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NEWSLETTER FOR THE

Canadian Antarctic Research Network

Inside

The History of Kamb Ice Stream, Antarctica as Revealed by Ice-penetrating Radar

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The West Antarctic Ice Sheet (WAIS) is the largest marine-based ice sheet on Earth. Its discharge is controlled by fast flowing (up to 800 m a-1) ice streams (regions where fast ice motion is allowed primarily through basal sliding) that extend far into the interior (Figure 1). Because these ice streams help to regulate mass balance of the ice sheet, the overall stability of West Antarctica may be related to their dynamics. Field studies in the Siple Coast area highlight the high degree of variability found in both ice stream position and discharge. One example is the discovery of buried crevasses marking the boundaries of a former ice stream (Kamb Ice Stream) that shut down in 1859 A.D. ±25 years (Retzlaff and Bentley, 1993). Such variability may in part be related to long-term climatic changes caused by the end of the last glacial maximum 14 k.y. ago; however the exact response of the ice streams to climate forcing remains unknown. The variability could also simply indicate that processes internal to the ice sheet are instrumental in causing large-scale fluctuations in ice stream discharge and position.

Much of what is known about ice stream variability comes from observations of changes to ice stream margins. Knowledge of how margin positions change over both long and short time scales aids in our understanding of the present and possible future behaviour of the ice sheet and its response to climate forcing. Ice stream margins mark the locations where horizontal surface velocities typically change by more than two orders of magnitude over a few kilometers and numerous chaotic crevasses form (Echelmeyer and Harrison, 1999). Shear stresses are large in the margins and basal shear stress is distinctly

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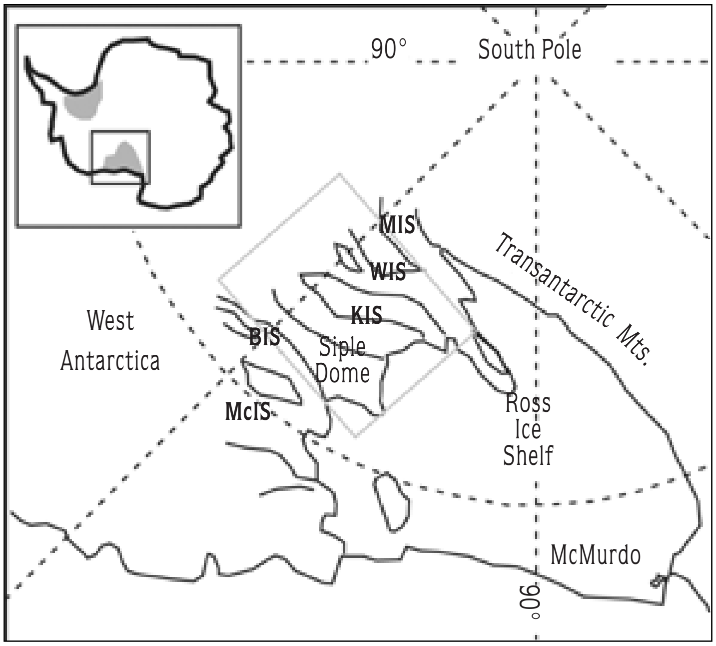


Figure 1
Site map of the Siple Coast Ice Stream System. Ice streams are Mercer Ice Stream (MIS), Whillans Ice Stream (WIS), Kamb Ice Stream (KIS), Bindschadler Ice Stream (BIS) and MacAyeal Ice Stream (McIS). Former names of these ice streams are A, B, C, D and E respectively. Siple Dome is a ridge that bounds the northern side of KIS. The light grey box outlines the area seen in Figure 2.

smaller than the driving stress due to the presence of a well lubricated, deforming bed (Kamb, 2001). As a result, the relatively narrow marginal bands typically support most of the driving stress (Raymond *et al.*, 2001).

Figure 2 shows a RADARSAT image of the Kamb and Whillans Ice Stream area including the complicated flat ice terrains that surround the downstream end of Kamb Ice Stream (KIS). The bright returns from the shear margins of Whillans Ice Stream (WIS) indicate the effectiveness of crevasses in active margins to scatter the incoming radar

