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SCMO

Canadian Meteorological
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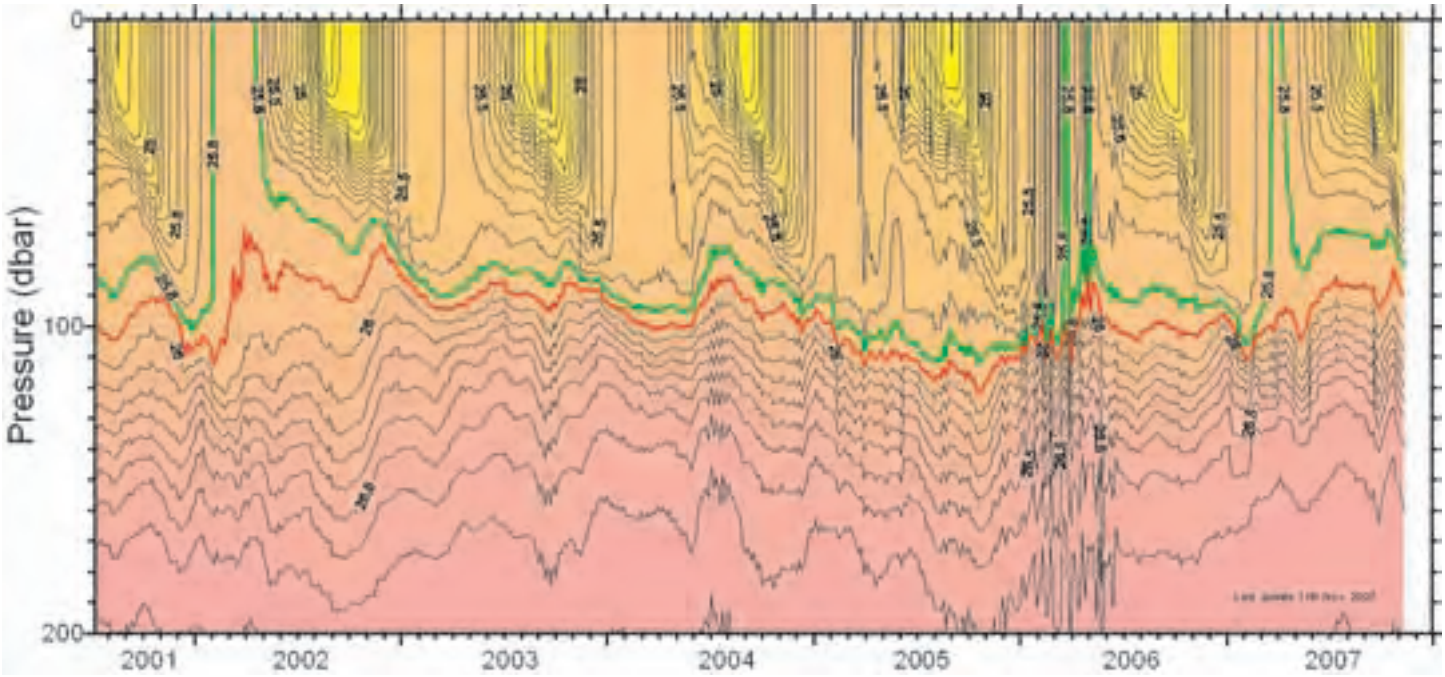
La Société canadienne
de météorologie et
d'océanographie

December / décembre 2007 Vol.35 No.6

Near Surface Stratification at Station Papa interpolated from Argo data

Stratification près de la surface à la station Papa interpolée à partir des données Argo



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

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Cover page : November 1st, 2007, was the target date to deploy 3000 Argo floats in the world's oceans. As expressed in an e-mail, which sounds like a song of victory, the goal was achieved and a celebration took place at the Institute of Ocean Sciences with the attendance of Michelle d'Auray, the new Deputy Minister of DFO. Shown on the cover page is an illustration of one of the oceanographic products generated by data collected by Argo floats. To learn more, please read the e-mail written by Dr. Howard Freeland to Canadians interested in Argo and reproduced here on **page 171**.

Page couverture : Le 1er novembre 2007 était la date butoir pour déployer 3 000 bouées Argo dans les océans du globe. Tel qu'exprimé dans un courriel, qui semble être un chant de victoire, le but fut atteint et une célébration a eu lieu à l'Institut des Sciences de la Mer en présence de Michelle d'Auray, la nouvelle Sous-ministre de Pêches et Océans. Illustré en page couverture, un des produits océanographiques généré en utilisant les données collectées par les bouées Argo. Pour en savoir plus, prière de lire le courriel écrit par le Dr. Howard Freeland aux canadiens intéressés par Argo et reproduit ici en **page 171.**

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Canadian Meteorological and Oceanographic Society (CMOS)

Société canadienne de météorologie et d'océanographie (SCMO)

Executive / Exécutif

....from the President's Desk

Friends and colleagues:

Dr. Paul Myers
CMOS President
Président de la SCMO

As 2007 slowly draws to a close, we can look back at an interesting year for CMOS and our associated science. Climate has remained a major focus, with much discussion and publicity. One thing I found quite surprising very positive was the recent awarding of a Nobel Prize to the IPCC for its work on reporting on the state of the climate through its analysis of the relevant scientific literature. Although not directly involved with this process, I know many Canadian scientists (and CMOS members) who were heavily involved, and heartily congratulate all of them for their efforts as part of this process.

In terms of CMOS matters, I remind people that the time is approaching when you should renew your membership for the upcoming 2008 year. Besides giving you access to CMOS publications and events, membership renewals help support the Society so that we can carry on our efforts to support and promote meteorology and oceanography in Canada, at all levels. I know I have heard people privately complain about CMOS fees, claiming they are significantly higher than those of equivalent American organizations (like AGU) - unfortunately this is purely a matter of scale, a significantly larger population base to support the Society while basic expenses for running even our minimal national office do not decrease with a smaller membership base. Furthermore, I would argue that CMOS provides a tremendous service to Canadian meteorologists and oceanographers completely out of proportion to its budget because of the tremendous amount of 'free' volunteer support that the Society receives. And for all of you who have done something for the Society (whether nationally or locally in your centre), a very strong thank you for your support.

(Continued on page 170 / Suite à la page 170)

Volume 35 No.6
December 2007 — Décembre 2007

Inside / En Bref

Articles

Our regular sections / Nos chroniques régulières

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

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

....from the President's desk (Continued / suite)

Finally, in an issue that is potentially very important to university members of the Society - CMOS has been asked by NSERC several times to comment on different aspects of its survey of the Discovery Grant program. As part of this process, the Society has been approached with the idea of aligning research in the Earth Sciences in Canada following the international structure - where the geological earth sciences fall under IUGS while our science would fall under the 'geophysical' banner of IUGG (International Union of Geodesy and Geophysics). I could note that 7 of the 8 associations of IUGG are represented by CMOS, or CGU (Canadian Geophysical Union) and such a breakdown is consistent with the interaction between CMOS and CGU in terms of a "Canadian Societies for the Geophysical Sciences" (CSGS) that was first discussed at the past St. John's Congress. I find this a very seductive idea as it brings together many branches of our science linked by similar underlying dynamics and supports broad areas of interdisciplinary research. Additionally if one defines geophysics as does the American Geophysical Union as including biogeosciences (which I personally think is the way to go), I see such a framework as supporting closer links between many diverse areas of marine sciences. Thus I personally think that such an approach might be a very positive thing for the Society to support. Yet I also know I am a fairly junior scientist in this area, and haven't been through all the NSERC re-allocation exercises that many others in our field went through. Thus I would really like as much feedback and thoughts on this issue as possible so that the CMOS Executive can make a truely informed decision on whether or not to strongly support this initiative, with the backing of its members. So, if you have any comments on this issue, whether for/against/ambivalent, please contact me, whether by email (president@cmos.ca or pmyers@ualberta) or phone (780-492-6706).

Paul Myers,
CMOS President
Président de la SCMO

URGENT - URGENT - URGENT - URGENT

Next Issue *CMOS Bulletin SCMO*

Next issue of the *CMOS Bulletin SCMO* will be published in **February 2008.** Please send your articles, notes, workshop reports or news items before **January 11, 2008** to the address given on page ii. We have an URGENT need for your written contributions.

Highlights of Recent CMOS Meetings

October 2007

October 16 - Executive Meeting:

- Discussion of matters for the Kelowna 2008 Congress, including with regard to attendence of government people related to various travel limitations;
- Brief discussion of some issues related to the Halifax 2009 Congress;
- Discussion of possible links with CGU in CSGS;
- Update on AO changes;
- Acceptance of a nomination for tour speaker for 2007/08;
- Discussion of a suggestion to create a new CMOS award for contributions to international programs;
- Discussion of the fact that the last annual audit suggested that CMOS needs to form an Audit Committee.

October 23 - Strategic Planning Committee Meeting:

- Update on the idea of CMOS getting a communications officer to help publicize our Society and science;
- Discussion of 2010 Congress, possible sites and links with CGU for another joint congress;
- Followed with a general discussion of congresses, local versus central organization and ability for all centres to host/run a congress as they become bigger;
- Discussion of location for the executive after Edmonton;
- Discussion of getting students more active in CMOS and how to provide 'services' of greater interest to students;
- Brief discussion of whether it would make sense to consider splitting the Alberta Centre into 2 (based around Edmonton and Calgary/Lethridge);
- Discussion of climate education and debate, both among CMOS members and for the general public.

Paul Myers,
CMOS President
Président de la SCMO

URGENT - URGENT - URGENT - URGENT

Prochain numéro du *CMOS Bulletin SCMO*

Le prochain numéro du *CMOS Bulletin SCMO* paraîtra en **février 2008.** Prière de nous faire parvenir avant le **11 janvier 2008** vos articles, notes, rapports d'atelier ou nouvelles à l'adresse indiquée à la page ii. Nous avons un besoin URGENT de vos contributions écrites.

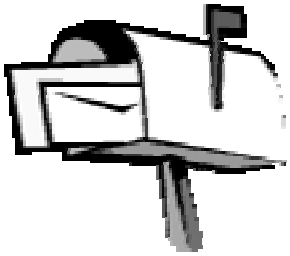
Correspondence / Correspondance

Date: 8 November 2007

To: Lewis Poulin

Subject: **PCGRIDDS32**

Bonjour Lewis,



I am currently at home recovering from back surgery. I thought I would make use of the time to try to teach myself how to use WINNGRIDS as described in your excellent article in the *CMOS bulletin SCMO* Vol.35, No.5 October 2007, pp.153-156. As I am working in a windows only environment, I have successfully downloaded WINGRIDDS. You mention that it is only necessary to change the path names - So my question is will the adjusted files to use CMC data which you have prepared in PCGRIDDS work in WINGRIDDS? Apologies if this is explained elsewhere!

Merci.

Peter Lewis
Darmouth, Nova-Scotia

Date: 8 November 2007

To: Peter Lewis

Subject: **PCGRIDDS32**

Hi Peter,

I wish you a speedy and full recovery. Hope it's not too painful! A caution though. PCGRIDDS32 and WINGRIDDS can be loads of fun. You may get addicted!

Yes the config files will work with both PCGRIDDS32 and WINGRIDDS.

A few corrections for the article:

(1) I refer to a macro mine.dat It should really be called mine.cmd instead.

It's easy to create a macro if you simply right click on existing macro in macros/ directory, paste it there as a copy of the original, then rename the copy as mine, then edit the contents of mine down to what you want.

(2) In the mine macro, you should use tcld sfc (instead of tcdc sfc).

I have not done much development work (yet) with WINGRIDDS. I focussed mainly on PCGRIDDS32. If you jump right to WINGRIDDS, you will have to read its documentation to see how to convert the raw grib data into WINGRIDDS format. It`s easy and should work fine after you have updated the wingridds config files as described for pcgridds. I think WINGRIDDS has come a long way and I encourage you to give it a good test drive. But that was one of the reasons I focussed mainly on PCGRIDDS32, which I found to be more stable.

Once you have it up and running, it's quite easy to set up your pc and use wget to retrieve CMC grib files and have them available for PCGRIDDS32/WINGRIDDS. I have some data retrieval files I could give you if you want to leap frog over the development stage for using wget.

One of the main reasons I wrote the article was to try and help my daughter (who is in grade 9) high school science teachers to see how easy it is now to set up a PC to retrieve model data so that it has become possible for high school students to consider making science projects using live atmospheric model data.

I encourage you to jot down your experiences and send them as a letter to the editor or follow up article to the *CMOS Bulletin SCMO* Editor (bulletin@cmos.ca).

If you encounter serious issues with either package, please let me know or send a note to Jeff Krob, the package's developer.

All the best.

Lewis Poulin
Pierrefonds-Roxboro, Québec

Date: 8 November 2007

To: Canadians interested in Argo

Subject: **Argo achieves the target array..**.

This email is addressed to people in Canada who have expressed some interest in Argo. Please feel free to share it with others, pass it on as needed. If you do not wish to be on this mailing list then please let me know.

News releases have been carried in almost all countries involved in Argo reporting that we have achieved the target array of 3000 floats. At the institute of Ocean Sciences we celebrated with an Argo cake and the first cut was made by Michelle d'Auray, the new Deputy Minister of DFO. She also had some nice words to say about the achievement.

It was tense getting there. Dean Roemmich and I had long ago realized that it would be hard to determine exactly when we crossed that magical threshold and so we decided that November 1st would be Argo-3000 day. We were pretty confident that we would in fact go over 3000 well before that date. As we got closer we started hoping, hoping that we would actually reach the magic number and start producing contingency plans for plausible fakery if we were close but short. In fact we didn't need to fake it, the Argo Information Centre (Mathieu Belbéoch) conducts our "official count" and verified that we had 3006 floats reporting on October 30th, so we didn't need to fake it but it was very close.

http://wo.jcommops.org/cgi-bin/WebObjects/Argo

News releases are dangerous things as one can easily get misquoted. I have fond memories of a newspaper article a couple of years ago (when we crossed 1500 threshold) that corrected my line about the floats observing the top 2 km of the ocean to "observing the top 2 m of the ocean". The same article also reported that Argo would aid in the prediction of "meteor showers". Think about that one for a while, the explanation is after this note.

Anyway, we have an occasional award at IOS called "The Fish" for achievements below the call of duty. Today I'd like to award "The Fish" to Nature. In the copy coming out tomorrow they will report on deploying the 3000th float and will report that "Argo oceanographers have deployed the last float". They will also report that the data are available only to the countries contributing, wrong on all counts. The data are universally and freely available and we are not about to stop deploying floats.

