres de l'Exécutif sont maintenant fiers de leur nouvel arrangement. Ils sont prêts à vous servir encore mieux et plus vite. Venez le constater par vous-mêmes!

Prière de noter que les numéros de téléphone et de télécopieur n'ont pas changé. Ils ont également la même adresse internet qu'auparavant.

Notes to the Editor

1) New pH electrode

A micro pH electrode has been developed which can measure samples as small as 5 microliters which is less than 1/10 the volume of a single drop of liquid.

The electrode fits directly into 96 well plates, microcentrifuge tubes, serum cups, capillary tubes, and NMR tubes.

The probe is all solid state with a Teflon body making it virtually unbreakable. It has a 1 mm tip and 2 mm body and can be used with any standard pH meter or strip chart recorder. For further details e-mail service@lazarlab.com or fax (213) 931-1434.

Micro probes are also available to measure ions such as Na, Cl, and K as well as pO2 and pCO2.

R. Chan, Ph.D.

2) RADARSAT International endorses IDRISI Software

RADARSAT International (RSI) of Richmond, British Columbia, Canada, is pleased to announce that IDRISI for Windows Version 2 has attained Level 2 endorsement RSI's highest level of RADARSAT compatibility for successfully incorporating a number of RADARSAT processing functions.

As the world's most widely used raster GIS, IDRISI is a professional level GIS and image analysis software package developed by The IDRISI Project, Clark Labs for Cartographic Technology and Geographic Analysis, Clark University of Worcester, Massachusetts. Under the RADARSAT Endorsement Program, RSI provides image processing and GIS organizations with RADARSAT product specifications, sample products and technical support. Once a supplier demonstrates that their software can read and manipulate RADARSAT data, RSI issues a Letter of Endorsement and adds the software package to its directory of RADARSAT-compatible software.

Three levels of endorsement are offered. Display Level (lowest level): automatic loading, ingest and display of RADARSAT images. Level 1: Display level plus filters, texture analysis, edge and radiometric enhancements, image arithmetic, and plotting. Level 2 (highest level): Level 1 plus data integration, geocoding, mosaiking, and RGB to IHS conversions. To date, four other image analysis and GIS packages have attained Level 2 endorsement.

As the world's first operationally-oriented radar satellite, RADARSAT is equipped with an advanced synthetic aperture radar (SAR). RADARSAT's unique capabilities open a vast new array of applications around the world.

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

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

3) RSI and PCI sign worldwide marketing agreement

RADARSAT International (RSI) of Richmond (British Columbia, Canada) and PCI Enterprises Inc. of Richmond Hill (Ontario, Canada) are pleased to announce that they have entered into a reciprocal agreement which enables each company to market the other's products.

"This new partnership, which brings together the exclusive distributor of RADARSAT data and the leading developer of remote sensing software, will allow us to offer our respective clients an exciting new range of integrated solutions," said Mr. Robert E. Tack, President, RADARSAT International. "This is a significant milestone in RSI's business strategy, and I anticipate that the strong complementary nature of PCI's and our products will also allow us to identify previously untapped marketing opportunities in Canada and worldwide."

Under the terms of the two-year agreement, PCI will have the opportunity to bundle RADARSAT data and image products with their software, and RSI will be able to offer PCI software with RADARSAT data. The two companies have appointed each other as non-exclusive authorized resellers of the other's products in Africa, Asia Pacific, Europe, North America, and South America except where there are existing distribution agreements. Educational institutions, Canadian and international federal government agencies and certain ground station countries are excluded from the agreement.

"PCI has developed many processing packages designed especially for use with RADARSAT imagery. These new technologies include DEM extraction as well as geoscience and rice crop monitoring application packages. This agreement is a natural extension of the

strategic alliance between us," commented PCI President Dr. Robert Moses.

PCI is a software developer based near Toronto (Ontario, Canada). For the past 15 years, thousands of GIS and Remote Sensing scientists and professionals in all corners of the world have relied on PCI products to monitor the Earth and its resources.

As the world's first operationally-oriented radar satellite, RADARSAT is equipped with an advanced synthetic aperture radar (SAR). RADARSAT's unique capabilities open a vast new array of applications around the world.