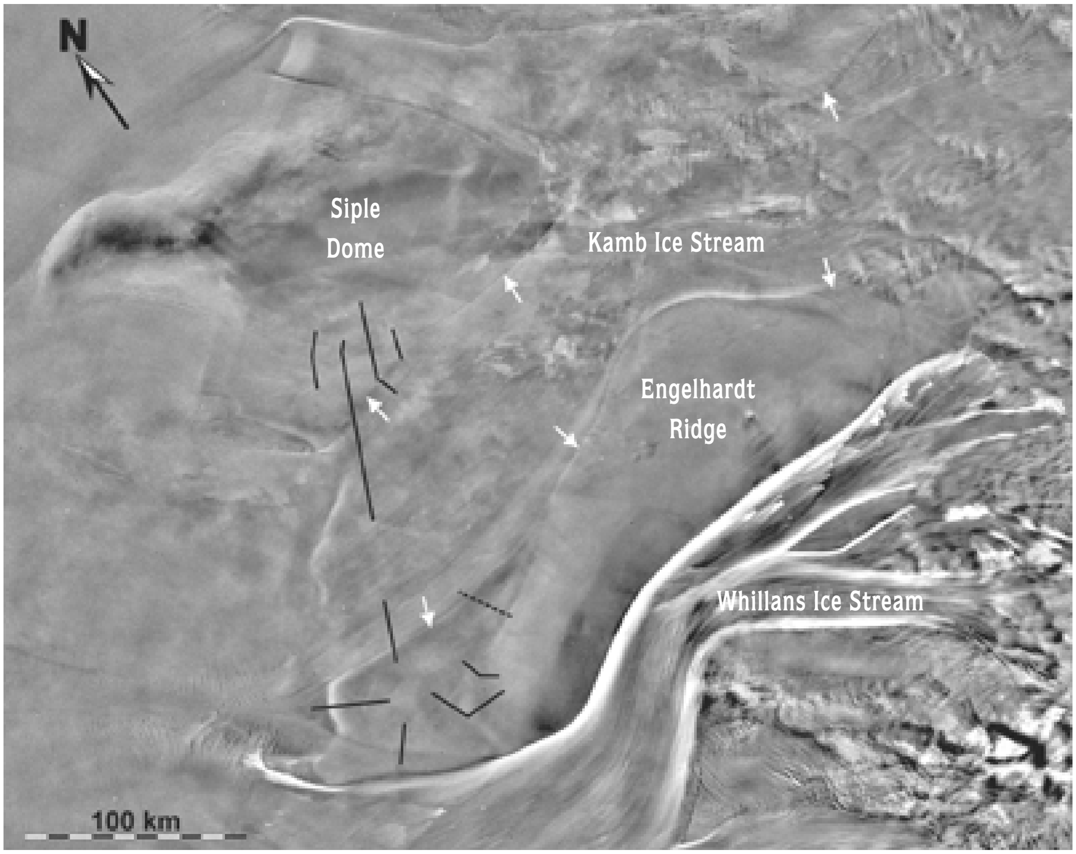
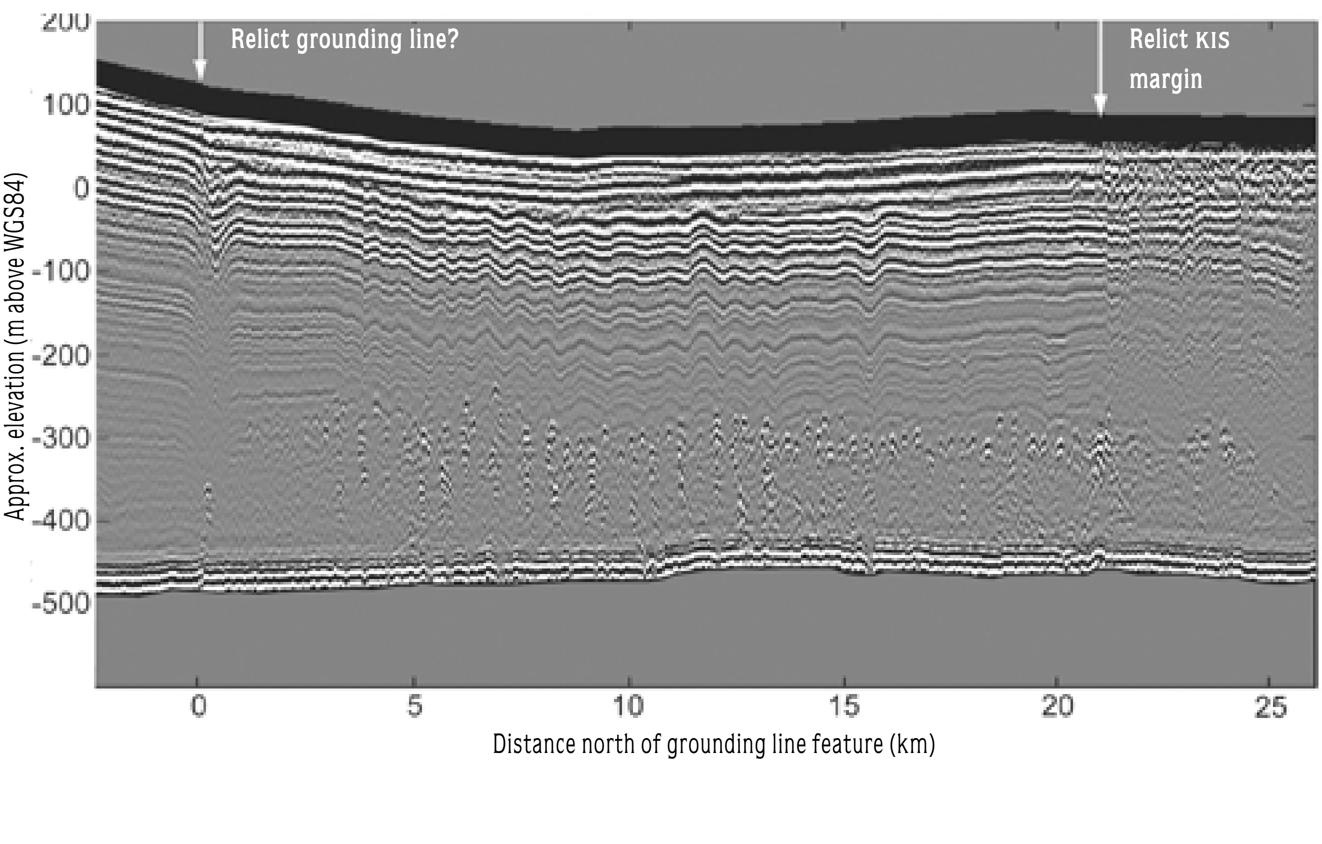


Figure 2
RADARSAT image of the KIS and WIS area. Flow direction is generally from the right to the left. Black lines represent radar profiles completed in the flat ice areas surrounding KIS during the 2001 and 2002 field seasons. The black dashed line indicates the location of radar data shown in Figure 3. White arrows point to the most recent (~150 year old) margin of KIS. Image from National Snow and Ice Data Center.

signal. In contrast, the margins of Kamb Ice Stream are dim from snow accumulated on the margins since shutdown. Several features in the flat ice terrain surrounding the downstream end of Kamb Ice Stream show characteristics similar to the relict margins of KIS. They are curvilinear bright or dark lines aligned sub-parallel to the ice flow direction. We use satellite images like Figure 2 in conjunction with ground-based radar collection (in a range of frequencies from 2–200 MHz) to investigate the likelihood that such features are relict margins and also to determine the timing of margin shutdown.

Our data across relict ice stream margins indicates that margins are typically characterized by the onset of shallow diffractors in the near-surface (likely related to buried crevasses) and a corresponding transition from continuous to discontinuous deeper layers (km 21 on Figure 3). Relict margins are also often associated with topographic troughs of up to 50 m depth over 10 km possibly related to melting where shear stresses are at a maximum. These troughs allow relict margins to be identified from satellite images, sometimes even when surface crevasses are deeply buried. During the 2000/01 and 2002 field seasons radar data was collected across these features to determine the burial depth of the crevasses, local accumulation rates and current ice speeds. From this information we have obtained shutdown ages for the four relict margins that surround the main

Figure 3
5 MHz radar data across two features in the downstream area of KIS along the dashed line in Figure 2 (km 0 is at the south end of the line). Ridge BC is on the left and the main body of KIS is on the right. The prominent return at roughly 500 m is the bed. The heavy black line covers the air-wave (direct wave from transmitter) return. Downwarped layers at km 0 may mark the position an old grounding line with strongly downwarped layers related to focused melting at the transition between grounded and floating ice. The relict margin at km 21 is the most recent margin of KIS dated at 1850 A.D. (Retzlaff and Bentley, 1993).



trunk of KIS thus providing a picture of past ice stream configurations. The outermost margin of KIS is 340 years old, roughly 200 years older than the most recent margin indicating that the ice stream may have shut down in stages.