Dean Roemmich and I have just drafted a letter to *Nature* this morning, it went to their editorial offices about 10 minutes ago. I think this is generally considered to be the less-desired route for getting a paper in *Nature*. We also quote the Japanese version of the international press release which says "This is the end of the beginning." I do wonder if they realize who they are quoting when they use that phrase. Anyway, to get the story right, we imagine that we have now established the global array. This clearly has had a profound impact on seasonal climate forecasting in Europe and the expectation is that we now embark on a new 10-year phase to maintain the array and demonstrate the value for forecasting.

We do not know which float took us over the 3000 threshold and always knew that this would not be something easily determined. To give everyone decent credit we decided that every float deployed in October 2007 had an equal call on being the 3000th float and we have a photo montage of 3000th floats, please visit at:-

http://www-argo.ucsd.edu/FrArgo_3000.html

There also is a link to the official international news release that was used as a basis for all of the national news releases around the world on the Argo Steering team web site:-

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

Eye candy is available for anyone who wants to see 3006 floats on the Earth. My rotating globe is on the Argo-3000 photo page, and also available at my web page at:-

http://www.pac.dfo-mpo.gc.ca/sci/osap/projects/argo/graphics_e.htm

Christmas is coming soon and if you would like to build an Argo-oriented decoration for your Christmas tree then try the Argo icosahedron at:-

http://www.pac.dfo-mpo.gc.ca/sci/osap/projects/argo/info_e.htm

Meanwhile Argo continues and I should present a report.

Some time ago I reported on the pressure offset errors on SOLO floats carrying FSI CTDs. The profiles affected were overwhelmingly in the Atlantic. The errors were correctable and corrections have been made. The corrected profiles have now been uploaded to the Argo Global Data Centres. There is a statement about this on the Argo Steering team web page.

Argo will be getting high-level exposure at an upcoming summit meeting of Environment Ministers in Cape Town, at the end of November. We also have another major exposure, we have an entry on Wikipedia. I guess nowadays that is considered to be notable. One might also try searching for “Argo” on YouTube, but someone seems to find that embarrassing so I’d better not suggest it.

The Argo data management team will be meeting in Hobart, Tasmania, later in November 2007, and the next meeting of the International Argo Steering Team will be in March 2008 in Exeter, UK, hosted by the UK Met Office.

The US Argo program has secure funding for the next 4 years. It is clear that NOAA does not expect it to end but we do not know whether the US Argo program will be transferred to an operational agency or kept for another 5 years within the US University system. Both are possible. I have heard rumours to the effect that China is about to announce major new funding for the Chinese Argo program. Within Europe a new EC infrastructure program will supply funds to take the EU contribution of floats (EU directly plus member countries) from the current level of 16% of the total array to 25%. I believe this funding is now secure. Other

countries are looking at various means of putting Argo on a long-term operational basis.

One of the first floats ever launched by Canada, it goes by the name 4900074, remains alive and well and is still supplying profiles. I have no explanation for the extreme longevity of this float. It was launched on 21st February 2002 and the latest profile reported is listed by the float as number 208. This might also have the record for the smallest average velocity of any float, over 5.6 years it has managed to travel a net distance of 60.6 km over 2080 days for an average velocity of 0.034 cm/sec roughly WNW. This float was purchased just as the manufacturer was trying to increase manufacturing capacity to meet the anticipated demands from Argo, and it was accidentally ballasted too heavy. The result is that every summer it has continued profiling but under the high summer stratification it has failed to reach the surface and so was unable to contact Service Argos and report a profile. Each fall it has returned shortly after the first major storm destroys a large part of the summer near-surface stratification. So though it has delivered fewer than 208 profiles, it has actually executed those profiles.

In the North Pacific I have been monitoring changing conditions routinely now for several years. I can map the circulation of the Gulf of Alaska pretty routinely, you can see the maps at:-

http://www.pac.dfo-mpo.gc.ca/sci/osap/projects/argo/Dhgts_e.htm

What is interesting is that I can monitor the strength of the flow of water towards the east and the split of water heading northwards around the Alaska Gyre and the remainder heading southwards into the California current system. Over the last couple of years there appears to have been a progressive increase in the transport in the North Pacific Current. This transport can be seen at the web site:-

http://www.pac.dfo-mpo.gc.ca/sci/osap/projects/argo/Gak/split.gif

and I would conclude that we are seeing the largest North Pacific current transport that has been seen at any stage in the last 5 to 6 years.

Many other indicators of the state of the NE Pacific are also being computed using Argo data and these can be seen starting from the web page:-

http://www.pac.dfo-mpo.gc.ca/sci/osap/projects/argo/Gak_e.htm

Howard Freeland
Institute of Ocean Sciences
Sidney, BC

P.S. I set a challenge earlier in this note, why did a reporter think that Argo would help forecast meteor showers? I think the answer is that the reporter thought that was what the science of meteorology was. Reminds me of astronomer colleagues who have stories of occasions when they are asked something like “Oh you are an astronomer, so can you tell me my horoscope” ?

Notes from the Editor:

1) Dr. Howard Freeland was awarded the **CMOS President Prize** for 2006 for his outstanding leadership in the development of a global array of drifting Argo floats documented in his paper, co-authored with Patrick Cummins, “*Argo: A new tool for environmental monitoring and assessment of the world’s oceans, an example from the N.E. Pacific*”, published in *Progress in Oceanography*, 2005, vol. 64, pp. 31-44.

2) List of available products in the Gulf of Alaska using Argo data at:

http://www.pac.dfo-mpo.gc.ca/sci/osap/projects/argo/Gak_e.htm

- Line-P temperature & salinity sections as seen by Argo;
- Near surface stratification at Station Papa interpolated from Argo data (illustrated on the cover page);
- The circulation of the Gulf of Alaska as seen by Argo;
- Current strength indicators for the N.E. Pacific;
- Mixed-layer depths in the Gulf of Alaska as seen by Argo.

3) For further information about Argo in Canada contact one of the following person: -

- Pacific Region:

Howard Freeland
Institute of Ocean Sciences
Tel: (250)-363-6590
Email: FreelandHj@pac.dfo-mpo.gc.ca

- National Capital Region (Ottawa):

Bob Keeley
Marine Environmental Data Service
Tel: (613)-993-4658
Email: keeley@meds-sdmm.dfo-mpo.gc.ca

- Quebec Region

Denis Gilbert
Institut Maurice-Lamontagne
Tel. (418)-775-0570
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- Atlantic Region:

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Planning for the Sustainability of the Marine Environment using RO Membrane Desalination Technology

by Gamal E. Omer Elhag-Idris[1] and Nedam Abed[2]

Abstract: In this work, we provide a brief review of the application of membrane RO (Reverse Osmosis) technology to seawater desalination. Desalination is receiving increased attention as an option to meet potable water demand in coastal and arid regions. Due to its distinctive features, desalination became the process of choice in many coastal areas, especially with cheap energy resources. A plan for seawater treatment by desalination requires taking different factors into consideration. These include capital costs, availability and selection of treatment chemicals, population growth and other expected domestic demand. As well, the direct impact on marine life and environment is critical. The sustainability of marine environment is important knowing its effect on other sectors of local economy (such as fisheries). In addition, desalination impact depends on the pretreatment of feed-water and the disposal of brine rejects (RO reject). Sustainability of marine environment remains a crucial factor in designing, building and operating desalination plants.

Introduction

1. Membrane Reverse Osmosis

Membrane Reverse Osmosis (RO) is a pressure-driven process for water treatment. It is based on utilizing a pressure difference or gradient to allow the seepage or flow of fresh water (called permeate water) through a polymeric membrane, leaving behind dissolved salts and other components. The concentrated or brine water produced is called reject water.

By controlling the applied pressure gradient, it is possible to achieve different degrees of salt separation. The membrane type and pore size has a direct effect on the overall efficiency of the separation process. New membrane types are very selective for certain chemical species (this is widely adopted in chlor-alkali industries) and have a prolonged lifetime. Because of these factors, membrane RO desalination is increasingly being used in areas that have a scarce supply of fresh water. The old method of evaporation desalination is facing nowadays the challenge of high energy costs, making membrane RO desalination the process of choice.

The continuous development in the type and design of membrane materials will enhance the adoption of this technology on a larger scale. Other challenges include the inventory of chemicals required with the associated impact on marine environment (toxicity risks for fish, plankton and other aquatic species).

2. Desalination

Desalination is a treatment process directed for salty or brackish water. It can also be used for saline aquifer water. The increased demand on fresh water with the exhaust of natural fresh water supplies made it necessary to look for new, practical and cost-effective treatment methods. As its name reads, water desalination is concerned with the removal of salt from water feed. The growing population and changes in life-style, especially in coastal and arid or semi-arid regions, encouraged researchers to find novel methods for utilizing seawater or underground brackish water for human needs. Such processes will aim at supplying fresh water in sufficient amounts and of good quality.

Desalination can also be extended to areas affected by natural disasters. Areas devastated by floods or hurricanes can utilize desalination to purify storm water for use as drinking water. With these possibilities, desalination can be a preferred option for a successful and cost-effective treatment. In this aspect, many researchers around the world are conducting detailed investigations about replacing classical methods with desalination (Atkinson, 2005; Reynolds, 2005).

Note from the Editor: This article, which is somewhat out of the normal editorial policy of the *Bulletin*, is nevertheless published here because it gives our readers the opportunity to consider the impact of water treatment technology on the marine environment.

Avis du Rédacteur: Cet article, qui est un peu en marge des sujets normalement traités dans le *Bulletin*, est tout de même publié parce qu'il donne l'occasion de considérer l'impact de la technologie du traitement de l'eau sur l'environnement marin.

[1] C.Chem, MCIC, CMOS Accredited Consultant

[2] PhD, P.Eng, formerly with Keyano College, Alberta

Requirements	Future
Saline water	Open intakes, beaches, wells, free of contaminants
Physical treatment	Filtration, thermal, etc
Chemical treatment	Anti-scaling, anti-corrosion, membrane clean, disinfection
Energy	Electric energy (operate RO systems)
Lands	Plant location
Health, environment & safety	Control pollution, public safety & waste discharge
Technical background	Experts, engineer, environmental, oceanographer, etc.

Table 1: Example of the Requirement of Desalination Plants

3. RO Desalination Plants

By combining the principle of RO membranes and the technology of desalination, RO desalination plants can meet the demand for fresh drinking water upon facing the challenges above. There are many treatment plants that use this method, largely in coastal areas. Examples include those plants along the shorelines of the Red Sea, Persian Gulf, Mediterranean Sea and the US (California, Florida).

Primary design consideration and approaches for RO plants should include degree of membrane rejection, permeate, flux and membrane system used. Table 1 summarizes some of the factors to be considered for such purposes.

Rejection is based on influent conditions and effluent requirements for components of interest. The correct design for a treatment plant by desalination requires, for example, the accurate determination of feed water composition.

Every plant will have a unique, but acceptable, lower limit of flux. The choice for the type and system configuration for the membrane might include different module types (spiral wound, hollow fiber, tubular, plate and frame) or membrane types (cellulose acetate, hollow polyamide fiber, composite or dynamic ones)

Designing a plant for desalination also requires an evaluation of recycle options within the plant. This is done by mixing the chemicals required with reject water prior to disposal into the marine environment. As such, these chemicals should not contain heavy metals, such as lead, mercury or cadmium, for their negative effect on aquatic life.

Other limitations include mixing the reject water with seawater, which might enforce discharging at distant points in seawaters (deeper seawater). This means additional operating costs for pumping the wastewater to the injection point. Alternatively, and as practised by several operators, this reject water can be utilized in chlor-alkali industries. Due to the excess content of salt, the reject can be used to produce chlorine gas and caustic soda, which have numerous usages for personal hygiene, domestic and industrial purposes.

By knowing the physical conditions and weather patterns (e.g. current direction, temperature, prevailing winds) in the studied areas, the movement and dilution of a patch of brine water can accurately be predicted. Obtaining data on flow and mixing could be very helpful. A carefully developed model can predict the dilution of concentrations at a specific discharge location, e.g., under particular tidal and wind conditions. If this model can be simulated on a computer using temporal and spatial coordinates, the researcher can easily decide on a suitable option by comparing data input and output for various scenarios. An example of such models is that published by Del Bene et al. (1994). Those researchers incorporated several factors in their model (water depth, temperature, salinity, tidal current, etc) and were able to decide on some feasible options for a desalination plant. It is apparent from this discussion that RO feed water and brine wastewater must be studied and controlled carefully to protect the surrounding marine environment.

4. Application of RO Membrane for Seawater Desalination

Seawater intake for a desalination plant is usually located at a distant offshore point. Intake can be through buried pipelines (commonly used) or on surface. The latter entails using some physical and/or chemical treatment methods to protect the RO membrane from fouling and wear (Einav et al., 2002). Examples of factors to be considered for water intake include:

- If seawater supply is from a distant offshore intake (e.g. through a buried pipeline), the feed water will have a certain level of salinity, the higher the salinity the greater the pressure gradient required for the RO membrane.
- If seawater supply is from a surface offshore intake, the feed will likely contain some colloidal materials (organic and inorganic compounds) and marine organisms. Solid particles can be removed by a pretreatment step, such as cartridge filters.
- If seawater supply contains some oil spills, these need to be treated to remove the oil particles. Physical (skimming), chemical (solvent addition) or biological methods can be used.
- Red tides (harmful algae blooms) can be treated with alkali salts, such as polyhydroxy aluminuium chloride, or with clay (Anderson, 1997).
- Some chemicals might affect the integrity of the membrane used. For example, chlorine is continuously injected at the discharge of seawater pump to act as a biocide. Excess amounts of chlorine can harm the membrane if intake involves stream recycling. Hence, feed dechlorination is needed. However, some membranes are inert to chlorine, hence dechlorination is not required. An example of this is cellulose acetate membranes.

Method	Chemicals	Risk
Control Biofilm	Chlorine compounds, copper salts	Harmful (e.g., THMs)
Scale control	Polymeric phosphates	Lead to eutrophication
	Sulfuric acid	Acidic media
Anti-foaming	Acrylated poly glycols	Effects on membrane cells
Anti-corrosion	Heavy metals e.g., copper	Toxic bioaccumulation
Oxygen scavenger	Sodium sulfate	Sulfide residual

Table 2: Examples of Chemicals used in Desalination, their By-product and Impacts on Marine Environment

THMs are trihalomethane compounds

Table 2 summarizes the effect of various chemicals on the marine environment, classified by their point of application. A more detailed discussion can be found in Glueckstern and Priel, 1996; and Morton et al., 1996. Therefore, it is necessary to understand the technology of the RO system for a better operation of the desalination plant and the sustainability of the marine environment.