RADARSAT International (RSI) is a world leader in providing information solutions from space. RSI has the exclusive licence to distribute RADARSAT products worldwide, and distributes ERS products in North America and SPOT, LANDSAT and JERS-1 products in Canada. RSI has its headquarters in Richmond (British Columbia, Canada) and offices in Ottawa (Ontario, Canada), Gatineau (Québec, Canada), and Farnborough (United Kingdom).

For more information on RADARSAT, please contact Cory Aspden at (604) 231-4916 or Robert E. Tack at (604) 231-4913, or read RADARSAT International homepage at www.radarsatinaction.com. For more information on PCI Inc, contact Jessica Shields at (905) 764-0614 or read their homepage www.pci.on.ca.

Vacant Forecaster Position in Saudi Arabia

A position for a Forecaster will become available about December 1, 1997, in Saudi Arabia.

The task will be to provide Marine Forecasts for the Arabian Gulf and Red Sea. The forecasts are provided to Saudi Aramco though the contract will be with the Dallah Group, a major Consulting Firm in Saudi Arabia and is for two years.

The Forecaster will be a member of a team of four, who as a group must operate and maintain a Forecast Office on a 24-hour basis. Shifts are of a twelve hour duration. One month paid vacation with return air fare is provided after five months continuous service. An extended service bonus equivalent to about one-month pay is provided after two years continuous service. Single living quarters and medical coverage are provided. A vehicle is also available for local use. There are no taxes in Saudi Arabia.

The Forecast Office is located at the Saudi Aramco Marine Terminal at Ras Tanura roughly 60-80 km by road from the twin cities of Ad Dammam and Al Khobar which have a combined population of about one million persons and offer nearly all modern shopping facilities.

Saudi Arabia is an Islamic State and the successful candidate will be expected to respect Islamic codes, traditions and practices.

The salary is to be negotiated.

An international search will be conducted but any interested candidates will be considered by the undersigned. Brief expressions of interest or enquiries for further information may be sent to me at the e-mail address shown below. Note that the Internet has not yet been allowed in Saudi Arabia so that references should not be made to Web sites.

The successful candidate must have a Forecaster's ticket and at least five years' experience. A reasonable level of computer literacy is required.

Short listing of candidates will begin in early September. Resumés and other written information should be sent directly to:

Bill Thompson
PO Box 616
Rahima, Saudi Arabia
31941

Material should not be sent to the Calgary address since it will be delayed in forwarding.

Wm.C. Thompson & Associates Ltd.
Atmospheric Environmental Consultants
112 Varsity Green Bay NW
Calgary, Canada T3B 3A7
Tel/Fax (403) 286-6215
E-mail address: thompsow@cadvision.com

1996 Prime Minister's Awards for Teaching Excellence in Science, Technology and Mathematics

Carlee Hurl is just the sort of multi-talented teacher willing to go the extra mile that Uncas Elementary School needed. Rural communities such as Ardrossan, Alberta, where the school is located, require someone who knows how to work independently and make the best use of local resources. Mrs. Hurl has filled this role admirably, creating, among other things, a program based on meteorology that led to the school receiving a weather station from Environment Canada and becoming part of a weather reporting network.

Luc Prud'homme is constantly on the lookout for stimulating activities that will help his students learn. One example of his efforts is a program that saw mineralogists visit his classes at École secondaire Hormidas-Gamelin in Buckingham, Québec, to explain what they do. He has also begun setting up a computerized meteorological station at the school. Over his career, Mr. Prud'homme has used this approach in teaching physics, mathematics and, more recently, environmental studies.

1995 Prime Minister's Awards for Teaching Excellence in Science, Technology and Mathematics

Pearl Bradd is sometimes called a "Pearl of Wisdom" at Riverside Secondary School in Windsor, Ontario, advocating as she does for her students, science and the environment. Her concerns are reflected in projects such as one in which students measure ultraviolet (UV) radiation behind the school. The results are noted on a poster that is updated daily. Students also prepared an information kit on UV radiation. It is this kind of dedication that won Ms. Bradd the Roberta Bondar Award for Educational Achievement in Science and Technology.