One important discovery made during our field seasons was that not all of the investigated features were relict margins. A second kind of feature with an unknown origin was found bounding the two ridges that surround KIS. Ground-based radar profiles across these features and the contiguous flat ice terrain that lies between them and the KIS relict margins reveal complex patterns of internal layering (Figure 3). Internal layers are strongly downwarped (at km 0) and lie adjacent to large areas (up to 2500 sq. km) of flat ice terrain containing lightly disturbed but continuous layers and diffractors at nearly half the ice thickness in depth (Figure 3, km 0 to km 21). There are no near-surface diffractors associated with these features to suggest that they are formed within ice stream margins.

The origin of these features remains unclear, and our working hypothesis to explain their characteristics is that they mark a former grounding line. Joughin and Padman (2003) find that melting beneath an ice shelf is focused at the grounding line, the location that marks the transition between grounded and floating ice. Such melt may be the cause of the strong downwarp seen in the internal layers at km 0. Furthermore, floatation conditions could allow bottom crevasses to form. These bottom crevasses may be responsible for the numerous diffractors detected at mid-depth. While this hypothesis accounts for many of the characteristics seen in internal layers, there are a few observations that are still not well explained. At present, ice in this region is 120 m above floatation. To achieve flotation conditions similar to that found on the Ross Ice Shelf, ice here must have either thickened substantially since it was grounded and/or the bedrock has uplifted from glacial unloading since the Last Glacial Maximum.

If this hypothesis is correct and the lower part of KIS was once floating but then grounded while the ice stream was still active, this would have had an enormous impact on the velocity of KIS. Our current focus now lies in determining past elevations of the ice sheet in these areas to ascertain when the area may have last approached floatation conditions. This will hopefully constrain the timing of when the lower end of KIS became grounded.

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What Scientists Should Know about the Antarctic Environmental Protection Act and Its Regulations

As part of a global effort to protect the Antarctic environment, Canada ratified the Madrid Protocol and brought the Antarctic Environmental Protection Act (AEPA) and its Regulations into force. The Antarctic is an environmentally significant region and contains relatively untouched ecosystems that are scientifically valuable. The newly passed Canadian legislation acknowledges the unique opportunities the Antarctic offers for scientific monitoring and research on processes of global as well as regional importance.

The AEPA and its Regulations require overseeing Canadian activities in the Antarctic (including scientific). As of December 1, 2003, scientists on Canadian-led expeditions will be required to apply for, and receive, a permit to be in the Antarctic, except when granted permission from another Party to the Madrid Protocol or in the case of an emergency. The Act enables one person, such as scientific expedition leader, to apply for a permit on behalf of others. The conditions of a permit apply to any person covered by that permit.

To obtain a permit, the proposed activities of the expedition would be subjected to an environment evaluation (EE) as prescribed by AEPA and its regulations. This evaluation assesses the potential impacts of proposed activities on the Antarctic environment and the means taken or envisaged to minimize these impacts. To facilitate the EE, the permit application must include information on potential environmental impacts, initial environmental reference states, and consideration of possible indirect or secondary environmental impacts. The application must indicate whether, in the applicant's estimation, the proposed activities will have more than a minor or transitory impact on the Antarctic environment. If, on the basis of the EE, the Minister of the Environment determines that the proposed activities are likely to have even a minor or transitory impact on the environment, further environmental assessment processes are initiated.

The lead scientist undertaking the expedition is also required to develop mandatory waste management plans and environmental emergency plans. There is no application charge for permits under the AEPA and its Regulations.

For scientific purposes, permits are provided for otherwise prohibited activities when requested by the scientists and deemed justifiable by the Minister of the Environment. This includes activities related to mineral resources; interference with wildlife indigenous to the Antarctic; introduction of animal or plant species that are not indigenous to the Antarctic; and any activity related to waste disposal.

Certain areas of the Antarctic have been set aside as specially protected areas, in order to preserve their unique natural, physical, and heritage value. Scientists planning to enter specially protected areas should note that, where management plans exist for a specially protected area, permit applications must be consistent with these plans. Permit applications must also describe proposed activities, including when, where, and by whom the activities will be conducted. Where management plans have not yet been developed, a permit to be in a specially protected area can be obtained only if the proposed activities have a compelling scientific purpose that cannot be conducted elsewhere and will not jeopardize the area's natural ecological system.

In line with the Madrid Protocol, scientists should take note that certain activities are prohibited under AEPA under any circumstance: burning waste in the open air; disposing of waste in ice-free areas or freshwater systems; discharging any products or substances into the sea that are harmful to the marine environment except under the conditions established for the disposal of domestic liquid waste;

introducing prohibited substances into the Antarctic; damaging historic sites or monuments. These conditions must be respected even when Canadian scientists are working in the Antarctic under the permit of any another country.

Canada is concerned with growing rate of genetic bioprospecting in the Antarctic. Under AEPA, Canadian-led scientific activities will be regulated to monitor access to genetic material. AEPA and its Regulations prohibit removal of any indigenous material from the Antarctic except in accordance with a permit authorized by the Minister of Environment. Note that the Minister of Environment holds the discretionary authority to cancel and suspend a permit at any time in the public interest. Compliance to all conditions in AEPA and its Regulations is mandatory.

Consistent with the approach taken by other Treaty countries Canada recognizes permits obtained from any country that is a party to the Protocol. However, in order to regulate Canadian activities in the Antarctic, Canada requires a copy of permits obtained from other Treaty countries. For more information on AEPA and its Regulations please visit Environment Canada website at ec.gc.ca/international/regorgs/antarctic/1antarctic_e.htm.

George Enei is Director, Conservation Priority Branch, Environment Canada, (819) 997-5079.