Impact of Seawater Desalination on the Marine Environment

The main byproduct of desalination plants is a concentrated brine stream, which is pumped back to the marine environment. This brine water would contain other chemicals as discussed above. This stream could affect the marine habitat and its role in stabilizing the composition of seawater. The major impact will be on the tolerance of the marine organisms to salt levels, affecting their growth and population (Morton, et al., 1996; Hoepner and Latteman, 2002). The brine water and associated chemicals will affect the organism metabolism and eventually the chemical composition of bulk seawater.

This net effect will find its way back to the desalination plant, since bulk seawater is the intake source for the plant itself. Hence, it is important to understand and assess the effect of back injection of brine water on continuous discharge of brine wastewater into marine environment. Of importance will be the tolerance exhibited by marine organisms in habitat areas and coral reefs (Morton, et al., 1996; Hoepner and Latteman, 2002).

The chemical composition and concentration of the brine wastewater from RO membrane desalination plants can be found in many references (Enav et al., 2002). As an average, the salt content is almost double that of fresh seawater, which is too high for most aquatic lives (Sadhwani et al., 2005).

The discharge of brine wastewater into the marine environment can lead to severe or adverse effects on aquatic life. It could cause a decline in the quality of marine environment, resulting in undesired changes the aquatic life cycle and the chemical composition of seawater. A few examples of adverse effects are summarized below:

a) Halogenated compounds used in desalination plants can react with organic compounds in seawater, resulting in the formation of halogenated by-products. Many of these by-products are carcinogenic or harmful to the marine environment.

b) Changes in nutrients ratio of seawater (nitrogen, phosphorus and silicon) can change the composition of phytoplankton species (Anderson, 1994). This can cause the formation of red tide blooms, which could kill fish, birds and other aquatic species. Besides, aerosol salt sprays contaminated with toxins and organism fragments (attached to salt particles) can cause neurotoxin poisoning and other side effects (Anderson, 1994).

c) The direct disposal of brine water to the marine environment can affect the temperature gradients within this environment. This change in temperature might not be tolerated for some species, especially phytoplankton and zooplankton living on surface water. Other adverse effects include negative effects on life stages, biological development, growth and population, as well as their sizes. These plankton species are the source of food for many aquatic species, which would in turn affect the latter's growth and abundance. As a result, economic sectors depending on exploiting sea resources, such as fisheries, would be critically affected (Miri and Chouikhi, 2005).

d) RO systems require a network of turbopumps to generate the required pressure gradients for treatment of millions of seawater gallons. These pumps are operated by electricity, which means generating millions of kilowatt-hours for these pumps. If electricity is generated by burning conventional fossil fuel (coal, oil, wood), huge atmospheric emissions of greenhouse gases will be encountered. This will contribute to the problem of global warming. Some desalination plants burn natural gas to generate electricity, but this is restricted to areas rich in natural gas (such as the Persian Gulf region). The best option here is a combination of water desalination and power generation, commonly referred to as RO plants with cogeneration, which allows production of drinking water, generation of energy required and exportation of some electricity produced to a nearby public grid.

Method	Engineering Future
Long discharge	Long pipe far in the sea
Direct discharge	At the coastal line
Combine discharge	• Diluted with cooling water • Diluted with ambient seawater
Evaporation	Using solar irradiation
Economic	Zero discharge, brine converted to salt production

Table 3: Different Methods of Seawater Desalination Discharge

e) RO Desalination plants also use a network of heat exchangers for stream heating, cooling and recycling. These networks consume considerable amounts of chemicals to reduce tube fouling and scale formation. Other chemicals are also needed for curbing corrosion in process equipment. As mentioned above, the waste stream from these networks is usually mixed with brine water prior to discharge in the aquatic environment. Chemicals used herein are salts of iron, copper, nickel, chromium and molybdenum. If these metals exceeded natural limits, they will also have an adverse effect on marine environment.

f) Chemical and brine water injected into the sea can affect the seawater composition by altering the residence time (RT), which is the retention time for the chemical in various levels of seawater. By this sense, seawater is seen as a sink for many natural or anthropogenic compounds. Seawater is divided into three layers (upper layer, mixed layer and deep layer). Each layer has its own characteristics. Most inorganic and organic compounds can transport and accumulate at the deep marine sediments, which, in the long run, will affect the nature and distribution of important marine organisms on the sea floor.

g) A possible adverse effect is the change in marine sediments from aerobic to anaerobic environment. This condition can lead to undesired remobilization of organic or inorganic compounds.

h) Mechanical failure of discharge pipes can inject considerable amounts of brine waste in the surrounding environment. This will create huge lumps of suspended or colloidal matter that can have a severe effect on aquatic life.

i) Other adverse effects of desalination plants include economic sectors depending on seafood industry, coastal recreational areas and tourism. There are cases of adverse hygienic effects in areas surrounding desalination plants (e.g. respiratory effects and dermal infection), caused by airborne salty particulates and high salt concentration in seawater. Other adverse impacts on marine life include increasing the death rate of endangered species (e.g. humpback whales) and the associated food chain.

j) Furthermore, the operation of desalination plants requires operating huge networks of pumps and other heat transfer equipment. This creates excessive levels of noise leading to hearing impairment. Besides, the sonic waves generated can drive off marine life from their natural habitat, leading to some of the negative effects discussed above.

Littoral areas are sensitive to such anthropogenic activities e.g., coral reefs, mangroves, salt marshes, sand beaches, seaweeds meadows, lagoons and shallow water areas. These areas are always characterized as sensitive for waste disposal. Special protection legislation is usually in effect.

Planning for Brine Wastewater Discharge

Planning for the discharge of brine wastewater into the marine environment requires taking different factors into consideration. The main objective is to maintain the sustainability of the marine environment. Such factors include the selected area, location of discharge point, water load, salt accumulation, quality of waste, etc. Environmental model of brine wastewater disposal to the marine environment should be thoroughly discussed and evaluated prior to the establishment of the desalination plant (Tsiourtis, 2001). It is also important to consider the long-term (5-10 years) effect of plant operation on marine environment, including changes to sea level and any disturbances to surrounding marine habitat (Hoepner 1999).

Brine discharge increases the local concentration of seawater salt, which later might require discharging into distant offshore points. In some cases, if the brine was discharged without suitable treatment, it might cause the formation of plume in high saline seawater. This plume corresponds to a condition of seawater that can have adverse effects at various depths, bathymetry, current directions and others. When highly dense, the plume might sink to the sea floor, causing severe effects on surrounding aquatic species.

Continual discharge of brine wastewater in marine environment could also create high concentration of salt layers. These layers can change the temperature gradients, direction and speed of sea currents and light penetration. Other factors that affect the selection of discharge point for the waste brine include:

a) Physical factors, such as sea depth, the diameter of the discharge pipe, waves, currents, etc. As an option, diffusers are sometimes used to direct the discharge flow at an angle of 30 to 90° to the sea floor, so that the concentrated brine is pushed away from the sea surface. The length of discharge pipe varies, depending on the capacity of the plant. In some cases, a pipe length of at least 1 km or 1.5 km is used. The outlet depth is at least 10 metre or greater below sea level (Squire et al. 1996; Doneker and Jirka, 2001). Table 3 summarizes some methods for discharging

brine wastewater.

b) Geographical factors, such as the topographic structure of the sea floor in the area, the sea conditions at the selected area, measurement of tides, currents and others (Del Bene et al. 1994). In some cases, the following are performed:

i) Detecting the sinking of salt concentration from sea surface to sea bottom;
ii) Detecting the salinity at the region of the plume (inlet to outlet);
iii) Determining the effects of brine wastewater on the surrounding marine environment just off the outlet discharge and noticing any high salt concentrations in the flow direction;
iv) Reduce the tendency of the brine from sinking to the seafloor.

In general, seawater salinity is in the range of 32 to 38 $^{o}/_{oo}$. Marine organisms are sensitive to large increases in salinity over long periods. Invertebrates, larvae of crabs, fish, seaweeds and the like are more sensitive than other species. The direct brine discharge results in a localized increase in salinity in the vicinity of the discharge pipe, which could impact the surrounding fauna and the flora. Over longer periods of time, the continued discharge may result in the disappearance of certain species from the littoral areas (Einav et al., 2002).

Combined effluents from a desalination plant must be treated before discharge to the marine environment. This is crucial to ensure metal levels are not exceeding the allowed or the natural limit in the marine habitat. In addition, the residence time for these chemicals along with their interference with the essential biological levels for the species need to be established. Most organisms need trace metal ions to complete their natural metabolism.

Another option for this brine wastewater is its reuse or recycling within the plant. In some cases, inland evaporation ponds are used to concentrate some of the chemical streams. These ponds are normally close to the shoreline to take advantage of natural evaporation rates. If the waste stream contains expensive chemicals, it might be a good choice to recycle a portion of it and use make-up quantities in-situ. The simplicity in design and operation of these evaporation ponds might become essential for the successful design and implementation of discharging.

Dilution is not a practical method for brine wastewater management and in most cases fewer benefits are achieved by the marine environment. However, dilution might become a solution to achieve control over marine pollution if brine wastewater concentration diminishes in marine environment by dilution. The problem would then be the flow load rather than its concentration. In this case, its long-term impact on marine environment needs to be established.

Plan for Sustainability of the Marine Environment Effected by Desalination

Toxic substances of brine wastewater (for example, plume) can accumulate in the deep marine environment, eventually making their way into the marine food chain. This can result in an interference with the marine life reproduction, development and other functions. As an example, there was a case of mercury poisoning in Japan where 46 fishermen died after eating fish from Minamata Bay contaminated with this heavy element. Heavy metals can't decompose in seawater, but microbial activities can convert them to more toxic forms of organo-metallic compounds (e.g., methyl mercury).

Sediments can act as indicators for anthropogenic activities. Continued disposal of brine wastewater containing organic and inorganic compounds, as well as colloids into the marine environment can find their way to these sediments. Identification of polluting materials in seawater might be difficult, since these materials move down to the sediments. The heavy metals from discharged brine wastewater can be strongly adsorbed by the clay and organic fraction of the sediments (Forstner and Muller, 1974). Hence, it is more convenient to use the sediment for detecting heavy metals, such as mercury and lead.

Other beneficial uses of desalination byproduct is for irrigation. Reject water can be slightly diluted and used for irrigating salt-tolerant plants, production of crops, dust suppression, roadbed stabilization and soil remediation. Other suggested uses are for road de-icing and injection concentrates in well drilling.

In emergency situation where signs of adverse effects on aquatic life are detected, action plans are always placed to contain and remove the causes, especially in coastal areas surrounding the desalination plants. Examples of these signs include: death of fish, shellfish poisoning and presence of red tides. The management of seawater desalination plants in various countries depends on local policies. Public health is protected through legislation concerning the design and operation of water treatment plants. Examples include governmental policies, WHO, UN, FAO, environmental law enforcement agencies and the like.

Disposal Challenges of Seawater Desalination

Building and operating seawater desalination plants poses an environmental challenge caused by disposal plans of reject water. Sustainability is a major issue here. Hence feasible and sound solutions for plant byproducts are required. Basic challenges are imposed by geographical location and future expansion plans. Further increase in the number of desalination plants in a confined region may increase the cumulative effect on receiving waters. Disposal of concentrate to surface water and/or groundwater could result in salt build-up, which eventually might prohibit further discharge (Rebhun, 2004).

The growing number of seawater RO desalination plants around the world with some having larger capacity may limit

the conventional options for disposal of desalination byproduct, because:

■ Disposal to surface waters and land can increase the salt load (build-up);
■ Disposal to evaporation ponds or to landfills may results in pollution;
■ Disposal to deep wells has risks of contaminating aquifers

Traditional disposal of desalination byproduct plants has always been re-injecting into the sea. However, these may require environmental impact assessment for specific injection points. Since the discharge on the long run is denser than the receiving water, the nearby aquatic life will be adversely impacted.

More concentrated desalination byproduct is more difficult to dispose of than a less concentrated one. Besides, the use of several chemicals in the RO system poses more challenges for disposal of desalination byproducts. Some of the suggested pretreatment steps could comprise:

■ Blending with surface water or feed streams to nearby wastewater treatment plant;
■ Blending with cooling water from power plants which use seawater (technically less encouraging);
■ Optimization of plant operation to reduce reject volume.

As mentioned earlier, the reject can be used as feed material for other industrial processes (chlor-alkali for example).

Stability of RO Membranes in Seawater Desalination Plants

The issue of membrane fouling is highly critical to RO processes. The effectiveness of such processes would be enhanced by the development of more foul-resistant membranes, the design of better membrane-cleaning procedures, and the optimization of pretreatment steps. Additional development might profitably focus on improving rejection of low-molecular-weight organics and on accommodating broader ranges of influent variables to minimize pretreatment requirements.

RO membranes are produced from synthetic polymers, such as cellulose acetate and polyamide. Due to membrane sensitivity, seawater feed may require conditioning prior to entering the system. For example, the feed pH or temperature may need adjustment in advance to inhibit deterioration of the membrane matrix and its subsequent collapse.

Membrane fouling can have severe effects on plant performance and economics, since a membrane failure could result in production disruption or operation shutdown for replacement and maintenance. Table 4 summarizes some preventive maintenance measures to ensure smooth membrane operation (Darton et al. 2004). RO membranes can reject different contaminants or components. Swelling or degradation of the membrane polymer matrixes might occur by such contaminants. Here a pretreatment step is needed, for example via granular activated carbon adsorption, to avoid direct contact with the membrane. RO membranes can foul because of different reasons. These include the following:

a) Bio-fouling, caused by slimes of polysaccharide film, bacteria, algae, fungi, diatoms, yeast, etc.;
b) Organic fouling, caused by humic, fluvic and other compounds;
c) Inorganic fouling, for example calcium scaling compounds (calcium carbonate, magnesium carbonate, silica, aluminum compounds and others); and
d) Colloidal particulate fouling, such as iron, silica and other fine particles.

These factors can alter the differential pressure across membranes used. For example, small quantities of oil can damage the membranes and might be difficult to remove without organic solvents. These solvents can weaken the strength and integrity of the membrane matrix (especially if it was of polymeric origin). Biological growth of algae and the like on membrane surfaces can be prevented by simple dilute chlorination.