John MacLeod has used the interest of his students at Gananoque Secondary School in Gananoque, Ontario, in meteorology to introduce them to high technology. The school operates its own rooftop weather station and students have recently begun downloading information from satellites to analyze on one of the school's computers. His students are learning how technology fits into the curriculum and are getting a better understanding of the natural environment.

Ronald Mihaychuk has set up programs to help everyone at John de Graff Elementary School in Winnipeg - from kindergarten students to senior staff - use computers with confidence. In one of his many successful programs, he co-ordinated efforts to set up a weather station on the school's roof. Grade 6 students use computers to get readings and then use this information to do a weekly weather synopsis for a local TV station.

Note from the Editor: Listed above are the winners of Prime Minister's Awards for Teaching Excellence in Science, Technology and Mathematics for the past two years where the citation mentions weather or meteorology (none mentions work in oceans or oceanography).

Pot-Pourri

Insurance Bureau of Canada Quarterly Analysis[1]
by Paul Kovacs, Toronto, Ontario

Severe weather was evident in most parts of the country in early 1997, particularly in Manitoba, yet insurance claims are below last year's record levels. Effective loss prevention measures helped to save Winnipeg from the flood of the century. Similarly, property owners have taken action across the country to protect their possessions from the threat of water damage this spring. The lesson is that loss mitigation can be very effective in protecting property.

[1]: Short extract only.

Celanese Canada Fellowship awarded for Study Abroad

Nathalie Le François is one of 25 candidates awarded Celanese Canada Fellowships for study or research work in countries other than Canada and the U.S. Ms. Le François is currently studying in a Ph.D. of Oceanography program at the Université du Québec à Rimouski. She will be using her Fellowship to do research and study aquaculture in Northern Ireland at Queen's

University in Belfast. Ms. Le François completed both her Bachelor of Biology and her Master of Oceanography at the Université du Québec à Rimouski.

Improving Public Safety with Canada's Doppler Weather Radar Network

On April 21, 1997, Environment Minister Sergio Marchi announced a $34.9 million, six-year plan to establish a national Doppler weather radar network.

The network will improve public safety by giving meteorologists the data needed to detect and predict severe weather more quickly and more precisely. For example, in the past, forecasters usually had to wait until there was an eye-witness account of a tornado before issuing a tornado warning. In many cases, this meant people had no advance warning to find safe cover. With the new Doppler weather radar network, meteorologists will be able to detect those conditions that could lead to a tornado developing and to issue a warning up to 15 to 20 minutes before the tornado strikes. This will allow more time for people to take precautions.

Using data from Doppler weather radar, meteorologists will also be able to provide more accurate information more quickly on where a storm will hit and the amount of snow or rain the area is likely to receive. In the event of a thunderstorm with heavy rains predicted, this information could be invaluable to organizations such as municipalities and conservation authorities in charge of flood control or the management of combined sewer overflow and storm water run-off in cities and towns. Similarly in the winter, information on the place, time and amount of snow predicted could help municipal and provincial road crews with their snow-clearing operations.

Severe weather such as hail, blizzards, tornadoes, freezing rain, strong winds, heavy snow and rain exact a heavy toll in lives and property damage. For example, in Canada, poor weather conditions cause on average 220 fatal car accidents and more than 11,500 severe injuries each year. The Edmonton tornado on July 31, 1987 killed 27 people, injured 253 people and had an economic impact of about $330 million. The snowstorm in Vancouver and Victoria in December 1996 had an economic impact of $200 million and the hail storms which hit Calgary and Winnipeg in July 1996 resulted in property losses of close to $300 million. Since Doppler weather radar will help meteorologists detect severe weather sooner, they will be able to issue weather warnings at an earlier stage in the storms' development. When minutes count, this would give Canadians more time to protect their families and property.

The New Doppler Weather Radar Network

Over the next six years, Environment Canada will buy 10 new Doppler weather radars and retrofit 16 existing weather radars with a Doppler capacity. At present, Environment Canada has three Doppler weather radars, one each in Edmonton, Montreal, and King City, north of Toronto. By 2003, there will be 29 Doppler weather radars across the country from Vancouver, British Columbia to Holyrood, near St. John's, Newfoundland. Data from the Canadian Doppler weather radar network and the U.S. Doppler weather radar network can be exchanged.