Simulation of the Antarctic Climate Response to Ozone Depletion

N.P. Gillett and D.W.J. Thompson

Recent climate change in the Southern Hemisphere (SH) has been marked by a strengthening of the westerly winds (blowing from west to east) which encircle the Antarctic throughout the depth of the atmosphere (Thompson and Solomon, 2002). In the stratosphere, above ~10 km, the trends are largest during the spring months; in the troposphere, below ~10 km, they are largest during the summer months. Based on the structure and seasonality of the observed trends, Thompson and Solomon (2002) argued that they are consistent with a response to stratospheric ozone depletion.

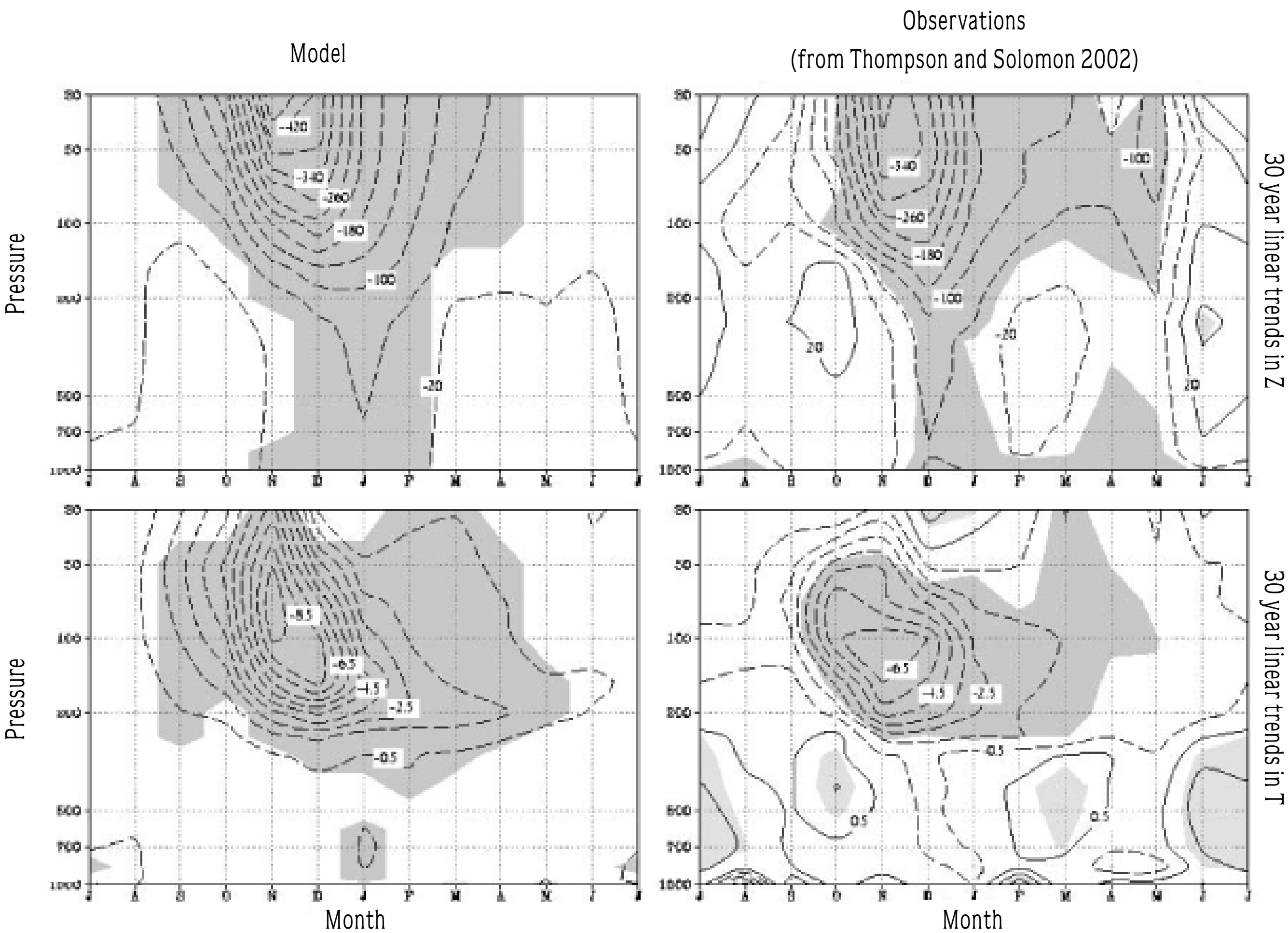
This article describes a modelling study to test the hypothesis that recent SH tropospheric circulation changes have been induced by stratospheric ozone depletion, and is based on a recently published report of the results (Gillett and Thompson, 2003). We use simulations from a high vertical resolution atmospheric model coupled to a simple ocean model (Gillett *et al.*, 2003). The impact of ozone depletion on the SH circulation is assessed by comparing two simulations run with different stratospheric ozone distributions; all other external variables were held fixed. The control simulation was run with a reconstruction of preindustrial ozone; the perturbed simulation was run with prescribed stratospheric ozone losses based on observed trends over the 18-year period 1979–1997 (Randel and Wu, 1999).

In the stratosphere, the prescribed ozone depletion induces cooling over the polar cap due to reduced absorption of ultraviolet radiation (Fig. 1, bottom left). Consistent with observations (Thompson and Solomon, 2002), the response is largest at the time of maximum ozone depletion when sunlight returns to the polar region in November, and it persists through the summer months. The simulated stratospheric cooling is accompanied by a decrease in geopotential height over the pole that also peaks during November (Fig. 1, top left) (geopotential height is the height of a level of fixed pressure, thus a decrease in polar geopotential height is equivalent to a decrease in pressure at fixed levels over the pole, resulting in a strengthening of the circumpolar westerly winds). During the spring and summer months, both the vertical structure and amplitude of the simulated stratospheric geopotential height and temperature trends bear marked similarity to the observations (Fig. 1, right panels).

The simulation of a large response in the polar stratosphere to ozone depletion is not surprising: such a response is expected based on both observations and modelling evidence. What is more surprising is the downward extension of the significant decreases in geopotential height to the surface in the summer months, despite the fact that the ozone changes are only applied in the stratosphere. The seasonality, vertical structure and amplitude of the simulated geopotential height changes in the troposphere (Fig. 1, top left) are similar to the observations (Fig. 1, top right). Like the observations, the largest and most significant simulated decreases in geopotential height in the troposphere occur ~1–2 months after the maximum cooling in the stratosphere. Note that the tropospheric warming observed during the other seasons is not evident in the simulated response to stratospheric ozone depletion, and is consistent with greenhouse gas increases.