Others materials that can cause the failure of the RO membranes include chemicals used in treatment of surface water (water intake), such as anti-scale and anti-corrosion chemicals. Moreover, extreme changes in temperature and pressure can affect the stability and performance of these membranes.

Once the real causes behind membrane failure are detected, further process or plant modifications can be used to enhance the quality of water produced and operability of the plant. Sometimes partial replacement of failed membranes or modified tube design and layout can evade the need for more robust materials or expensive new designs.

Desalination is the Solution for the Global Water Crisis

Desalination can be the right solution for many regions around the world that suffer from potable water shortages. Shrinking amounts of available drinkable surface water and groundwater, increased population and water-related illness can find their answer in water desalination. Conflicts caused by demand on fresh water from shared resources can be mitigated or resolved by adopting alternative methods for obtaining drinkable water. Once sustainability is achieved in RO water desalination, it can be considered the most appealing and peaceful solution to the global water crisis.

Requirement	Function
Seawater	Concentration of seawater e.g., ions, salinity, organic
RO feed	Chemical and physical treatment or combined
RO membrane	Type fouling resistance
Flux rate (GFD)	The lower flux rate, the lower rate of fouling
RO shutdown	Flushed RO membrane system to remove scale, etc.
Normalization	Comparing variable change with adjustment
RO clean	Whenever normalization e.g., pressure drop, conductivity increases, etc.

Table 4: Examples of Preventive Maintenance for Protection of RO Membrane

GFD = gallon per square feet of membrane area per day.

Application of RO Membrane Desalination in Canada

Canada has enough fresh water resources. Therefore seawater desalination is not popular. However, RO membrane treatment can be vital for some industries, such as power plants, electronic, food and pharmaceutical industries, which require trace levels of contaminants (Clearwater Systems). RO membrane treatment can find important applications in portable water treatment units, especially for war-torn or areas devastated by natural causes (earthquakes, hurricanes, etc.). Canada has adopted environmental regulations which dictate the rules and procedures for protecting natural water resources (e.g. Regulation 347 – Environmental Protection Act, Canada).

In general, many industries need large amounts of water for daily production, called process water. This poses a pollution risk if pre-disposal measures are overlooked. Portable and small-scale RO membrane units can be used for process water treatment prior to direct disposal to nearby aquatic environment (lakes, rivers, seawater or oceans). RO membrane treatment can help industries to treat and recycle their daily output of wastewater, thus preserving the surrounding aquatic environment.

Environmental remediation in Canada (e.g. CANDESAL Water System) has adopted the application of RO membranes in environmental remediation. Because of the growing concern on the fate of industrial wastewater, RO membrane can be the right solution even for small-size industries (Humphries and Wood, 2004). In industrialized nations like Canada, RO membrane technology is capable of affording the quality of drinking water to meet the required standards. It is believed herein that RO membrane technology is capable of meeting any futuristic demand on quality of drinking water.

Conclusion

The performance and advantages of membrane RO desalination plants were reviewed. Plant design and operations require thorough understanding of the technology. This understanding will lead to proper planning and performance of the plant, as well as a feasible framework to control the by-product of the plant (brine wastewater). Primary concerns are the proper location of the desalination plant, sufficient studies on environmental and marine impact assessment, and detailed evaluation of the long-term effects on aquatic life.

It is important to control the water rejected to the marine environment for its various impacts on aquatics life, plant performance, public health and other economic sectors. The approach suggested herein is to find a suitable solution for the brine wastewater prior to discharge into the marine environment. The factors affecting this are the concentration and load volume, which can be managed by distribution into large areas.

Seawater and marine organisms are natural resources that can be utilized with global sustainability. Any side effects on these resources can be minimized by careful planning and developing suitable models during the design stages of new RO desalination plants or upon reviewing expansion plans.

The attached tables gave an idea on the potential benefits of careful design and planning of membrane desalination plants. The major concern is the sustainability of the marine environment. These were based on practical experience and scientific facts. The presented information is suitable as a framework for decision makers concerned with the design, operation and legislation governing this type of water treatment method. Finally, one of the goals of this work is to shed some light on the importance of minimizing the environmental impact of desalination technology and to attain a high degree of sustainability.

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The Montreal Protocol: Twenty Years of Progress [1]

If you walk down any street in Canada and ask what the Montreal Protocol is, you'll likely get more blank stares than informed answers. If you ask the same people if they checked the UV Index or applied sunscreen before leaving home that morning, they would very likely reply, yes. Without the Montreal Protocol, that process would probably not be commonplace.

A NASA image of the ozone hole over the Antarctic in September 1987. Photo courtesy of NASA, 2007.

Introduced in 1987 at a United Nations environmental conference in Montreal, the Montreal Protocol is the international agreement prompting action against the depletion of the ozone layer.

The ozone layer acts as our planet's sunscreen, providing an invisible filter to help protect all life-forms from the sun's damaging ultraviolet (UV) rays. This is why when scientists observed the ozone layer depleting (commonly known as the Ozone Hole), it demanded international attention.

191 countries have since ratified the Montreal Protocol and Canada has played a key role in the agreement's remarkable achievements. At the forefront of the Canadian contribution were Jim Kerr and Tom McElroy, two individuals among the team of Environment Canada scientists who dedicated years of work to researching the ozone layer. Their scientific breakthroughs had a significant impact on the way that Canada, and the world, understands the issue of ozone depletion.

Fast Facts:

■ Environment Canada scientists Jim Kerr and Tom McElroy, along with David Wardle, will receive the United Nations Environment Programme's Montreal Protocol Innovators Award during the 20th anniversary celebrations of the Montreal Protocol.

■ Tom McElroy and Jim Kerr were part of the team that co-invented the Brewer Ozone Spectrophotometer. Approximately 200 Canadian-made Brewer instruments now monitor ozone in 41 countries.

■ The same team, including Tom McElroy and Jim Kerr, developed the UV Index in 1992. The UV Index is used by weather services around the world.

Interviewer: Can you briefly describe what you were working on 20 to 25 years ago, and how that related to the Montreal Protocol?

Dr. Tom McElroy, with a Brewer ozone spectrophotometer, on the roof of Environment Canada's ozone observatory in Toronto. Photo courtesy of Environment Canada, 2007.

Tom McElroy: In 1985, our group had concluded an 11-year-long series of high-altitude balloon flights aimed at understanding the chemistry of the ozone layer.

One of the unique Canadian contributions to this process was the development of the Brewer Ozone Spectrophotometer between 1979-1982 and its introduction to the ozone community with the first three commercial instruments. I personally delivered the first instrument, and trained the local scientists, in Thessaloniki, Greece in February, 1982.

Jim Kerr: I was working on research on the ozone layer. The topics of research included ongoing development of the Brewer Ozone Spectrophotometer; measurements of stratospheric trace gases from the ground, high altitude balloons, and the space shuttle; analysis of ozone records to identify possible long-term changes; participation in the organization, operation, and upgrading of the World Meteorological Organization's World Ozone Data Centre that has been located in Toronto for nearly 50 years.

In 1985, the Antarctic ozone hole had been discovered, which accelerated the ratification of the Montreal Protocol in 1987. However, there was no indication that ozone was depleting over densely populated tropical and mid-latitude regions. My early work on looking at ozone records from Toronto indicated a possible decline in stratospheric ozone starting around 1980. This was reported in an Environment

[1] Environment Canada Web site, end of September 2007 (http://www.ec.gc.ca/EnviroZine/)

Canada internal report in 1987 and later published in the peer-reviewed literature in 1991.

Interviewer: Did you carry out this work in preparation for the conference in Montreal, or was that coincidental to your efforts?


Jim Kerr. Photo courtesy of Environment Canada, 2007.

Jim Kerr: Our research group had a scientific display at the United Nations Environment Programme convention in Montreal, and several of our group members were on hand to provide information to the visiting delegates. I had attended an earlier convention in Stockholm that was one of several meetings leading up to the development of the Montreal Protocol.

Tom McElroy: The work we did was aimed at understanding the mechanism behind ozone depletion and predicting the future course of the ozone layer. This is the scientific underpinning of the policy decisions that led to the introduction of the Protocol. In a sense, our work was done before the meeting began, but we were available for consultation.

Interviewer: How big a role did you and your colleagues play in the proceedings?

Jim Kerr: Our scientific team played a significant role in contributing to worldwide knowledge of the science of the ozone layer. The policy team also played an important role through contributing to international negotiations. One of the main reasons that international regulation of the control of ozone depleting substances was ratified in Canada was in recognition of the roles that Canada played leading up to the proceedings.

Interviewer: Did you have any idea that the work you were doing would have such an impact on society?

Tom McElroy: Yes, we were well aware of the importance of the issue. We worked very hard for over a decade to develop new instruments and to use them to obtain the information needed to understand ozone depletion. This is what led to the idea of implementing the UV Index and Ozone Watch programs to inform the general public, so they would back the decision to implement the Protocol and so they would better understand the health risks of ultraviolet exposure.

Jim Kerr: Technical specifications regarding refrigeration and air-conditioning would have to change, affecting both industrial and personal activity and economy. We had little idea that the importance would become more urgent as more scientific discoveries were made in years to follow leading to the strengthening of the Protocol with subsequent amendments.

Interviewer: How has your work changed over the twenty years since the Montreal Protocol?

Jim Kerr: The ozone depletion story is a long-term scientific question. It started before I was born, in the 1930s, with the invention of ozone-depleting substances (chlorofluorocarbons or CFCs), and it is predicted to end in the mid-to-later part of this century, after my time. Research on a long-term issue has to be carried out over a long period of time, so the general goals of the research remain long-term in nature.

There are interactions with other short-term and long-term environmental concerns. The main question is: What are the interactions between climate change and the ozone layer? Changes of the ozone layer can cause climate change, and climate change can affect the ozone layer.

Interviewer: The Montreal Protocol has been called the most successful international agreement on the environment. What do you think has to happen in the future to sustain the success of the Montreal Protocol?

Tom McElroy: We have to be prepared to fund research and monitoring in these areas to a reasonable degree. Otherwise the regular meetings of the technical panel and Parties to the Protocol will not provide any protection for us. The composition of the atmosphere is changing with time and we need to understand what the impact of these changes will have on the ozone layer. This goes beyond just the impact of CFCs, halons and other ozone-depleting substances to include the effects of aerosol on chemistry and possible consequences of climate change.

Jim Kerr: We must also remember that a much bigger issue faces us in the future: climate change. Hopefully we can address and take action on this issue with the same science-driven responsibility that was carried out with the development and implementation of the Montreal Protocol.

The Brewer Ozone Spectrophotometer and the UV Index [2]

The 1920s would see the discovery of insulin, the bread-slicing machine and adhesive bandages. It was in this technological climate that Gordon Dobson, a relatively new lecturer in meteorology at Oxford, created his spectrophotometer to measure the amount of ozone in a column of air. Ozone science moved into the technological era.

Necessity as the Mother of Invention
While undoubtedly a technological marvel as the first instrument of its kind, the Dobson ozone spectrophotometer was a manual instrument that required a great deal of human handling to produce its readings. Tom McElroy, a research scientist with Environment Canada speaks from experience when he describes as being arduous the task of calibrating the Dobson and keeping it calibrated.

The distance between the technology in the Dobson and the technology that became available decades later pointed to an opportunity for some Canadian innovation. Dr. McElroy was part of a team of Environment Canada researchers -- Jim Kerr, David Wardle and Alan Brewer -- who wanted to take advantage of newer electronics and the benefits of automation to build a better ozone-reading instrument.

According to Dr. McElroy, the push to build the Brewer came in the mid- to-late 1960s. In fact, the 1960s were busy times for ozone science in Canada. In 1960, Canada was asked to house the World Ozone and Ultraviolet Radiation Data Centre, an honour it still maintains in Toronto. The data centre collects and shares ozone and ultraviolet radiation figures from 39 countries. It was in 1962 that Alan Brewer brought his knowledge from the University of Oxford to the physics department at the University of Toronto. In 1964, John Hampson from the Canadian Armaments and Research Development Establishment warned of the potential for ozone damage from water vapour emissions produced by rockets and high-flying aircraft.

Not too many years later, the Brewer ozone spectrophotometer was created.

The Brewer Ozone Spectrophotometer
The standard instrument for ground-based ozone measurements, the Brewer ozone spectrophotometer, was originally developed by Dave Wardle and Alan Brewer. It uses the readings of five wavelengths of light from the sun to measure the total amount of ozone overhead. Because the Brewer is automated, those ozone readings can be and are fed directly into the world data centre. The result is a daily accumulation of data on the state of the ozone layer across Canada and around the world.

Innovation, of course, does not stand still. Jim Kerr and Tom McElroy subsequently refined the Brewer. An upgrade in the 1980s enabled the Brewer to go beyond measuring total ozone and added the capability to measure surface UV radiation too.

A double Brewer instrument containing two spectrophotometers was developed in 1992. It is currently the most accurate ozone-measuring instrument in the world.

Fast Facts

■ The Brewer Ozone Spectrophotometer is currently the most accurate ozone-measuring instrument in the world.

■ The Canadian UV index was adopted by the World Meteorological Organization and the World Health Organization and is now used worldwide.

■ The World Ozone Data Centre has been located in Toronto for nearly 50 years.

■ Canadian scientists Jim Kerr and Tom McElroy wrote the award-winning paper entitled Evidence for Large Upward Trends of Ultraviolet-B Radiation Linked to Ozone Depletion (1993) originally published in Science. Their work uncovered the linkage between the depletion of the ozone layer and increases in UV-B radiation levels.

The UV Index
When Dr. Kerr and Dr. McElroy tweaked the Brewer to be able to measure the amount of ultraviolet radiation reaching the ground, they opened the door to developing the means to share important environmental information with the general public. Environment Canada scientists -- Tom McElroy, Jim Kerr and David Wardle -- developed the UV Index in 1992 to keep Canadians informed about the strength of the sun's ultraviolet rays and to raise awareness about the need to take action to protect their health. Over-exposure to ultraviolet radiation can cause sunburn, skin cancer, skin aging, cataracts, and possible suppression of the immune system.

To produce a UV forecast, data from a cross-country network of 12 ozone-measuring stations is fed into a giant supercomputer at the Canadian Meteorological Centre in Montreal. Using a special modeling program, the computer produces a forecast of the thickness of the ozone layer. This ozone forecast is then combined with information on the time of year, latitude and the weather forecast for a particular location to generate the daily UV Index forecast.