The Doppler weather radars will have an effective range of 350 kilometres in diameter. The full network will cover those areas which are particularly prone to severe weather and protect 90 per cent of the country's population.

The area covered by the network was determined first, by the probability of severe weather such as tornadoes, blizzards, hail, and heavy rain and second, by population density. The new sites for the individual Doppler weather radars were determined in part by the location of the gaps in areas covered by the present Canadian and U.S. Doppler weather radar networks.

National Doppler Weather Radar Network Plan Implementation Schedule

1998 Regina (Saskatchewan)
Lac Castor (near Chicoutimi, Québec)

1999 Saskatoon (Saskatchewan)
Franktown (southwest of Ottawa, Ontario)
La Morandière (north of Val d'Or in the Abitibi Region, Québec)
Winnipeg (Manitoba)
Vancouver (British Columbia)[2]

2000 Southwestern Nova-Scotia
Sept-Iles (Québec)
Southwestern Newfoundland
Grande Prairie (west central, Alberta)
Montreal River (north of Sault Ste Marie, Ontario)

2001 Exeter (southwestern Ontario)
Calgary (Alberta)
Okanagan (south central British Columbia)
Dryden (northwestern Ontario)
Villeroy (between Québec City and Trois-Rivières, Québec)

2002 Holyrood (near St. John's, Newfoundland)
Britt (north of Parry Sound on Georgian Bay, Ontario)
Cape Breton (Nova Scotia)
Grandview (western Manitoba)
Prince George (British Columbia)

2003 Nipigon (northern Ontario)
Northeastern New Brunswick
Port Hardy (north of Vancouver Island, British Columbia)
Medicine Hat (Alberta)

Conventional weather radars are able to detect the intensity and location of precipitation such as rain, snow or freezing rain. Doppler weather radars do this and also measure the motion of the precipitation within the storms. Using sophisticated computer techniques, meteorologists can derive other valuable information about the motion of the air currents within the storms. Meteorologists then search the wind and precipitation patterns for the characteristic signatures of different types of severe weather such as strong squalls, down bursts, severe thunderstorms and tornadoes. With this information and other data from satellites, computer models, weather observations and volunteer observers, the meteorologist issues severe weather warnings. These warnings are broadcast on Environment Canada's Weatheradio service and are provided to television and radio stations.

(2) An experimental Doppler weather radar facility is currently being installed in Aldergrove (near Surrey, B.C.) to evaluate the use of Doppler weather radar in rugged terrain and mountainous areas. The Aldergrove Doppler weather radar will be replaced in 1999 by a permanent installation in Vancouver.

Long-Range Weather and Crop Forecasting Working Group Meeting

The plans have been finalized to hold the Third Meeting of the Long-Range Weather and Crop Forecasting Working Group at the Canadian Meteorological Centre (CMC) in Dorval (suburb of Montréal), from October 20th to 22nd 1997. The CMC is the nerve centre of the Canadian numerical weather prediction and has recently embarked upon operational implementation of long-range (1 to 3 months) forecasts for Canada, based on dynamical and statistical techniques. The Meeting is officially hosted by the CMC and is supported by the Canadian Meteorological and Oceanographic Society (CMOS).

No specific theme for the meeting is being proposed at this time, but we encourage and solicit papers on any aspect of long-range weather and crop forecasting and its operation utility. It is anticipated that the development of the present El Niño episode in the equatorial Pacific and its possible impact on world-wide climate anomalies will be an important topic of discussion at the meeting.

A block of rooms has been reserved at the Quality Suite in Pointe-Claire, Québec, which is about 5 km from the CMC building and is only minutes away from Montréal's Dorval International Airport. This delightful hotel offers excellent suites at a special price of $88 Cdn per night (for reservation, please call 514-421-5060, or toll free 1-800-228-5151, and ask for special rates for the "Long-range Forecast Group").

Kindly fill out the registration on opposite page and return the same with a registration fee of Cdn $100 (US $75). The registration fee includes the cost of two lunches (to be provided on Monday and Tuesday) plus a dinner on Monday evening at a delightful restaurant in downtown Montréal. Please submit the registration form at your convenience but preferably before (or shortly after) August 31, 1997.