During the summer months of December–February (when the simulated tropospheric response is largest), the horizontal structure of the simulated tropospheric geopotential height trends (Fig. 2, top left) closely resembles the horizontal structure of the observed trends shown in Thompson

Figure 1
Simulated (left column) and observed (right column) changes in (upper row) geopotential height (m) and (lower row) temperature (K) poleward of 65 S. Geopotential height decreases over the pole correspond to decreases in pressure on fixed levels. Observed changes are taken from Thompson and Solomon (2002), and simulated changes from Gillett and Thompson (2003).



and Solomon (2002) (Fig. 2, top right): both reveal falling geopotential heights poleward of 60 S and rising geopotential heights in the middle latitudes. The simulated trends during the summer months are accompanied by a significant surface cooling over most of Antarctica and by a strengthening of the surface westerly flow at around 50–60 S (Fig. 2, bottom left), also consistent with the observations (Fig. 2, bottom right). The relatively weak warming over the Antarctic Peninsula and Patagonia is also consistent with the

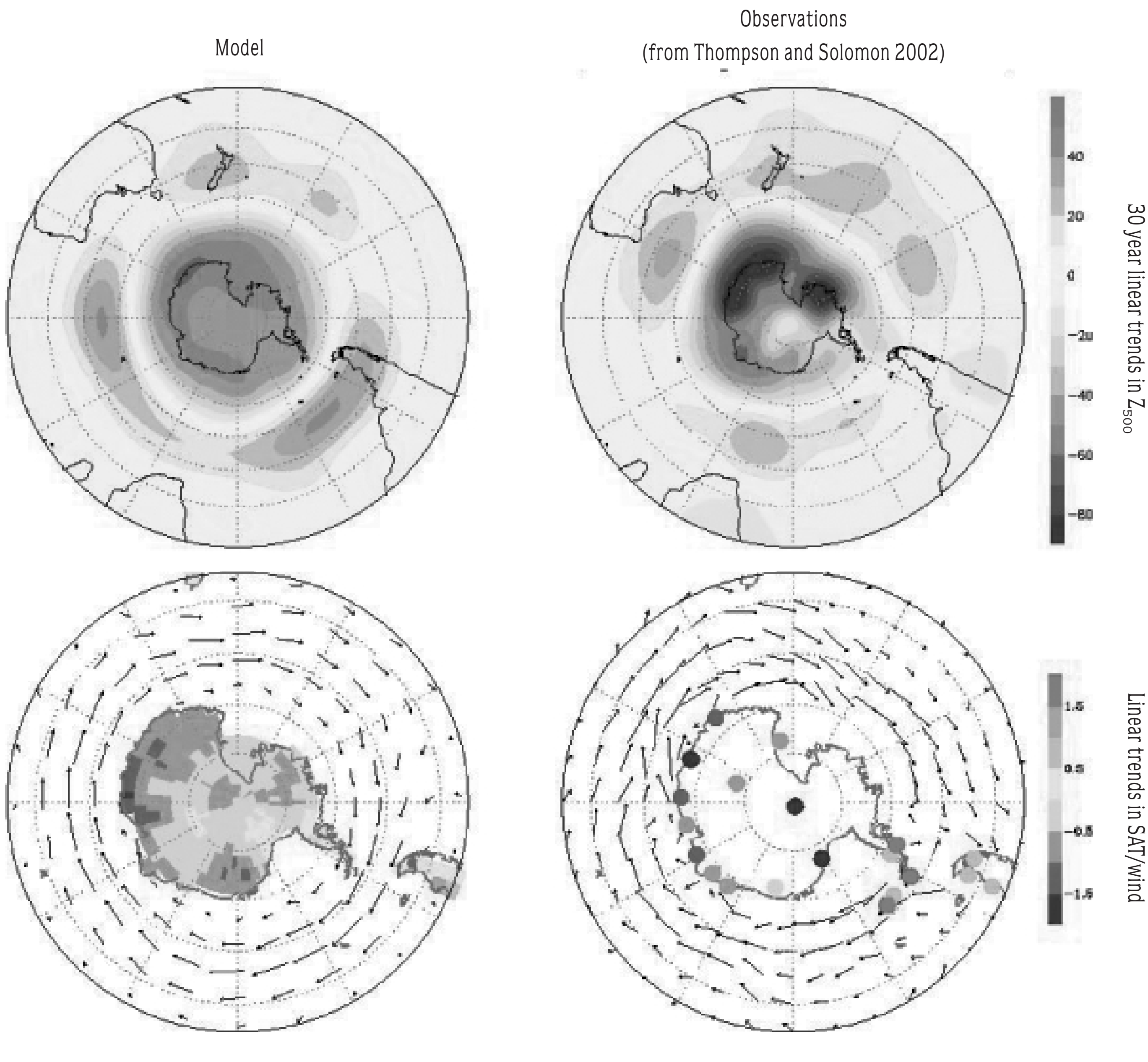


Figure 2
Simulated (left column) and observed (right column) summer changes in (upper row) 500-hPa geopotential height (m) and (lower row) near-surface temperature (K) and winds. Observed changes are taken from Thompson and Solomon (2002), and simulated changes from Gillett and Thompson (2003). The longest wind vector corresponds to ~4 m/s.

observations, and likely reflects the impact of the strengthened westerly winds streaming from the relatively warm waters west of the Drake Passage.

Several factors have been proposed as capable of driving trends in the Southern Hemisphere circumpolar westerly flow. Models incorporating increasing greenhouse gases reveal circulation trends that are of the same sign as the observed trends, but the amplitude of the simulated trends is considerably smaller than that observed. The results reported in this study support the hypothesis that ozone depletion has played a critical role in driving recent climate change not only in the SH stratosphere, but in the SH troposphere as well. These results add to an increasing body of both observational and modelling evidence that suggests stratospheric processes play an important role in driving climate variability at the surface of the Earth on a range of timescales, particularly at high latitudes (Baldwin *et al.*, 2003). The simulations suggest that stratospheric ozone depletion is unlikely to have had a comparable effect on Arctic climate, owing to the much smaller ozone depletion observed there (results not shown). However, the mechanisms underlying the Antarctic response may still have implications for understanding coupling between the stratosphere and troposphere in the Northern Hemisphere. Taken together with the observations presented in Thompson and Solomon (2002), the findings reported here strongly suggest that human emissions of ozone-depleting gases have demonstrably impacted Antarctic surface climate over the past few decades.