The UV Index is a simple way of expressing the sunburning potential of ultraviolet radiation at the Earth's surface. It is expressed as a number from 1 (very low) to 11+ (extremely

[2] Environment Canada Web site, end of September 2007 (http://www.ec.gc.ca/EnviroZine/)

high). In Canada, the UV Index usually varies between 1 and 10 and is included in weather forecasts whenever a value of 3 or higher is expected. The Canadian index was adopted by the World Meteorological Organization and World Health Organization and is now used worldwide.

Groundbreaking Achievements

In 1993, Dr. Kerr and Dr. McElroy published a landmark paper in the journal Science, proving and quantifying a direct link between ozone changes in the stratosphere and changes in UV radiation at the Earth's surface. They concluded that ozone losses in previous decades had caused a significant rise in surface UV levels. The paper later won them the World Meteorological Organization's 1995 Norbert Gerbier-Mumm International Award.

Recent research by Vitali Fioletov of Environment Canada has demonstrated how surface UV trends at various Canadian sites have changed in response not only to changes in ozone, but also to climate-related changes.

Evolving from the need for an instrument that could take accurate ozone measurements from the ground, the creation of the Brewer helped vault Canada to the status of world leader in research on the ozone layer and UV levels.

In 1987, there were about 30 Brewer Spectrophotometers in use world wide, including Canada. Today there are nearly 200 Brewer instruments in use, making the Brewer network the world's largest spectral-UV measuring network.

At the time of the introduction of the UV Index, incidences of skin cancer and mortality rates were increasing. There was a need for this product in order to keep the public informed and reminded about the potential health concerns regarding ozone depletion.

For Jim Kerr, it is the change in public attitudes subsequent to the technological innovations of the Brewer and UV Index that is of most significance.

When we were children, we were never warned to avoid sun exposure. Now, protection from sun exposure is common practice in parenting and educating young children. As a result, adults of the future will automatically take more precaution.

Achieving International Success: the Multilateral Fund for the Implementation of the Montreal Protocol and Canada's Bilateral Program [3]

Acording to the former United Nations Secretary General, Kofi Annan, the Montreal Protocol is, perhaps the single most successful international environmental agreement to date [1]. A critical factor for such progressive international cooperation continues to be the Multilateral Fund for the Implementation of the Montreal Protocol, the main financial means through which industrialized countries help developing nations comply with Montreal Protocol objectives to phase out ozone-depleting substances (ODS). Environment Canada's Bilateral Program is part of Canada's contribution to this international success story.

Why the Fund was Established

Consider this: two years after the inception of the Montreal Protocol in 1987 and prior to the Fund's establishment, less than 10 out of over 140 developing countries had ratified the Protocol [2], illustrating these countries' concerns that phasing out ODS would impair their developing economies. This was a clear indicator of the necessity of a global solution for the global problem of ozone depletion, leading to the establishment of the Fund in 1991. Currently, of the 191 countries that have ratified the Montreal Protocol agreement, 146 are developing countries considered by UNEP to be in need of assistance through the Fund.

Since the creation of the Multilateral Fund, more than $2 billion has been spent to finance over 5000 projects in developing countries. This has proven to be money well spent. As of 2005, developing countries have phased out over 190,000 tonnes of ODS consumption and have eliminated over 116,000 tonnes of ODS production. This represents over 70 per cent of developing country ODS totals [3], and reflects the remarkable strides made by the international community in the fight against ozone depletion since the adoption of the Montreal Protocol.

Canada's Role

Canada holds a distinguished role in the inception and implementation of the Multilateral Fund. Since 1991, Canada has regularly been one of the fourteen Party countries elected to the Fund's rotating Executive Committee. This ensures a strong Canadian voice in the Fund's critical decision-making processes. Within the Executive Committee, Canada has played an active role, including chairing the Committee in 2007.

Environment Canada provides support to the Multilateral Fund in several other ways. The Department has assumed the additional costs of housing the Multilateral Fund

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[3] Environment Canada Web site, end of September 2007 (http://www.ec.gc.ca/EnviroZine/)

Secretariat in Montreal. In 1993, the Montreal Protocol Bilateral Program, funded through Environment Canada's contribution to the Multilateral Fund, was established. Through this Program, Canada has directly contributed to the phase-out of ozone depleting substances in more than fifteen developing countries in Latin America and the Caribbean, Africa and Asia.

The Bilateral Program at Work

Training of facility operators in halon recovery and recycling as part of the Halon Management and Banking Project in India.

Since 1993, Environment Canada has completed close to 30 bilateral projects under the Multilateral Fund and is currently undertaking 12 projects. These projects offer a variety of Canadian expertise and technology to target some of the most common ODS still prevalent in developing countries, such as CFCs (used in refrigeration, air conditioning, foam products and aerosols), halons (used in fire extinguishers) and methyl bromide (used in fumigation practices).

In collaboration with developing country governments and industries, the Bilateral Program projects assist countries to reduce their reliance on importing new ODS through the implementation of appropriate policies, training workshops and ODS recovery and recycling programs.

For example, the Refrigeration Management Plan project in Chile aims at phasing out CFC consumption for the servicing of refrigeration and air conditioning equipment. Key achievements to date include: the training of 1650 refrigeration technicians in good practices to reduce emissions of CFCs when servicing equipment; the development of a Code of Good Refrigeration Standards and Practices that has also been incorporated into educational institutions' curricula; and, the creation of a CFC Recovery and Recycling Network, enabled by over 70 CFC recovery and recycling machines donated to selected refrigeration technicians in Chile. Through these and other initiatives, Chile seems well on its way to meeting the 85 per cent CFC reduction target for 2007 required under the Montreal Protocol.

Fast Facts

■ Two years after the inception of the Montreal Protocol in 1987 and prior to the Fund's establishment, less than 10 out of over 140 developing countries had ratified the Protocol's provisions.

■ Currently, of the 191 countries that have ratified the Montreal Protocol agreement, 146 are developing countries, most of whom are making concrete progress on reductions with the assistance of the Multilateral Fund.

■ Since the creation of the Multilateral Fund, more than $2 billion has been spent to finance over 5,000 projects in developing countries.

■ As of 2005, developing countries have phased out over 190,000 tonnes of ODS consumption and have eliminated over 116,000 tonnes of ODS production, constituting over 70 per cent of developing country ODS totals.

■ Through the Bilateral Program, Canada has directly contributed to the phase-out of ozone-depleting substances in more than fifteen developing countries in Latin America and the Caribbean, Africa and Asia.

■ Since 1993, Environment Canada has completed close to 30 bilateral projects under the Multilateral Fund and is currently undertaking 12 projects.

With assistance from Environment Canada's Bilateral Program, the Refrigerant Management Plan and Terminal Phase-Out Management Plan initiatives helped Jamaica to become the first country in Latin American and the Caribbean to completely eliminate CFC consumption -- four years ahead of the Montreal Protocol phase-out schedule for developing countries.

As well, projects centred upon training and information workshops, technology transfer and policy development, have been implemented to address halon consumption and management in India and methyl bromide use in Mexico.

Particularly successful were Jamaica's Refrigerant Management Plan and Terminal Phase-Out Management Plan initiatives, which saw Jamaica become the first country in Latin American and the Caribbean to completely eliminate CFC consumption. The projects achieved Jamaica's ambitious goal to completely eliminate CFC consumption as of December 31st, 2005, four years ahead of the Montreal Protocol phase-out schedule for developing countries. These Jamaican initiatives will be formerly recognized with a Multilateral Fund Exemplary Project Award at the 19th Meeting of the Parties of the Montreal Protocol this September.

These projects have allowed Canada to share its expertise in phasing out ODS worldwide and have provided us with unique opportunities to learn about the particular challenges faced by developing countries in addressing their obligations under the Montreal Protocol. The Bilateral Program illustrates how international cooperation to address global environmental issues can bring mutual benefits and deliver concrete results.

[1] Key Achievements of the Montreal Protocol to Date (UNEP, 2007).

[2] The Montreal Protocol on Substances that Deplete the Ozone Layer 2007: A Success in the Making (UNEP, 2007).

[3] Key Achievements of the Montreal Protocol to Date (UNEP, 2007).

Precipitation
Theory, Measurement and Distribution

by Ian Strangeways

Cambridge University Press, New York, 2007
ISBN 0-521-85117-3, 290pp, Hard Cover, US$130

Book reviewed by Kenneth A. Devine[1]

Ian Strangeway's book, *Precipitation; Theory, Measurement and Distribution*, is an overview of the field of precipitation covering its progress from ancient theories to future of precipitation measurements. Like his recently published "Monitoring the Natural Environment", his style is quite readable. An expert in the field of data acquisition, Dr. Strangeways also authored the award winning series "Back to the Basics" which was published in twelve parts in Weather. The book consists of five parts which are broken down into fifteen chapters. References are listed at the end of each of these chapters with a four page index at the rear.

Chapters

1. The ancients covers the period from the Greeks in 600 BC until emergence of a description of the hydrological cycle in about 1500. The theory of four elements: fire, air water, and earth, held back the development of a complete theory until the late middle ages. This theory led to the belief that air changed into water underground. While the logic of Aristotle and the church suppressed independent thought during this time, finally in the 16th century the explanation of the hydrological cycle appeared. A list of the twenty-seven contributors mentioned during this two millennium period is supplied.

2. The renaissance led to a 300 year period in which an understanding of evaporation, clouds, precipitation and dew gradually, but not continuously, developed. Rhetorical arguments were gradually replaced by observation-based theories championed by Francis Bacon and Rene Descartes. Water vapour became separated from air and being lighter led to the cloud formation with the necessary condensation nuclei of John Aitken in the nineteenth century. Finally, the initial theories of rain and hail formation were developed. A list of the seventy-six contributors mentioned during this three century period is supplied.

3. Basic processes of how water is transformed and moved vertically in the atmosphere are covered. The ideal gas law is mentioned and its effect on atmospheric profiles. Included is a review of radiation in its various forms.

4. Formation of the different cloud types is covered including the more extreme convective clouds and unusual stratospheric clouds. Lists of the principal cloud names which began with Luke Howard in 1802, and their varieties, are presented. Clouds are depicted both from satellite images and from the polar front model. Finally, cloud height measurements including balloons and ceilometers are described.

5. Cloud droplets, ice particles and precipitation are each described. The formation of precipitation in both warm and cold clouds and a description of the physics of clouds detailing raindrop and ice crystal formation including fall rates are covered. The author mentions his own experience with ice riming while developing instrumentation in Scotland.

6. Lightning formation is described with the inclusion of recently revived theory of the influence of cosmic rays on discharge initiation. Ball lightning, Saint Elmo's fire, and the modern observations of sprites are all mentioned. Most of the rest of the chapter covers the detection of lightning, mainly by the direction or time of arrival of the sferic waves. Satellites using optical imagers can locate the sources of lightning on a global scale.

7. Early attempts to measure rainfall dating from 4th Century BC in India are recounted along with the progress in rain gauge development up to the middle of the 19th Century. The Korean rain gauges of the 14th century are very similar externally to some manual gauges still in use today. A sketch shows the single tipping bucket gauge of Christopher Wren and Robert Hooke that is not only the first automatic gauge in 1680 but also the first attached to a meteorograph or recording device. The effects of wind on gauges are discussed and illustrated.

8. Measuring precipitation with rain gauges during the 20th century includes manual gauges, various mechanical recording gauges as well as optical and impact sensors. The ingenuity of mankind is illustrated by the many different devices used to measure precipitation. An estimated 150,000 manual rain gauges of fifty different types are used by weather services worldwide. Various errors related to gauges are discussed in general as well as some methods of reducing their effects. Wind which produces the most severe errors can be reduced by putting the rain gauge in a pit at ground level, surrounded by an antisplash grating.

[1] Meteorological Instrument Consultant, Aurora, Ontario

9. Measuring snow has no simple solution according to the author. While he admits that the manual snow courses are one of the best method of measuring snowfall he states that accurate measurements of snowfall in gauges is not possible due to wind effects . The extensive WMO 1998 Solid Precipitation Measurement Comparison - Final Report by Goodison et al is not referenced.

10. Measuring precipitation with radar is both extensive and expensive. After a short overview of weather radar principles the author bases most of his discussion on UK radar systems. He states that radar measurements are not as precise as a good rain gauge network. CW Doppler systems like the Precipitation Occurrence Sensor System used for precipitation detection and typing are given only a casual mention.

11. Measuring precipitation from satellites is much more extensive and even more expensive. The basic satellite systems are covered followed by a description of how precipitation is determined from measurements which are made from space. Even less accurate than radar it has the advantage of covering that 70% of the globe that has no precipitation measurements, namely the oceans.

12. Rain gauge and satellite datasets preparation results from the problems of lack of data over the oceans and the declining networks. The author describes the major organizations that have prepared these precipitation datasets. Errors in the data can be reduced by combining these datasets and correcting the initial measurements.

13. Precipitation means and trends reveal that the global variations are greater than the changes over the last century. Two-and-a-half centuries of annual rainfall in the UK showed an upward trend of more than one percent per year.

14. Precipitation variability and extremes are influenced by the major forcing factors such as El Nino and NAO which are described with their effects on precipitation around the globe. Historical trends in extreme precipitation are also reviewed.

15. The future of precipitation measurement as envisaged by the author assumes that the measurements will be automated even though manual measurements are superior. There are suggestions for a rain gauge network and its operation including siting and metadata recording. Radar and satellite measurements would still be dependent upon rain gauges for ground truthing.

Written in a very readable fashion the author gives a broad view of the field of precipitation without being simplistic. He has used a descriptive style while introducing formulae only when that would expand insight for the reader. Everyone including professionals in the field of atmospheric sciences will gain some new knowledge from this book.

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

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

The Equations of Oceanic Motions, by Peter Müller, Cambridge University Press, ISBN # 0-521-85513-6, 2006, pp.291, Hardback, US$80.

The Chronologers' Quest: The Search for the Age of the Earth, by Patrick Wyse Jackson, Cambridge University Press, ISBN # 0-521-81332-8, 2006, pp.291, Hardback, US$30.

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

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

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

Numerical Modeling of Ocean Circulation, Robert B. Miller, Cambridge University Press, ISBN 978-0-521-78182-4, Hardback, pp.242, US$65.

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

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

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

Seeking Sustainability in an Age of Complexity, by Graham Harris, 2007, Cambridge University Press, ISBN 978-0-521-87349-9, pp.366, US$130.