It is proposed to publish the Proceedings of the Third Meeting at a later date. More details on submission of papers will follow shortly.

Louis R. Lefaivre, CMC, Dorval, Local Organizer;
E.Ray Garnett, Canadian Wheat Board, Winnipeg;
Madhav L. Khandekar, Environment Canada, Downsview.

REGISTRATION FORM

Long-Range Weather and Crop Forecasting Working Group
Third Meeting, October 20-22, 1997
Canadian Meteorological Centre, Dorval, Québec, Canada

Name:_____Telephone #:_____

Organization:_____Fax #: _____

Address:_____e-mail:_____

Will you be attending the meeting? Yes _____ No_____

Will anybody else in your organization be interested in attending? Name:_____

Will you be making a presentation at this October workshop? Yes_____ No_____

Tentative title of your presentation:_____

Suggestions for working group sessions:_____

Would you be interested in chairing a working group session? Yes_____ No_____

Registration fee: Cdn $100.00 (US $75.00)
Please make the cheque payable to: The Receiver General of Canada
(a receipt will be provided at the meeting).

Please mail this form with your cheque to:

Mr. Louis Lefaivre
Chief, Numerical Weather Prediction Division
Canadian Meteorological Centre
2121, Trans-Canada Highway
Dorval, Québec H9P 1J3 Canada

For more information please contact Mr. Lefaivre:

Fax: (514) 421-4657; e-mail: louis.lefaivre@ec.gc.ca

Result of Mail Ballot on Proposed Constitution/By-Law Amendments

Résultat du scrutin postal sur les modifications de la Constitution et des Règlements

Ref: CMOS Bulletin SCMO, Vol.25, No.2, April/Avril 1997

Number of bulletins received: 30 Invalid: 0
Nombre de bulletins reçus: 30 Non valable: 0

Constitution/By-Law Constitution / Règlement	Description of the amendment Description de l'amendement	For Pour	Against Contre	Abstain Abstention
Article 5, para. b	Notification period for amendments changed from 60 to 30 days / La période d'avis pour les amendements change de 60 à 30 jours	23	4	2 *
By-Law/ Règlement 1	New membership categories (Honorary Fellows, Fellow Members) / Nouvelles catégories de membres (Fellows honoraires, Fellows)	24	4	2
By-Law/ Règlement 16	New organizational structure of Committees, and change of name of Broadcaster Endorsement Committee to Weathercaster Endorsement Committee / Nouvelle structure organisationnelle et remplacement du nom du Comité de présentateurs d'information météo par Comité des présentateurs météo.	29		1
Idem	Creation of CMOS Scholarship / Établissement d'une bourse d'étude de la SCMO	27	1	2
General Amendment / Amendements généraux	Removal of gender distinction throughout the text / Enlèvement de la distinction de sexe dans le texte	28	1	1

* One vote invalid / Un vote invalide

N.J.Campbell, Executive Director / Directeur-exécutif

Plea to all CMOS Members!

We are in need of one or more volunteers to help us out in reviewing publications on atmospheric sciences. Let us know if you are interested and can help us out.

N.J. Campbell, Executive Director

Appel aux membres de la SCMO!

Nous avons besoin de volontaires pour faire la révision de publications portant sur les sciences atmosphériques. Prière de nous laisser savoir si vous êtes intéressés à nous aider.

N.J. Campbell, Directeur-exécutif

Announcement / Annonce

The André J. Robert Memorial Volume is going to press soon. If you are interested to receive your own copy, please fill up the order form (CMOS Bulletin SCMO, Vol.25, No.3, page 80) or contact as soon as possible the NRC Research Press at:

Tel: (613) 993-0151; Fax: (613) 952-7658.

Le livre en mémoire du Dr André J. Robert est sur le point d'aller sous presse. Si vous êtes intéressé à recevoir votre copie, prière de remplir le bon de commande (CMOS Bulletin SCMO, Vol.25, No.3, page 80) ou contacter le plus vite possible les Presses Scientifiques du CNRC aux numéros suivants:

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