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Some Recent Canadian Contributions to Antarctic and Bipolar Science

(Names of Canadian co-authors are underlined)

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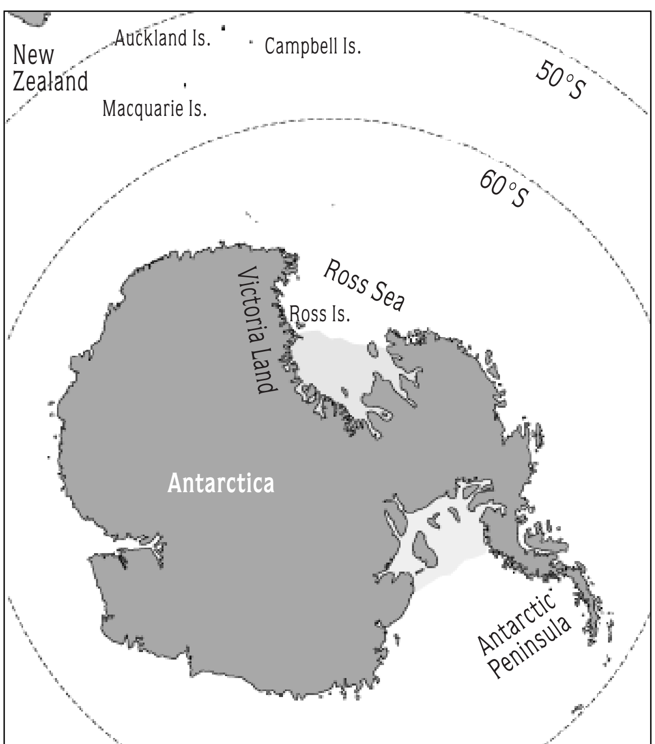
Exploring Visitor Experience in the Ross Sea region, Antarctica

P.T. Maher

One key area of focus in visitor management should be on understanding the visitor. Impacts and problems related to tourism do not occur in a vacuum. The tourist is intimately involved, and it is therefore important to understand tourists' dynamic and constantly changing thought processes throughout the experience.

The research outlined in this paper is the result of the author's doctoral work, which involves understanding visitors and their experience in the Ross Sea region (Figure 1). Focusing the geographic scope of the research on the Ross Sea region served to broaden the scope of tourism/visitor research beyond the peninsula (Bauer, 2001). Experience included a 6–8 month longitudinal period looking at visitors well in advance of their visit, and then through their time on-site, and as a follow-up, back at their homes. Previous studies (Arnould and Price, 1993; Borrie and Roggenbuck, 2001) document well the theoretical background and history of studying this type of multi-phasic or "extraordinary" experience. Visitors were defined as those who come into direct contact with the "ice", but are not science or logistics personnel. This group included commercial tourists, journalists, artists and writers, invited government visitors, and those associated with educational programmes. It was felt that the term *visitor*, rather than tourist, provided a better explanation of this group, which consists of people wishing to further their understanding of the region, the science that takes place there, or both.

Figure 1
The Ross Sea region



A three-part methodology was used to examine a cycle of experience. Groups of visitors were compared through this cycle, and analysis for resulting change or transition was undertaken. Visitors with four organisations participated, to varying degrees, in a number of data gathering activities during the 2002/2003 and/or 2003/2004 seasons. Methods included: self-administered surveys sent to the respondent's home (up to 3 months in advance of the trip); personal narratives and journals while on the trip (regardless of trip length: 4–28 days); in-depth interviews held in Christchurch directly before and after the trip when possible; and email-surveys (2–3 months following the visit). In 2003/2004, supplemental data was collected in the field. Activities included familiarisation, participant observation, and informal interviews at Scott Base.

Most data for the project has now been collected, and results from the 2002/2003 season have undergone preliminary analysis. The following statements should thus be recognised as exploratory rather than conclusive.

- Visitors are younger and more "professional" in occupation category than previously recognised.

- Visitors are well educated, but have not necessarily travelled extensively to other remote regions. A minority of the visitors have previously been to the peninsula or flown over the continent.
- Visitors are less attached to environmental or conservation groups than revealed in previous tourism research, but are extremely well-read and aware of issues.
- Visitors begin with quite pro-environment worldviews; but comparison of scores on quantitative scales indicates little change from the anticipation stage to the recollection stage, despite a plethora of qualitative responses that might suggest otherwise.
- Post-trip, environmental awareness and knowledge have increased, but visitors appear to have very little intention of putting this into action, either in the context of Antarctica or another context, despite the fact that most participants now label themselves "ambassadors" for the continent.
- Throughout the phases, visitors appear to have a complex understanding of their impacts, the impacts of other users or forces, and the geopolitics involved in such visitation.
- Visitors place much more emphasis on scenery and challenge as motivations than indicated in published research.
- Although well aware of exploration heritage from the "heroic era" in the region, visitors do not generally place aspects of human presence (past or present) in their image of the continent. Rather they seem to purposefully exclude the scientific bases of today, although they are extremely disappointed if they do not reach such sites.
- An interesting dilemma exists in that visitors arriving by ship had a strong desire to visit Ross Island huts and stations, although ice conditions occasionally hampered these excursions; those arriving by plane, however, could see huts and stations, but craved the superior wildlife viewing ability of the ship-based groups. There was some lack of previous awareness that this might occur.
- Regarding such critical issues for the region as the replication or restoration of huts, or using the South Pole overland route, visitors have well informed and well thought out opinions, both positive and negative.

At present, supplemental data from the 2003/2004 season have just been added, and final analysis should take place in May 2004. From initial data it seems clear that the overall experience is dynamic, and so too are individual phases and their transitions. Although many facets of the experience have been examined in this research, only a few points have been presented in this paper. Understanding the visitor may yield implications for policy, regulation, and management for the region, and also provides broader perspective on visitors continent-wide.

Acknowledgements

The success of this project has depended on the insight of visitors during both field seasons, and the support of the organisations that brought these visitors to the region. As well, the following provided financial and/or in-kind support: the Commonwealth Scholarship Programme, New Zealand Post, Antarctica New Zealand, McEwing's Mountain Sports, and Macpac Wilderness Equipment.