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

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

A-O Abstracts Preview

Avant Première des résumés de A-O

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

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

The Circulation and Residence Time of the Strait of Georgia Using a Simple Mixing-Box Approach

RICH PAWLOWICZ, OLIVIER RICHE AND MARK HALVERSON

Abstract
New observations in the Strait of Georgia, British Columbia, Canada show that temperature and dissolved oxygen have a pronounced seasonal cycle, with a spatially varying phase. Phase lags in oscillating systems arise due to internal time scales which can be interpreted in fluid systems as residence times. Exploiting phase we construct a quantitative and internally consistent circulation scheme for this body of water after dividing it into four regions: the Fraser River plume, the surface waters down to 50 m, the intermediate waters down to 200 m, and the deep water. In this scheme the intermediate water, the largest region by volume, is continually renewed, and its characteristics change in response to continuous changes in the characteristics of source waters. The dependence of the estuarine circulation on variations in fresh inflow is weak. The deep water is volumetrically less important, but seasonal changes in the density of oceanic source waters can produce a variation in the overall circulation by driving an additional inflow which leads to both deep renewal and increased upwelling. In turn, this increased upwelling results in lower surface temperatures than might otherwise be expected. Intermediate water residence times are about 160 days. Deep water is renewed once per year in summer and is affected only by vertical diffusion during the rest of the year. Surface water residence times for the entire Strait are a few months at most, but the Fraser River plume has a freshwater residence time of approximately 1 day. In addition, we find that the residence time of oceanic source waters in the Strait is 1.7 years due to a substantial recirculation in Haro Strait. Other consequences of this scheme are consistent with independent estimates of horizontal transports, air-sea heat fluxes, subsurface oxygen (O_2) utilization, and primary production. Finally, analysis of the spatial phase variations suggests that the intermediate inflow enters the Strait as a boundary current along the slopes of the Fraser delta.

Résumé
De nouvelles observations dans le détroit de Georgie, en Colombie-Britannique, au Canada, montrent que la température et l'oxygène dissous ont un cycle saisonnier marqué, avec une phase qui varie dans l'espace. Les déphasages dans les systèmes oscillants sont causés par des échelles de temps internes pouvant être interprétées dans les circuits de fluides comme des temps de séjour. À partir de la phase, nous construisons un schéma de circulation quantitatif et intérieurement cohérent pour cette masse d'eau après l'avoir divisée en quatre régions : le panache du fleuve Fraser, les eaux de surfaces jusqu'à 50 m de profondeur, les eaux intermédiaires jusqu'à 200 m et l'eau profonde. Dans ce schéma, l'eau intermédiaire, la région la plus grande de par son volume, est continuellement renouvelée et ses caractéristiques changent en fonction des changements continuels dans les caractéristiques des eaux sources. La circulation estuarienne n'est que faiblement influencée par les variations dans l'apport d'eau douce. L'eau profonde est moins importante au point de vue volumétrique mais les changements saisonniers dans la densité des eaux sources océaniques peuvent causer une variation dans la circulation générale en produisant un afflux d'eau supplémentaire qui entraîne à la fois un renouvellement en profondeur et davantage de remontée d'eau froide. À son tour, cette remontée d'eau froide plus importante fait en sorte que les températures de surface sont plus basses que ce qui aurait été observé autrement. Les temps de séjour de l'eau intermédiaire sont d'environ 160 jours. L'eau profonde est renouvelée une fois par année en été et n'est influencée que par la diffusion verticale pendant le reste de l'année. Les temps de séjour de l'eau de surface pour l'ensemble du détroit sont de quelques mois tout au plus, mais l'eau douce du panache du Fraser a un temps de séjour d'environ 1 jour. De plus, nous trouvons que le temps de séjour des eaux sources océaniques dans le détroit est de 1,7 an, à cause d'une recirculation importante dans le détroit de Haro. Les autres conséquences de ce schéma sont compatibles avec les estimations indépendantes des transports horizontaux, des flux de chaleur air–mer, de l'utilisation de l'oxygène (O_2) de subsurface et de la production primaire. Finalement, l'analyse des variations spatiales de la phase suggère que l'afflux d'eau intermédiaire pénètre dans le détroit sous la forme d'un courant de bord le long des pentes du delta du Fraser.

Short-Wave Radiation and Sea-Ice in Baffin Bay

EWA DUNLAP, B. M. DETRACEY and CHARLES C. L. TANG

Abstract
The sensitivity of the annual cycle of ice cover in Baffin Bay to short-wave radiation is investigated. The Princeton Ocean Model (POM) is used and is coupled with a multi-category, dynamic-thermodynamic sea-ice model in which the surface energy balance governs the growth rates of ice of varying thickness. During spring and summer the short-wave radiation flux dominates other surface heat fluxes and thus has the greatest effect on the ice melt. The sensitivity of model results to short-wave radiation is tested using several, commonly used, short-wave parameterizations, under climatological, as well as short-term atmospheric forcing. The focus of this paper is short-term and annual variability. It is shown that simulated ice cover is sensitive to the short-wave radiation formulation during the melting phase. For the Baffin Bay simulation, the differences in the resulting ice area and volume, integrated from May to November, can be as large as 45% and 70%, respectively. The parameterization of the effect of cloud cover on the short-wave radiation can result in the sea-ice area and volume changes reaching 20% and 30%, respectively. The variation of the cloud amount represents cloud data error, and has a relatively small effect (less then ±4%) on the simulated ice conditions. This is due to the fact that the effect of cloud cover on the short-wave radiation flux is largely compensated for by its effect on the net near surface long-wave radiation flux.

Résumé
Nous étudions la sensibilité du cycle annuel de la couverture de glace au rayonnement de courtes longueurs d'onde dans la baie de Baffin. Nous nous servons du modèle océanique de Princeton (POM) que nous couplons avec un modèle multicatégorie dynamique-thermodynamique de glaces de mer dans lequel le bilan énergétique de surface gouverne les taux de croissance de glaces de différentes épaisseurs. Durant le printemps et l'été, le flux de rayonnement de courtes longueurs d'onde prédomine sur les autres flux de chaleur à la surface et a donc le plus grand effet sur la fonte de la glace. Nous étudions la sensibilité des résultats du modèle au rayonnement de courtes longueurs d'onde au moyen de plusieurs paramétrisations de courtes longueurs d'onde couramment utilisées pour le forçage climatologique ainsi que pour le forçage météorologique à court terme. Cet article porte principalement sur la variabilité annuelle et à court terme. Nous démontrons que la couverture de glace simulée est sensible à la formulation du rayonnement de courtes longueurs d'onde durant la phase de la fonte. Pour la simulation dans la baie de Baffin, les différences dans l'étendue et le volume résultants, intégrées de mai à novembre, peuvent atteindre 45 % et 70 %, respectivement. La paramétrisation de l'effet de la couverture nuageuse sur le rayonnement de courtes longueurs d'onde peut occasionner des changements dans l'étendue et le volume des glaces de mer atteignant 20% et 30%, respectivement. La variation dans l'étendue des nuages représente l'erreur attribuable aux données sur les nuages et n'a qu'un effet relativement faible (moins de ±4%) sur les conditions glacielles simulées. Cela est dû au fait que l'effet de la couverture nuageuse sur le flux de rayonnement de courtes longueurs d'onde est en grande partie compensé par son effet sur le flux net du rayonnement de grandes longueurs d'onde près de la surface.

A Practical Approach for the Assimilation of Cloudy Infrared Radiances and Its Evaluation Using AIRS Simulated Observations

SYLVAIN HEILLIETTE and LOUIS GARAND

Abstract
A variational estimation procedure for the simultaneous retrieval of cloud parameters and thermodynamic profiles from infrared radiances is proposed. The method is based on a cloud emissivity model which accounts for the frequency dependence of cloud absorption and scattering, and possible mixed phased situations. An effective cloud top height and emissivity are assumed. Monte Carlo experiments performed in a 1D-var assimilation context using simulated Atmospheric Infrared Radiance Sounder (AIRS) observations from 100 channels demonstrate the substantial added value, in theory, of cloudy radiance assimilation as opposed to clear-channel assimilation. Improved temperature and humidity retrievals are obtained for a broad layer above the cloud as well as below cloud level under partial cloud cover conditions. The impact is most pronounced in broken to overcast situations involving mid-level clouds. In these situations, the effective cloud top height and emissivity are retrieved with estimated rms errors typically lower than 30 hPa and 3%, respectively. Expected relative errors on the retrieved effective particle size are of the order of 30-50%. The methodology is directly applicable to real hyperspectral infrared data upon inclusion, for local estimation, of the cloud parameters in the Canadian 4D-var assimilation system.

Résumé
Nous proposons une méthode d'estimation variationnelle pour l'extraction simultanée de paramètres de nuages et de profils thermodynamiques à partir des luminances infrarouges. La méthode est basée sur un modèle d'émissivité des nuages qui prend en considération la relation entre l'absorption/diffusion par les nuages et la fréquence ainsi que les situations de phases mixtes possibles. Nous supposons une hauteur effective et une émissivité pour le sommet des nuages. Des simulations de Monte Carlo effectuées dans un contexte d'assimilation 1D-var et utilisant des observations simulées de sondeur infrarouge de l'atmosphère (AIRS) dans 100 canaux ont démontré l'importante valeur ajoutée, en théorie, de

l'assimilation de la luminance dans des conditions nuageuses par opposition à l'assimilation dans un canal clair. Nous obtenons des extractions de température et d'humidité améliorées dans une large couche au-dessus des nuages de même qu'au-dessous du niveau des nuages dans des conditions de couverture nuageuse partielle. L'amélioration est particulièrement marquée dans les situations de ciel fragmenté à couvert avec des nuages d'altitude moyenne. Dans ces situations, la hauteur effective et l'émissivité du sommet des nuages sont extraits avec des erreurs-types estimées généralement inférieures à 30 hPa et 3 %, respectivement. Les erreurs relatives attendues sur la taille effective extraite des particules sont de l'ordre de 30 à 50 %. La méthodologie est directement applicable aux données infrarouge hyperspectrales réelles après inclusion, pour l'estimation locale, des paramètres de nuages dans le système d'assimilation canadien 4D-var.

Spatio-Temporal Variability in a Mid-Latitude Ocean Basin Subject to Periodic Wind Forcing

L. SUSHAMA, M. GHIL and K. IDE

Abstract
The mid-latitude ocean's response to time-dependent zonal wind-stress forcing is studied using a reduced-gravity, 1.5-layer, shallow-water model in two rectangular ocean basins of different sizes. The small basin is 1000 km x 2000 km and the larger one is 3000 km x 2010 km; the aspect ratio of the larger basin is quite similar to that of the North Atlantic between 20°N and 60°N. The parameter dependence of the model solutions and their spatio-temporal variability subject to time-independent wind stress forcing serve as the reference against which the results for time-dependent forcing are compared.

For the time-dependent forcing case, three zonal-wind profiles that mimic the seasonal cycle are considered in this study: (1) a fixed-profile wind-stress forcing with periodically varying intensity; (2) a wind-stress profile with fixed intensity, but north–south migration of the mid-latitude westerly wind maximum; and (3) a north-south migrating profile with periodically varying intensity. Results of the small-basin simulations show the intrinsic variability found for time-independent forcing to persist when the intensity of the wind forcing varies periodically. It thus appears that the physics behind the upper ocean's variability is mainly controlled by internal dynamics, although the solutions' spatial patterns are now more complex, due to the interaction between the external and internal modes of variability. The north–south migration of wind forcing, however, does inhibit the inertial recirculation; its suppression increases with the amplitude of north–south migration in the wind-stress forcing.

Model solutions in the larger rectangular basin and at smaller viscosity exhibit more realistic recirculation gyres, with a small meridional-to-zonal aspect ratio, and an elongated eastward jet; the low-frequency variability of these solutions is dominated by periodicities of 14 and 6–7 years. Simulations performed in this setting with a wind-stress profile that involves seasonal variations of realistic amplitude in both the intensity and the position of the atmospheric jet show the seven-year periodicity in the oceanic circulation to be robust. The intrinsic variability is reinforced by the periodic variations in the jet's intensity and weakened by periodic variations in the meridional position: the two effects cancel, roughly speaking, thus preserving the overall characteristics of the seven-year mode.

Résumé
Nous étudions la réaction de l'océan dans les latitudes moyennes au forçage variable dans le temps de la tension du vent zonal au moyen d'un modèle d'eau peu profonde à gravité réduite, à 1,5 couche, dans deux bassins océaniques de taille différente. Le petit bassin mesure 1000 km x 2000 km et le plus grand mesure 3000 km x 2010 km; le rapport de forme du plus grand bassin est assez semblable à celui de l'Atlantique Nord entre 20°N et 60°N. La dépendance des solutions du modèle à l'égard des paramètres et leur variabilité spatio-temporelle sous un forçage par une tension du vent indépendante du temps servent de référence pour la comparaison des résultats obtenus avec un forçage variable dans le temps.

Dans le cas du forçage variable dans le temps, nous avons utilisé pour cette étude trois profils de vents zonaux qui émulent le cycle saisonnier : (1) un forçage par la tension du vent à profil fixe avec une intensité variant périodiquement; (2) un profil de tension du vent ayant une intensité fixe mais avec une migration nord–sud du maximum de vents d'ouest des latitudes moyennes; (3) un profil avec une migration nord–sud dans lequel l'intensité varie périodiquement. Les résultats des simulations avec le petit bassin montrent que la variabilité intrinsèque constatée pour le forçage indépendant du temps persiste quand l'intensité du forçage par le vent varie périodiquement. Il apparaît donc que la physique régissant la variabilité de la partie supérieure de l'océan libre est principalement contrôlée par la dynamique interne, bien que les configurations spatiales des solutions soient maintenant plus complexes, à cause de l'interaction entre les modes externe et interne de variabilité. La migration nord–sud du forçage du vent, cependant, empêche la recirculation inertielle; la suppression de cette dernière augmente à mesure qu'augmente l'amplitude de la migration nord–sud dans le forçage de la tension du vent.

Les solutions du modèle dans le plus grand bassin rectangulaire et à plus faible viscosité montrent des tourbillons de recirculation plus réalistes, avec un petit rapport de forme méridional à zonal et un courant-jet allongé vers l'est; la variabilité de basse fréquence de ces solutions est dominée par des périodicités de 14 et de 6–7 ans. Les simulations effectuées dans ce contexte avec un profil de tension du vent produisant des variations saisonnières d'amplitude réaliste à la fois dans l'intensité et

dans la position du courant-jet atmosphérique montrent que la périodicité de 7 ans de la circulation océanique est robuste. La variabilité intrinsèque est renforcée par les variations périodiques de l'intensité du courant-jet et affaiblie par les variations périodiques de la position méridienne : les deux effets s'annulent, de manière générale, ce qui préserve les caractéristiques du mode de sept ans.

