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Students on Ice: Antarctic Activities

Geoffrey D. Green

Students on Ice (SOI) is an award-winning organization offering unique educational expeditions to the Antarctic and the Arctic. Its mandate is to provide students, educators and scientists from around the world with inspiring educational opportunities at the ends of the Earth and, in doing so, help them foster a new understanding and respect for the planet. Since the year 2000, Students on Ice has taken over 1200 students from more than 40 countries to both the polar regions.

SOI was proud to have its SOI–IPY Youth Expeditions 2007–2009 fully endorsed by the International Polar Year (IPY) Joint Committee as a prominent and valued part of the current IPY. SOI's expeditions and related educational activities represented one of the largest IPY outreach, training and communications events in the world (Fig. 1).

Now entering its tenth year, SOI has grown in scale, scope and depth. Since conducting the first youth-specific expedition to Antarctica in the world, the organization now leads 2–4 youth expeditions every year for both high-school and university students. Just one of the unique features of the program is how the expeditions reach thousands via an exciting and educational expedition website, allowing people from around the world to track the students on the expeditions and share their personal growth and experiences.

The Students on Ice program has consistently received awards and endorsements, such as the following:

- *Michael Smith Award for Science Promotion (2004):* This prestigious award honours outstanding contributions to the promotion of science through activities encouraging popular interest or developing science abilities.
- *Certificate of Special Congressional Recognition (2004):* In acknowledgment of outstanding and invaluable service to youth and education.

Figure 1
Students on Ice Antarctic University Expedition, February 2009.

- *Canada's "Top 40 Under 40" (2004):* An annual national prize event saluting Canada's top young leaders; awarded to Geoff Green.
- *The Explorers Club Citation of Merit (2007):* The Students on Ice Foundation received this prestigious award for its outstanding work in the field of exploration and conservation.

The following is a list of highlights as they relate to recent activities in the Antarctic:

1. Since 2000, SOI has led over 600 students from 40 countries on nine Antarctic expeditions. 2010 is the tenth anniversary year for SOI, and the tenth annual Antarctica expedition will be taking place.
2. A carbon neutral continent: Students on Ice Expeditions (SOI) and the SOI Alumni Association are initiating a campaign to advocate for a carbon neutral Antarctica. By engaging with and lobbying relevant stakeholders, we hope that Antarctica will become the world's first carbon neutral continent by the end of 2015.
3. In June 2009, SOI and SOI alumni met with the International Association of Antarctica Tour Operators (IAATO) members at their annual meeting in Providence, Rhode Island, to discuss future plans for a carbon neutral Antarctica. SOI's delegation delivered a convincing presentation to the membership and meeting observers (which included governmental and NGO representatives involved with Antarctic Treaty Consultative Meetings). The presentation was well-received by the membership and supported through statements from various operators around the table. We're pleased to report that IAATO members unanimously approved our motion to recognize modern climate change as a significant threat to the Antarctic environment. This acknowledgement is a significant step for the 100+ member-driven, private-sector organizations. In line with IAATO's objectives to advocate, promote and practice safe and environmentally responsible private-sector travel to the Antarctic, IAATO members supported our motion to establish a working group to explore ways to mitigate our contributions to climate change. SOI will lead this working group in presenting specific proposals to IAATO members in support of a carbon neutral Antarctica, specifically, building on the recommendations developed by alumni this spring in the discussion paper made available to IAATO members in advance of the meetings.
4. In 2009, SOI produced "*Imiqutailaq – Path of the Arctic Tern*", a one-hour documentary about a true life-altering journey from Nunavut to Antarctica, by two Inuit teens (Terry Noah and Jason Qaapiq) from Grise Fiord, Canada's northernmost Arctic community. The journey was the dream of the late Dr Fritz Koerner (1932–2008), whom the people of Grise Fiord named *Imiqutailaq* (Arctic Tern),