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The International Partnerships for Ice Core Science (IPICS): a Manifesto for Future Ice Coring

Workshop, Algonkian Park, Virginia March 15–16, 2004

This was a very significant two day meeting, as most individuals who have used an ice coring drill or analyzed ice cores from the Arctic Islands, Greenland and Antarctica in the last 30 years were present. Representatives from 11 countries took part in the US-hosted meeting. The National Science Foundation (NSF) funded participation.

During the past few decades, ice cores have contributed the lion's share of paleo-climate information linking changes in temperature, accumulation and air chemistry to changed forcing processes such as changes in greenhouse gases and other anthropogenic impacts, volcanic activity, and in solar insolation.

There is clearly a feeling in the community that it is time to take stock, because the major and obvious reconnaissance holes have now been drilled. The preliminary first order picture has been captured and now is the time to ask where to drill in the future, for which variables, and for what periods of time. A new phase of ice coring is beginning. The sense was that future drilling should be even more international than it has been in the past, at all levels, from planning and science to funding, logistics and hardware. In this way we get the most from our resources.

The following general goals were agreed on and many of them became central to a ten-year drilling proposal submitted to the International Polar Year.

1. Find the Oldest Ice

Use radar sounding and improved accumulation maps to find and sample the oldest ice in Antarctica (~1.5 Ma). At present the oldest core (from Dome C) is about 800 ka old and includes about 8 glacial cycles. The objective is to sample the oldest ice on earth and trace the changes in the CO_2 history, in particular the change in glacial period amplitudes.

In Greenland the NGRIP core did not capture an Eemian record, and the question remains whether there were sudden climate changes during the Eemian interglacial. The issue of sudden changes in an interglacial has clear relevance for modern society, and it is thus of great interest to obtain an Eemian record. The Danes have found a site believed to hold an Eemian period and they plan to drill there with an international team.

2. Focus on Arrays of Cores

In the Polar Regions, obtain dateable core records from the Arctic Islands of Canada, Svalbard, and Russia to provide paleo-climate histories with sufficient geographical coverage to meld into the other paleo-climate nets, *e.g.*, tree rings and lake sediments. The ice core records do not suffer from the "growth-segment-length curse" that affects records based on live-organisms. Ice cores record all the frequencies, not just the higher ones.

New analysis methods, and even new variables for natural and anthropogenic substances, mean that some old sites might have to be re-visited and cored. Having regional maps of variations in pollutants through time allow one to identify the sources of the pollution and the results of efforts to reduce it (*e.g.*, lead and acids in the Arctic).

Antarctic arrays of cores covering a much larger portion of the interior were suggested. The International Trans-Antarctic Scientific Expedition (ITASE), which for several years has collected ~100 m cores that are analyzed for isotopes and chemical composition, must continue for many years yet, in order to give the required level of basic coverage.

A coastal array of bedrock cores is suggested for Antarctica to illuminate the glacial and de-glacial history of the outer parts of Antarctica. The interior cores all tend to look alike because they come from the massive isolated accumulation zone of the continent. The variable parts of Antarctica are the outer coastal regions and it is here that one must look for changes in mass balance and volume. Similarly some of the islands around Antarctica are ice-cap covered and these offer very good sites for obtaining a more responsive climate history. The James Ross Island ice cap is particularly attractive, as it is close to the Larsen Ice Shelf which recently broke up.

3. History of non-polar ice masses.

This is a pressing matter because climate warming in many areas is threatening to melt these ice stratigraphic "archives". Since the thinking today is that the polar climates are to a great extent driven by events in the tropics, these non-polar ice core records could contain histories of the low latitude drivers of change. The very high elevation sites like Mt. Logan (5400 m above sea-level) in the mid latitudes can also "see" what is going on in the tropics. Other old high elevation sites in Europe are particularly useful as records of human interference in climate and air chemistry.

Three Canadians participated in the workshop: myself, Erik Blake, and Mike Gerasimoff. Mike, formerly with the Geological Survey of Canada, now works in the US programme with Bruce Kocci's deep drill engineering group. Erik Blake makes a popular copy of the GSC ice coring drill (under an old licensing agreement), which itself is a copy of the original Danish tipping tower drill. I spoke for Canada's rather small ice core community. I mentioned our plans to partner with Canadian universities (chiefly Martin Sharp and Shawn Marshall) to drill a core on the Prince of Wales ice cap, under what would now become part of the Arctic Array of ice cores.

European and US funding agencies participated in the workshop (four from NSF [including Karl Erb] and two from ESF) so they clearly considered the workshop as very significant. There are important challenges ahead for those who are interested in ice core drilling and analyses.

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Hunting Dinosaurs in Antarctica

Philip John Currie

Alberta has long been known for its rich dinosaurian resources, and since the establishment of the Royal Tyrrell Museum of Palæontology in Drumheller, institutions from around the world often call on Canadian expertise in dinosaur collection and research. For example, as part of the Canada-China Dinosaur Project, we worked in both Canada and China from 1986–1991. Two of the many joint expeditions were on the Arctic islands, where we recovered the remains of 75 million year old dinosaurs similar to those of Alberta and parts of China.

Last year, I was asked to join an Antarctic expedition to collect the rest of the only known skeleton of an unusual crested meat-eating dinosaur known as *Cryolophosaurus ellioti.* The skeleton, which had been found in 1990, was high on the flanks of Mount Kirkpatrick, less than 600 kilometers from the South Pole. Kevin Kruger, who worked for several years in the labs of the Tyrrell Museum, also became part of the six-man team under Dr. William Hammer (Director of the Fryxell Museum of Geology, Rock Island, Illinois). The project is funded by the National Science Foundation, Washington, DC.

In late November (2003) we flew to a camp near the infamous Beardmore Glacier, high in the Transantarctic Mountains. Another five field parties of geologists and palæontologists were based there, although their projects had nothing to do with dinosaurs. I was surprised, but should not have been, by how much of the clothing and camp equipment was made in Canada. The top of Mount Kirkpatrick was visible from our tents on the glacier, although it was necessary to take a helicopter almost 40 kilometres to get to the dinosaur quarry. High winds and cloud-enshrouded mountaintops often made this trip impossible. On the days when we were on the mountain, we enjoyed one of the most spectacular views imaginable.