ATMOSPHERE-OCEAN Invites Submissions

The co-editors of ATMOSPHERE-OCEAN (http://www.cmos.ca/pubs.html#Atmosphere-Ocean), Dr. Andrew Bush from University of Alberta and Dr. Patrick Cummins from the Institute of Ocean Sciences in Sidney, wish to remind readers that our Canadian journal is not limited to physical oceanography, but will also consider papers in chemical, biological and interdisciplinary oceanographic topics. Furthermore, A-O now has a second section highlighting applied research (in both meteorology and oceanography). A-O does not have a backlog of articles, so that publication can be achieved in as few as 6 months from initial submission. ATMOSPHERE-OCEAN has a good impact factor, occasionally ranking in the top ten oceanographic journals, according to ISI Citation Index reports.

Authors who are tempted to publish in journals that do not have page charges should consider that their library may no longer be able to buy subscriptions to these journals because they generally have very high suscription fees. On the other hand, A-O operates on a non-profit basis; its page charges are $85 per page and subscription $125, a very modest cost.

Richard Asselin
Director of Publications

Une invitation de ATMOSPHERE-OCEAN

Les éditeurs scientifiques d'ATMOSPHERE-OCEAN (http://www.cmos.ca/pubs.html#atmosphere-ocean), les Drs Andrew Bush de l'Université de l'Alberta et Patrick Cummins de l'Institut des sciences de la mer à Sidney, désirent rappeler à tous nos lecteurs que notre revue canadienne ne se limite pas à la météorologie et à l'océanographie, mais considère aussi les articles en océanographie chimique et biologique ainsi que les sujets interdisciplinaires. De plus, A-O offre maintenant une seconde section mettant en valeur la recherche appliquée (en météorologie et en océanographie). A-O n'a pas de réserve d'articles de telle sorte qu'un article peut être publié aussi tôt que 6 mois après la soumission du manuscrit. ATMOSPHERE-OCEAN a un bon facteur d'impact, se plaçant occasionnellement parmi les dix meilleures revues océanographiques, selon les rapports d'index de citations de l'ISI.

Les auteurs qui sont tentés de publier dans des revues qui n'ont pas de frais d'auteur devraient considérer la possibilité que leur bibliothèque ne puisse continuer à s'abonner à ces revues parce que les frais d'abonnement sont très élevés. Pour sa part, A-O fonctionne sans objectif de profit; ses frais d'auteur sont 85$ par page et son abonnement 125$, des frais bien modestes.

Richard Asselin
Directeur des publications

CMOS Congress

First Call for Papers

42nd Annual Canadian Meteorological and Oceanographic Society Congress May 25 to 29, 2008 Kelowna, British Columbia, Canada http://www.cmos2008.ca

The Great Okanagan Lakefront & Resort Conference Centre

The Canadian Meteorological and Oceanographic Society (CMOS) Congress 2008 will be held in Kelowna, British Columbia, Canada at the Grand Okanagan Lakefront Resort from 25 to 29 May, 2008. The Congress theme is "*Water, Weather, and Climate: Science Informing Decisions*".

The 2008 Congress will feature:

- Plenary presentations by leading researchers.

■ Science sessions that highlight top Canadian and international research contributions to climate, meteorology, oceanography, and hydrology, as well as the policy implications of research in these fields.

■ An evening lecture of general-interest, open to the public, on the theme of regional climate.

■ A banquet, a hosted lunch, awards of CMOS prizes, and the CMOS Annual General Meeting.

In addition to the normal CMOS Congress program, the following special sessions have been proposed:

International Polar Year; Polar climate stability; Alpine hydrometeorology; Forest hydrometeorology; Operational oceanography; Coastal and inland waters in a changing climate; Impact of climate change on biogeochemical cycles in the coastal ocean; Atmosphere, ocean and climate dynamics; Atmospheric Modelling for Research; Health issues of weather and climate; Global coupled atmosphere-ocean modelling and assimilation; Scientists involvement in decision-making processes; Use, application and impact of satellite based earth observing systems over the ocean; Aviation Weather Science and Service for Decision Makers; Forecasting the weather and climate beyond one week; Scale relationships in Atmosphere and Ocean forcing of sea ice; Training of decision-makers in meteorology and hydrology; Fire weather and forecasting; Air quality in valleys; Avalanche science and forecasting; Energy and climate; Climate change policy and economic impacts; Water Resources and climate change.

Please submit abstracts electronically to the link found on the Congress website (http://www.cmos2008.ca) **after January 7, 2008 and before the deadline of February 15, 2008**. You will be asked to submit your abstract to one of several planned sessions that are listed on the website and to specify your preference for either an oral or a poster presentation. The poster venue is on a spectacular sheltered outdoor patio overlooking Okanagan Lake and the surrounding valley. An abstract fee of $50 will be charged at the time of submission that will be credited toward your Congress registration. Your abstract will be evaluated by the Congress's Science Program Committee and you will be notified by the end of March 2008 if your presentation has been accepted for oral or poster presentation.

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

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

http://www.cmos2008.ca

and contact us at cmos2008@cmos.ca for further information.

Peter Jackson and Diane Masson
Co-Chairs of the CMOS 2008 Scientific Program Committee (peterj@unbc.ca, MassonD@pac.dfo-mpo.gc.ca)

Kent Johnson
Chair of the CMOS 2008 Local Arrangements Committee (Kent.Johnson@ec.gc.ca)

Congrès de la SCMO

Première demande de communications

42ième Congrès annuel de la Société canadienne de météorologie et d'océanographie du 25 au 29 mai 2008 à Kelowna, Colombie-Britannique, Canada http://www.cmos2008.ca

L'hôtel "The Great Okanagan Lakefront & Resort Conference Centre"

Le congrès 2008 de la Société de météorologie et d'océanographie (SCMO) aura lieu du 25 au 28 mai 2008 à Kelowna en Colombie-Britannique, Canada, au *Grand Okanagan Lake Front Resort*. Le thème du congrès est "Eau, météo, et climat: la science comme outil de décision".

Le congrès de 2008 inclura:

■ Conférences plénières par des chercheurs de pointe.

■ Sessions scientifiques mettant en évidence la recherche canadienne et internationale dans les domaines du climat, de la météorologie, de l'océanographie et de l'hydrologie, ainsi que sur les implications politiques de la recherche dans ces domaines.

■ Une présentation en soirée d'intérêt général, ouvert au public, sur le thème du climat régional.

■ Un banquet, un déjeuner inclus, remise des prix SCMO, et réunion générale annuelle du SCMO.

En plus du programme habituel de la SCMO, les sessions spéciales suivantes ont été proposées:

Année Polaire Internationale; Stabilité du climat polaire; Hydrométéorologie alpine; Hydrométéorologie forestière; Océanographie opérationnelle; Eaux côtières et intérieures dans un climat changeant; Impact du changement climatique sur les cycles biogéochimiques dans l'océan côtier; Dynamique de l'atmosphère, de l'océan et du climat; Modélisation pour la recherche sur l'atmosphère; Santé publique et la météo et le climat; Modélisation et assimilation dans les modèles couplés atmosphère-océan à l'échelle du globe; Implication des scientifiques dans le processus de prise de décision; Utilisation, application et impact des systèmes satellitaires d'observation planétaire sur l'océan; Science de la météo pour aviation et service pour les décideurs; Prédiction de la météo et du climat au delà d'une semaine; Relations d'échelle dans le forçage atmosphérique et océanique de la glace de mer; Formation des décideurs en météorologie et hydrologie; Météo de feu et prédiction; Qualité de l'air dans les vallées; Science d'avalanche et prédiction; Énergie et climat; Impacts économiques et politiques du changement climatique; Ressources en eau et changement climatique.

Veuillez soumettre vos résumés électroniquement en utilisant le lien sur le site du congrès (http://www.cmos2008.ca) entre le **7 janvier et le 15 février 2008**. Vous devrez soumettre votre résumé sous une des sessions affichées sur le site et spécifier votre préférence quant à une présentation orale ou un poster. Les posters seront affichés à l'extérieur, sur un patio avec vue magnifique sur le lac Okanagan et sur la vallée avoisinante. Un frais de $50 sera chargé au moment de la soumission qui sera ensuite crédité au moment de l'enregistrement au congrès. Votre soumission sera évaluée par le comité du programme scientifique du congrès qui vous avisera avant la fin du mois de mars 2008 de la décision de présenter votre contribution oralement ou avec un poster.

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

Si vous êtes un exposant, un éducateur, un membre des médias, ou quelqu'un avec un intérêt pour le congrès, veuillez visiter le site Web du congrès(http://www.cmos2008.ca) ou contactez-nous au cmos2008@cmos.ca pour obtenir plus d'information.

Peter Jackson et Diane Masson
Co-Présidents, Comité du programme scientifique de SCMO 2008 (peterj@unbc.ca, MassonD@pac.dfo-mpo.gc.ca)

Kent Johnson
Président, Comité des arrangements locaux de SCMO 2008 (Kent.Johnson@ec.gc.ca)

CMOS has a new Office Manager

Lise Harvey, who had been CMOS Office Manager since June 2004, gave her notice in September of her intention to resign in order to follow a long-held ambition to make a career change to interior design. Lise made an enormous contribution to CMOS during her three years with us, as all members, subscribers and congress attendees who had contact with her during that time will know. She kept our accounts in good shape, made numerous suggestions to improve the software and the procedures for handling renewals and registrations and she re-organised all our files, implementing a system of individual files for all members and key contacts. She kept the office administration running efficiently and effectively. Lise's involvement with CMOS actually goes back to 2000 when she was hired as the first office manager for CFCAS and she did such a good job that when the Office Manager position at CMOS came open, she was the obvious choice. We all wish her well in her new career that started 14 November with a training program in Montréal.

As the result of a competition held in late September and early October, Ms. Qing Liao was selected as our new CMOS office manager. She arrived on 29 October, received training in office procedures from Lise Harvey during her first two weeks and has been on her own since 7 November. Qing comes to us with excellent qualifications including a Diploma in Professional Accounting from Algonquin College in Ottawa and a Master of Electrical Engineering from Xi'an JiaoTong University in Xi'an China. She worked as a software engineer developing financial software for a company in Singapore and as a result developed an interest in accounting before coming to Canada. In addition to earning an accounting diploma she has experience working for local non-profit organizations as well as for a local accounting firm. Since arriving at CMOS, she has very quickly picked up the traces from Lise and in spite of this being a very busy period with membership and subscription renewals flooding in, the transition has been quite seamless. I am sure that all CMOS members join the CMOS office staff in welcoming Qing to our team.

The telephone and fax numbers and e-mail address for the CMOS Office Manager remain the same as before.

Ian D. Rutherford
Executive Director

Proposed Amendments to the CMOS Constitution and By-Laws with rationale

Note: Comments will be considered by Council up until the end of December

BY-LAW 8 - Prizes, Awards and Scholarships Replace all references in the by-law and in appendix I to "prizes and awards" by "prizes, awards and scholarships".	To recognize scholarships as a separate category of award.
APPENDIX I TO BY-LAWS **PRIZES, AWARDS AND SCHOLARSHIPS** *Replace* f) **The Graduate Student Prizes** One or more graduate student prizes may be awarded each year for contributions of special merit by graduate students registered at a Canadian university or by Canadian graduate students registered at a foreign university. One of these prizes should be named the **Tertia MC Hughes Memorial Prize**. *by* f) **The Tertia MC Hughes Memorial Graduate Student Prizes** One or more prizes ($500) may be awarded each year for contributions of special merit by graduate students registered at a Canadian university or by Canadian graduate students registered at a foreign university.	The current wording creates a situation where the ordinary CMOS Graduate Student Prizes are reduced to secondary status because they are not and they carry no monetary award, whereas the T. Hughes Prize includes a $500 award. It is proposed to drop the ordinary CMOS graduate student prizes and allow more than one Tertia Hughes prize to be awarded in any one year. The Tertia Hughes Fund has already been combined with the Scholarship Fund.
Replace j) **Postgraduate Scholarship** The CMOS Postgraduate Scholarship is awarded annually in association with the Natural Sciences and Engineering Research Council of Canada as a Postgraduate Supplement. The successful student must be eligible for an NSERC Scholarship and indicate his/her intention to pursue advanced studies and research in atmospheric or oceanographic sciences at a recognized Canadian university with postgraduate studies in these fields. The award is tenable for a maximum of 24 months, provided that the holder continues to be a full time candidate for a higher degree in a Canadian University. *by* j) **Postgraduate Scholarship Supplements** The CMOS Postgraduate Scholarship Supplements are awarded in association with the Natural Sciences and Engineering Research Council of Canada (NSERC). The successful students must have been awarded an NSERC Postgraduate Scholarship or Canada Graduate Scholarship and indicate their intention to pursue advanced studies and research in atmospheric or oceanographic sciences at a recognized Canadian university with postgraduate studies in these fields. The awards are tenable for a maximum of 24 months, provided that the holder continues to hold the NSERC award. Two new supplements may be awarded each year, as follows: ● The CMOS - Weather Research House NSERC Scholarship Supplement; ● The CMOS - CNC/SCOR NSERC Scholarship Supplement in Ocean Sciences .	To reflect the fact that these scholarships are actually supplements to NSERC awards and that there are now two supplements awarded each year.

Insert k) The CMOS Undergraduate Scholarships Two CMOS undergraduate scholarships ($500) may be offered annually to students planning a career in atmospheric, hydrological, oceanographic or limnological sciences. These scholarships are tenable at any Canadian university. Applicants must be Canadian citizens or have landed immigrant status and be in their penultimate undergraduate year; the scholarships are to support the students' final university year. To be qualified, students should be taking four or more half courses in one or more of the following areas in their final year: meteorology, physical or chemical oceanography or limnology, hydrology or climatology. l) The CMOS - The Weather Network/Météomédia Scholarship This Scholarship ($1500) is offered to a 3rd or 4th year female student at a Canadian university who intends to pursue a career in the fields of Forecast Meteorologist, On-Air Meteorologist or Meteorological Briefer.	To add to the list two scholarships that have been awarded for several years but never listed.