after the little seabird that flies from the Arctic to the Antarctic and back each year. The film is a tribute to this legendary glaciologist (two-time recipient of the U.K. Polar Medal), to his 50 years working at the Poles, to the mentoring role he played with SOI participants, and to his desire that Inuit youth and others better understand the impacts of climate change and are inspired to protect the Poles and the Planet. Produced by Geoff Green who co-directed it with Michel Valiquette, its world premiere was in Ottawa on 30 September 2009 during an IPY Film Festival. Another tribute to Fritz "*The Fritz Koerner Legacy – Students on Ice Antarctic University Expedition 2009*", that captures the spirit and essence of the polar classroom, can be seen on YouTube (www.youtube.com/watch?v=bHM-NFe8XR8).

5. Students on Ice has offered to assist with the clean-up and removal of an old hut at Neko Harbour, on the Antarctic Peninsula, which was blown to the ground in February 2009. This clean-up would take place on the SOI Antarctica Expedition 2009/10.

For more information see www.studentsonice.com and www.uantarctic.org.

Geoff Green (geoff@studentsonice.com) is the founder and Director of the Canada-based Students on Ice organization. He is a Fellow of the Explorer's Club and the Royal Canadian Geographical Society.

Professors' account of Students on Ice IPY Antarctic University Expedition

Marianne Douglas, Luke Copland and Patrick Maher

In February 2009, three Canadian universities joined forces with the polar educational outreach group Students on Ice (SOI) for the first ever Canadian university expedition to Antarctica. The universities of Alberta, Ottawa and Northern British Columbia offered three field courses aboard the ship MV *Ushuaia.* University students from across Canada, as well as from international schools, were able to enrol in these accredited courses as part of their own undergraduate degrees and, in a few instances, graduate students also participated.

The MV *Ushuaia* served as a floating classroom, and home, that sailed around the Antarctic Peninsula, allowing students to explore and experience first-hand the diverse habitats and landscapes of the Antarctic. The three courses offered on this expedition included a cold regions geosciences course (UAlberta 4th year undergraduate, taught by Prof. Marianne Douglas [UAlberta] and Dr Eric Galbraith [postdoctoral fellow at Princeton University, now on faculty at McGill University]), glaciology (UOttawa 4th year undergraduate, taught by Prof. Luke Copland [UOttawa] and Dr David Burgess [Geological Survey of Canada]) and Antarctic tourism (UNBC 4th year undergraduate, taught by Prof. Patrick Maher [UNBC] and Dr Hans Gelter [Luleå University of Technology, Sweden]). Apart from these instructors, numerous other educators accompanied the expedition.

EAS429: *Practical Study in Earth and Atmospheric Sciences: Antarctica,* was the field course offered through the Department of Earth and Atmospheric Sciences at the University of Alberta. Seventeen students, including one University of Calgary student, were enrolled. Field-based exercises involving observations and basic measurements of Antarctica's ocean, terrestrial and glacial environments were designed to allow students to gain a better understanding of the unique

geology and biological characteristics of the Antarctic. Throughout the expedition, students took temperature-depth-salinity profiles of the waters in order to observe and understand the ocean currents. Analysis of the phytoplankton and nutrients at each of these stations enabled them to compare primary production along a latitudinal gradient. The influence of large nesting colonies of penguins and other bird species on inland waters was observed, while elsewhere students observed the evidence of past volcanic activity on the Peninsula and surrounding islands. There was also an opportunity to visit the Ukrainian scientific research base Vernadsky. Formerly the British Faraday station, this site had recorded over 50 years of temperature and stratospheric ozone measurements. These long-term data provided convincing evidence of warming trends and the ozone hole. Students also benefited from interactions with the other two courses on board, including measurements of glacial environments and consideration of the effects of tourism in the Antarctic. Most students had also taken a full semester 4th year undergraduate lecture course on Antarctica during the preceding term and therefore had good prior knowledge of the Antarctic and its important geological and historical background.