Although the sun never sets in November and December, the temperature was always well below freezing, far too cold to mix plaster with water to protect the specimen. Fortunately, the dinosaur is in extremely hard rock. Dynamite was used to remove the overburden. Then gas-operated jackhammers and rock saws were used to cut the rock-encased bones into blocks. These were taken down to camp by helicopter, and by Hercules aircraft to McMurdo Station. At the time of writing they were on a ship enroute to North America for preparation.

While collecting the *Cryolophosaurus,* the partial skeleton of a plant-eating dinosaur was found a short distance away. We removed this specimen as well, but will not know exactly what it is until it is prepared. Dinosaurs from 200 million years ago are relatively rare, particularly in that part of the world, and almost always produce previously unknown species.

For more details on this expedition and other Tyrrell activities, visit tyrrellmuseum.com.

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News in Brief

For seven weeks (December 2003 – February 2004) the Canadian flag flew beside the Bulgarian tricolour in Antarctica. **Dr. Marianne Douglas (Canada) and Dr. Christo Pimpirev (Bulgaria)** were part of the **Canadian Arctic Antarctic Exchange Program** sponsored by Canada's Polar Continental Shelf Project. This exchange program was developed a number of years ago to promote Canadian research in the Antarctic. Canadian researchers host an Antarctic researcher in the Arctic and in exchange, are hosted by a colleague at an Antarctic base. Dr. Pimpirev, executive director of the Bulgarian Antarctic Institute and Professor in the Faculty of Geology and Geography, Sofia University, spent a warm field season at Lake Hazen, Ellesmere Island during the northern summer of 2003 examining the sedimentology of the Hazen basin. Dr. Marianne Douglas, Associate Professor, Department of Geology, University of Toronto, **spent seven weeks at the Bulgarian Antarctic Base** on Livingston Island, South Shetland Islands (NW of Antarctic Peninsula) conducting limnological surveys and paleolimnological studies in order to characterize the degree of recent environmental change.■

"Microbial Ecosystems of Antarctica", the 1988 seminal book by Laval University **Prof. Warwick Vincent,** has been reprinted and released (March 2004) as a paperback by Cambridge University Press.■

"Under the Ice", a children's book by Kathy Conlan has been very well received and has been nominated for several awards. The book will go into second printing and is also available in French.■

Drs. Siciliano and Si, of the University of Saskatchewan's Department of Soil Science, have been awarded a **three year, NSERC Special Research Opportunity grant,** to collaborate with Drs. Riddle and Snape of the Australian Antarctic Division. The $74,000 awarded by NSERC will enable a Toxicology graduate student to develop soil toxicity tests suitable for Antarctic soils. The research team hypothesizes that the liquid water regime of these cold-region soils and how it responds to petroleum contamination will be the critical factor **determining the overall impact of a petroleum hydrocarbon spill in cold regions.** Over the three year period Canadian scientists will work with Australian scientists at Casey Station in Antarctica as well as spend time in Australia with other toxicologists investigating ecotoxicity in Antarctica. At the conclusion of this project, new soil toxicity tests suitable for oil remediation projects in Antarctica will have been developed.■

A workshop on the project entitled **"Enhanced ultraviolet-B radiation in natural ecosystems as an added perturbation due to ozone depletion"** was held in Buenos Aires from March 31 to April 2, 2004. Forty-two participants from eight countries of both North and South America discussed the project's results. The purpose of the project, which was funded by the Inter-American Institute for Global Change, was to study the impact of UV radiation on various ecosystems from polar to southern latitudes. Participation by Canadian researchers **Serge Demers, Michel Gosselin, Émilien Pelletier and Suzanne Roy of the Institut des sciences de la mer de Rimouski (ISMER), Université du Québec à Rimouski (QUAR),** was made possible by a NSERC grant provided under the Special Research Opportunity program. During the workshop, the research team mandated to study the impact of UV radiation on the marine ecosystem, led by Serge Demers, Director of ISMER, announced the findings of their work undertaken in part in Antarctica. Furthermore, the group expressed a wish to follow up on this research program. An application for funding entitled **"Impact of simultaneous temperature increase and solar UVB radiation on biologically mediated atmosphere-ocean CO_2 fluxes in the Argentine Continental Shelf and the Antarctic Ocean"** and including researchers from the Institut des sciences de la mer de Rimouski has already been submitted to the Antorchas Foundation. If the requested funds are provided, the field work should start during the summer of 2005. The workshop proceedings should be published in 2005 in a special issue of a scientific journal that has not yet been determined.■

Prof. Robert Gilbert, Queen's University, was part of the team led by Prof. Eugene Domack, Hamilton College, NY, that recently discovered a submarine volcano in the Antarctic Strait, off the Antarctic Peninsula (see NSF press release, May 20, 2004, at nsf.gov). In May 2004, the team onboard the US research vessel "Laurence M. Gold" sailed on another cruise to study the seafloor that recently became accessible by surface vessel after the break-up of the Larsen B ice-shelf. However, heavy ice conditions prevented them from reaching their intended field site. Instead they investigated a volcano-like sea bed feature they had seen earlier. Prof. Gilbert has been working in the Peninsula area as part of an international team for several years.■

Dr. Christian Otto, an emergency physician from Kingston, Ontario, has recently been appointed by the US Antarctic Program to serve as the South Pole physician for the 2004/05 summer and winter season. This will be **Dr. Otto's second tour with the US Antarctic Program** having already served a one year tour as the physician at McMurdo Station during the 2002/03 seasons. Dr. Otto is an associate member of SCAR's Expert Working Group on Human Biology and Medicine and a visiting professor at the University of Texas where he is completing his Master's of Science degree. **His research deals with remote medicine and the use of telemedicine.** Dr. Otto completed his undergraduate and medical degree at the University of Ottawa.■

Dr. Thomas James, Geological Survey of Canada, Natural Resources Canada, in Sidney, BC, is the lead editor, with T.H. Jacka (Australia), A. Morelli (Italy) and R. Dietrich (Germany), of **"Ice Sheets and Neotectonics", a Special Issue of the journal *Global and Planetary Change.*** Dr. James is also a co-author of one of the 21 peer reviewed papers in the issue, which they hope will be printed and ready for distribution at the **SCAR meetings in Bremen in July 2004.** Two of the papers deal with northern hemisphere phenomena, while the rest focus on Antarctica. The issue is a significant contribution to our understanding of the mass balance of the Antarctic ice sheet and to our understanding of the interactions between ice sheets and the solid Earth.■

CCAR/CCRA Members and Advisers

CARN Newsletter

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