Proposition d'amendements à la Constitution et aux Règlements de la SCMO et rationalisation

Note: Vos commentaires seront considérés par le Conseil jusqu'à la fin de décembre

RÈGLEMENT 8 - Prix, honneurs et bourses Remplacer toute référence dans le règlement et dans l'appendice I à "prix et honneurs" par "prix, honneurs et bourses".	Pour reconnaître les bourses comme catégorie distincte des honneurs.
APPENDICE I AUX RÈGLEMENTS **Prix, honneurs et bourses** *Remplacer* f) **Les Prix pour étudiants diplômés** Un ou plusieurs prix pour étudiants diplômés peuvent être décernés aux étudiants diplômés, inscrits à une université canadienne ou aux étudiants canadiens inscrits à une université étrangère, ayant accompli un travail exceptionnel. Un de ces prix devrait être dénommé **le prix commémoratif Tertia M. C. Hughes**. *par* f) **le prix commémoratif Tertia M. C. Hughes** Un ou plusieurs prix (500 $) peuvent être décernés aux étudiants diplômés, inscrits à une université canadienne ou aux étudiants diplômés canadiens inscrits à une université étrangère, ayant accompli un travail exceptionnel.	Le texte actuel crée une situation où les prix pour étudiants diplômés sont réduits à un statut secondaire parce qu'ils n'impliquent aucun prix monétaire alors que le prix commémoratif T. Hughes inclut une somme de $500. On propose de laisser tomber les prix ordinaires pour étudiants diplômés et d'admettre la possibilité de plus d'un prix T. Hughes. Les fonds Tertia Hughes sont déjà amalgamés aux fonds de bourses d'étude.

Remplacer j) **Bourse de troisième cycle** La Bourse de troisième cycle de la SCMO est décernée chaque année en collaboration avec le Conseil de recherches en sciences naturelles et en génie (CRSNG) comme supplément de troisième cycle. Le candidat doit être récipiendaire d'une bourse du CRSNG et indiquer ses projets concernant ses études supérieures et ses recherches en sciences de l'atmosphère ou des océans dans une université canadienne offrant des études de troisième cycle dans ces domaines. Ce prix est offert pendant une période maximale de 24 mois, pourvu que le récipiendaire poursuive ses études supérieures à temps plein dans une université canadienne. *par* j) **Suppléments aux bourses de troisième cycle du CRSNG** Les suppléments SCMO aux bourses de troisième cycle du CRSNG sont décernés chaque année en collaboration avec le Conseil de recherches en sciences naturelles et en génie (CRSNG). Les candidats doivent être récipiendaires d'une bourse ES du CRSNG ou une Bourse d'études supérieures du Canada et indiquer leurs projets concernant leurs études supérieures et leurs recherches en sciences de l'atmosphère ou des océans dans une université canadienne offrant des études de troisième cycle dans ces domaines. Ces prix sont offerts pendant une période maximale de 24 mois, pourvu que le récipiendaire poursuive ses études supérieures à temps plein dans une université canadienne. Deux nouveaux suppléments peuvent être décernés chaque année : ● Supplément SCMO – Weather Research House en sciences de l'atmosphère ou des océans; ● Supplément CMOS – CNC SCOR pour les sciences de la mer.	En reconnaissance du fait que ces bourses sont vraiment des suppléments aux bourses du CRNSNG et que maintenant il y a deux suppléments disponibles chaque année.
Insérer k) Bourses d'études de premier cycle Deux bourses d'études de premier cycle (500 $) peuvent être offertes aux étudiants qui planifient leur carrière dans les sciences atmosphériques, hydrologiques, océanographiques et limnologiques. Ces bourses d'études ne sont valides que dans les universités canadiennes. Les candidats doivent être citoyens canadiens ou détenir le statut d'immigrant admis et être dans l'avant-dernière année du premier cycle; ces bourses serviront à appuyer les étudiants lors de leur dernière année universitaire. Afin d'être admissibles, les étudiants doivent suivre au moins quatre demi-cours dans au moins un des domaines suivants durant leur dernière année: météorologie, océanographie physique ou chimique ou limnologie, hydrologie ou climatologie. l) La bourse SCMO - The Weather Network/Météomédia Cette bourse (1 500 $) est offerte à une étudiante dans la 3^{e} ou 4^{e} année d'un programme de Sciences atmosphériques dans une université canadienne, avec aspirations de carrière en tant que Météorologue prévisionniste, Météorologue "en- ondes" ou Météorologue "breffeur".	Pour ajouter deux bourses d'études qui sont disponible depuis plusieurs années sans être mentionnées.

Beyond the Sea[1]

Eddy Carmack has a special affinity for American ecologist Edward Ricketts, who was fictionalized in John Steinbeck's novel *Cannery Row*. Studying marine life along the Pacific coast aboard small fishing vessels, Ricketts became known as the father of "fishboat science".

Carmack, a climate oceanographer with Fisheries and Oceans Canada in Sidney, B.C., also subscribes to fishboat science, "which is synonymous," he says, with "on the cheap". In his spare time, he explores the Koeye River and estuary on British Columbia's central coast from the deck of his converted 1947 troller. His goal, he says, is simply to document this unspoiled ecosystem "before it is too late".

It is a measure of his passion for lakes, rivers and oceans that Carmack devotes holidays to monitoring the Koeye. In his day job at the Institute of Ocean Sciences, he is an internationally respected expert on the Arctic Ocean. Over the past four decades, he has participated in more than sixty field studies in Western Canada, Siberia, Antarctica and the Arctic, including the first scientific crossing of the Arctic Ocean via the North Pole.

For his leading role in ocean science, Eddy Carmack has been awarded the 2007 Massey Medal for outstanding achievement in Canadian geography. Established by Governor General Vincent Massey in 1959, the award is administered by The Royal Canadian Geographical Society.

A creative thinker, Carmack has a knack for making science accessible. As a volunteer on Students on Ice expeditions to the Arctic and Antarctica, he has introduced teenagers to the complexities of ocean currents by having them drop beer bottles into the water to see where they would end up. "He got the students switched on to ocean currents", says Geoff Green, executive director of Students on Ice. "He was explaining climate change to students way before it became the big issue that it is today".

For International Polar Year, Carmack is embarking on the most ambitious study yet of Canada's oceans. Scientists aboard two icebreakers will document the oceans' physical properties, such as currents, and life forms ranging from bacteria to whales. They will travel a 12,000-kilometre course, from Victoria through the Northwest Passage to Halifax. Their goal is to develop a large-scale picture of the ecosystems in the Arctic and subarctic seas. Geographic research usually implies things terrestrial, explains Carmack. "What we are exploring is a part of Canada that is very poorly explored. It is almost like the last wilderness area of the world ocean".

Monique Roy-Sole

[1] Reprinted by permission of Monique Roy-Sole, Canadian Geographic, July/August 2007, p.9.

Two Professors from McGill University Honoured

Congratulations to Prof. Hong Guo (Department of Physics) and Prof. Isztar Zawadzki (Department of Atmospheric and Oceanic Sciences), who have been elected Fellows of the Royal Society of Canada (RSC).

RSC, founded in 1882, is Canada's oldest and most prestigious scholarly organization. Election to RSC is the highest honour that can be attained by scholars, artists and scientists in Canada. "The Society is proud to celebrate the intellectual achievements of the new Fellows", said Dr. Patricia Demers, President of the Society. "We wish to recognize the extraordinary accomplishments of persons of talent, expertise and creativity in all fields, from experimental and applied sciences to health and medical sciences, and from social sciences and humanities to the various artistic domains."

Professor Zawadski's citation reads as follows:

"Isztar Zawadzki has made exceptional and long-lasting contributions to our understanding of precipitation processes using radar measurements. He has related the statistical properties of raindrops to their physical origin and has parameterized their attributes. He then directed the incorporation of his raindrop parameterization scheme into an advanced mesoscale numerical weather prediction model for the benefit of the meteorological community. He has designed novel experiments, and followed them through with superb quantitative interpretations. For his many contributions to radar meteorology, Professor Zawadzki was awarded in 2006 the first-ever Remote Sensing Prize of the American Meteorological Society."

Canadians have directly benefited from the outstanding achievements of these individuals. The new Fellows of RSC are among those who, today, build the world we

will live in tomorrow. This year's new Fellows were inducted at a ceremony held Saturday, November 17, 2007 in Edmonton.

Ken Denman Recipient of Wooster Award

Dr. Ken Denman, research scientist at the Institute of Ocean Sciences (IOS), is the recipient of the Wooster Award for 2007. The award was presented by Professor Kuh Kim at the 16th annual meeting of the North Pacific Marine Science Organization (PICES) in Victoria B.C. in late October 2007.

Dr. Ken Denman

Dr. Denman has built a biological oceanographic program at IOS over many years with a focus on how oceanographic and environmental factors affect plankton, which supports fish populations. He is an internationally respected scientist who helped establish links between physical and biological processes in the upper ocean. He was recently a lead author in the 4th Assessment Report of the Intergovernmental Panel on Climate Change.

The Wooster Award is named in honour of Professor Warren Wooster, a principal founder and the first Chairman of PICES, and a world-renowned researcher and statesman in the area of climate variability and fisheries production. The award is given annually to an individual who has made significant scientific contributions to North Pacific marine science, such as understanding and predicting the role of human and climate interactions on marine ecosystem production. The main criteria for selection are sustained excellence in research, teaching, administration or a combination of the three in the area of North Pacific marine science. Special consideration is given to individuals who have worked in integrating the disciplines of marine science. Individuals who were or are currently actively involved in PICES activities are preferred but the award may be given to any suitable candidate, including those from outside PICES member countries.

The Sangster Award

The Canadian National Committee for CODATA (CNC/CODATA) is accepting applications for The Sangster Award. This award, valued at Can. $3000, will enable a graduate student enrolled in a Canadian University, or a graduate who has completed his or her graduate degree within 3 years of the application deadline, to attend and present their work at the 21st International CODATA Conference, Scientific Information for Society – from Today to the Future, 5-8 October 2008, Kyiv, Ukraine.

It is expected that the award winner's field of study will support the general objectives of CODATA, namely, to help foster and advance science and technology through developing and sharing knowledge about data and data-related activities. The deadline for Applications is March 31st, 2008. For application guidelines and award details: http://www.codata.org/canada/sangster For Conference details http://www.codata.org and follow the posted links.

L'Institut Maurice-Lamontagne célèbre ses 20 ans[2]

L'année 2007 marque le 20e anniversaire de l'Institut Maurice-Lamontagne (IML) de Mont-Joli, Québec, qui fait partie du réseau des centres de recherche de Pêches et Océans Canada. C'est sous le thème "20 ans de réalisation au profit des collectivités" que les célébrations ont commencé le 12 juin dernier, date de l'inauguration officielle de l'IML en 1987.

L'Institut est un des principaux centres de recherche francophones en sciences de la mer dans le monde. Doté d'un budget de 32 millions $, il emploie environ 400 personnes. Nous sommes loin des 75 employés qui y travaillaient à son ouverture!

Les activités de recherche et de surveillance de l'IML visent à mieux comprendre les écosystèmes aquatiques et l'impact des activités humaines sur ces écosystèmes, et à garantir la sécurité des voies navigables. On y effectue des travaux sur les poissons et mammifères marins, la biodiversité, l'environnement marin, l'océanographie, l'hydrographie, la gestion intégrée des océans et la protection de l'habitat du poisson.

Pour fêter ses vingt ans d'existence, l'IML a organisé plusieurs activités jusqu'en décembre, certaines pour ses partenaires et clients, à Trois-Rivières, Mont-Joli, Sept-îles, Grande-Rivière et Cap-aux-Meules. L'institut a également été présent lors d'événements tenus à Rimouski et Matane. Une activité très prisée du grand public s'est tenue en octobre: les journées portes ouvertes de l'IML.

Ces portes ouvertes offrent l'occasion aux visiteurs de découvrir les infrastructures de recherche et

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[2] Reproduit avec permission du rédacteur, *Océans*, Juillet-Août 2007, p.16.

d'approfondir leurs connaissances des sciences de la mer, de la conservation des océans et de la gestion de l'habitat du poisson, tout en les informant sur les services offerts par la Garde côtière. Les visiteurs ont aussi le loisir de s'arrêter aux différents stands animés vulgarisant les travaux scientifiques. Lors de la dernière activité de ce genre tenue en 2002, l'IML avait accueilli plus de 3 600 personnes.

Selon Ariane Plourde, directrice générale de l'IML, le bilan des vingt dernières années est éloquent. Elle mentionne la recherche en sciences halieutiques, l'évaluation des stocks de poissons, les avancées dans le domaine de l'habitat du poisson, de la biologie et de la physiologie marines, des espèces en péril et, bien sûr, des changements climatiques et de leur impact sur le milieu aquatique.

Johanne Fournier
Conseillère principale des communications,
Région de Québec, Ministère des Pêches et Océans

Arctic Council Working Group meeting of PAME

Representatives from the Arctic countries met in Reykjavik, September 26 and 27, 2007 at an Arctic Council Working Group meeting of PAME (Protection of the Arctic Marine Environment), currently chaired by Chris Cuddy (DIAND). The meeting was preceded (September 24) by a Workshop on the Regional Programme of Action (RPA) that is being reviewed by PAME as part of its work program. The RPA is the regional response to the Global Programme of Action (GPA) on the Land Based Sources of Marine Pollution. The eight Arctic Countries had signed the original agreement in 1998 and wished to have it brought up to date in the light of new events, policies and priorities. The activity is being led by Canada and Iceland and the Workshop was jointly chaired by Hugi Olafsson (Iceland) and Peter Farrington(Environment Canada). The impact of global warming on the social, economic and environmental situation in the north was one of the most dominant concerns of participants. It was realised that the RPA was but one of the many governmental structures needed to protect the arctic marine environment from anthropogenic sources and that other regional actions would eventually be needed to address marine transportation, offshore resource development and fisheries. Other Canadian participants included Anne Blauveldt (Canadian Ambassador to Iceland), Maureen Copley (EC), Renée Sauvé (DFO), Derek Mahoney (DFO), Ross MacDonald (TC) and Geoff Holland (consultant). The results of the Workshop will be used to draft potential changes to the existing RPA that will then be brought back to PAME for review and forwarding on to Senior Arctic Officials and to the Arctic Ministers.

Geoff Holland, CMOS Member,
Consultant

Guidebook on Preparing for Climate Change

"*Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments*" is designed to help local, regional, and state governments prepare for climate change by recommending a detailed, easy-to-understand process for climate change preparedness based on familiar resources and tools. These steps include creating a climate change preparedness team; identifying community vulnerabilities to climate change; and identifying, selecting, and implementing adaptation options. The book is available at http://www.cses.washingon.edu/cig/fpt/guidebook.shtml

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