The University of Ottawa class, GEG4100 *(Glaciology),* involved ten students from the University of Ottawa and six others from across Canada – the University of Northern British Columbia, McGill and Université Laval. The class combined daily field trips with a review and discussion of recent studies describing the cryosphere and its changes along the Antarctic Peninsula. Large tabular icebergs from the calving of nearby ice shelves were spotted on the east side of the Peninsula, glaciers were visited that enabled the digging of snow pits and completion of shallow ice cores, and ice deposits, that had been buried by large volcanic eruptions in the 1960s, were investigated on Deception Island. In addition, a new glacier-monitoring site was established by the students on a small pillow ice cap in the Wauwerman Islands; surface elevations were measured with a differential GPS system, an ablation stake was installed to measure future accumulation/ablation rates, and a shallow ice core was taken. This site will continue to be monitored by SOI trips in future years. Overall, the course provided an excellent opportunity for students to get an up-close and personal experience of glaciology. The ability to combine theoretical concepts in lectures with field visits deepened students' knowledge of the subject.

Antarctic Tourism: Examining Impacts and Management in Practice (ORTM433) was the University of Northern British Columbia (UNBC) course taught on the expedition. This course sought to examine the impacts (positive and negative) of Antarctic tourism. Students also learned about the complexities of managing Antarctic tourism today, as well as scenarios for the future. As part of UNBC's Outdoor Recreation and Tourism Management Program, the course included three UNBC students, one student from each of Thompson Rivers, Vancouver Island, Aberdeen (Scotland) and Victoria universities. Prior to the departure of the ship, students had written research papers and prepared introductory presentations on a variety of inter-related topics. From this starting point, staff and students were able to engage in a number of stimulating discussions based upon the theoretical knowledge gained beforehand and the practical knowledge gained during daily landings. Particular stops of interest for this course were Deception Island, Port Lockroy and Vernadsky Station. In addition to discussions, students also participated in a small pilot study of monitoring visitor impacts and experiences, using GPS, heart rate, and camera technology provided by Hans Gelter. Overall, the course was an excellent means to actually show students some of the impacts they had read about, and engage them in meaningful discussions about potentially practical solutions for management now and into the future.

Antarctica is the only continent reserved exclusively for scientific exploration and has plenty to offer. Overall, it is very rewarding to teach field courses in Antarctica despite the challenges that such a remote location presents. Most lectures were delivered while the ship moved to the next location. The worst conditions were encountered crossing Drake Passage, a 1000 km wide stretch that is home to fierce winds and waves that cause the ship to pitch and roll. During

"Drake Shake" conditions it is nearly impossible to maintain an upright position, and one might even be thrown out of bed. The challenge for the students was to sit, listen and learn, while fighting off seasickness; the lecturers tried to stay upright as they pitched back and forth in the lecture hall, also fighting off nausea. The key was not to eat before lectures and always keep those little white motion-sickness bags on hand. Lectures were interspersed with many outings on deck for fresh air and to view wildlife while the ship sailed to the next location. It is necessary to design a flexible course, as unpredictable weather and ice conditions may prevent landings at specific sites. Luckily there were alternatives available, so if one site was inaccessible another location could be visited. The importance of experiential learning cannot be undervalued. Not only does this first-hand experience enhance any lecture material, but it also helps put a global perspective on issues such as global warming, rising sea levels and general Earth dynamics. All three university professors involved in these courses also teach field courses elsewhere in Canada's Arctic and alpine regions, but they will never forget the expressions of awe and delight on students' faces during their time in the Antarctic. As professors, we benefited tremendously from the excellent organizational support provided by the SOI team. Executive director and expedition leader Geoff Green is truly inspirational. His team consisted of highly qualified educators and film makers who had prior Antarctic experience and who also doubled as Zodiac drivers. And finally, we were all privileged to work with the highly motivated students who had worked so hard to get themselves on board.

It was especially fitting that we were able to organize this inaugural university expedition during the International Polar Year (IPY 2007–2008). Students benefited tremendously from their experiences and new knowledge gained in this field course. *University Affairs* magazine (July 2009) published a comprehensive article on the expedition which included some insights from both students and professors (www.universityaffairs.ca/scholar-ship.aspx). In addition, the expedition was highlighted by other media including CBC's The National (www.cbc.ca/mrl3/23745/thenational/archive/roumeliotisarctic-022709.wmv) and Discovery Channel's Daily Planet (http://watch.discoverychannel.ca/daily-planet/february-2009/daily-planet-february-26-2009/#clip144133).

Based upon the remarkable success of this first expedition, the next is already being planned. The same universities will be taking part in a second Students on Ice Antarctic University Expedition in 13–28 February 2011 and anticipate we will be joined by other universities. Additional information can be found at www.uantarctic.org.

Marianne Douglas is a Professor in the Department of Earth and Atmospheric Sciences and Director of the Canadian Circumpolar Institute at the University of Alberta, as well as Chair of the Canadian Committee on Antarctic Research (marianne.douglas@ualberta.ca). Luke Copland is an Associate Professor in the Department of Geography at the University of Ottawa (luke.copland@uottawa.ca). Patrick Maher is an Assistant Professor in the Outdoor Recreation and Tourism Management Program at the University of Northern British Columbia (maherp@unbc.ca).

With the Students on Ice Antarctic University Expedition

Cassandra Budd

With a new semester of school underway, it's hard to believe that only seven months ago I was in the Antarctic. From 12 to 28 February 2009, 71 students (including 18 from high schools and four international) and an education staff of 17 joined together to form the first ever Students on Ice (SOI) Antarctic University Expedition. This trip was a once-in-a-lifetime opportunity for all of its student participants, most of whom were enrolled in a university course. Not only did it supply us with our first taste of the isolated seventh continent, but it did so with an approach that allowed us to learn experientially. We were not just tourists on a ship, but instead members of the international scientific community. Although we did take enough pictures to make even the most seasoned tourists proud, photography was far from our only activity in the south. A wealth of first hand field experience was gained – something made possible by the three accredited courses offered on the expedition.

Figure 1
Ice coring at Neko Harbour, 21 February.

EAS429: *Practical Study in Earth and Atmospheric Study* was run by the University of Alberta. Led by Dr Marianne Douglas, Director of the Canadian Circumpolar Institute. This course included everything from examining algae and zooplankton to water chemistry testing and basic oceanography. The most important aspect of our fieldwork was that we studied the same types of samples/data in several locations along the Antarctic Peninsula. This allowed us to observe similarities, differences and even trends from site to site. For example, we conducted a series of five CTD (conductivity-temperature-depth) casts during the course of the expedition, at sites such as Elephant Island, Paulet Island (Fig. 2) and Deception Island. Even this relatively simple fieldwork garnered enough data to identify trends in Southern Ocean currents.

GEG4100: *Glaciology,* from the University of Ottawa, taught by Dr Luke Copland, was the second course offered. This included collecting and analyzing ice cores, as well as learning about the glaciers of the Antarctic and observing some of the many icebergs they produce. During our 21 February landing at Neko Harbour, all students were given the chance to gain hands-on ice-coring experience (Fig. 1). For those of us just being introduced to glaciology, we learned about many aspects of the science, including annual layers, mass accumulation and snow-crystal shape. Icebergs were

observed daily and during our many Zodiac cruises we were able to get up close and see what the different characteristics could tell us about the history of the iceberg as well as its glacier of origin.

The third course offered was ORTM433: *Antarctic Tourism*, a University of Northern British Columbia class led by Dr Pat Maher. The tourism industry plays a large role in the Antarctic. Far from invisible, it has environmental, economic and even social impacts associated with it. These were some of the topics covered during the course, but perhaps the favourite part for the students was the data collection being done via helmet camera and heart-rate monitor. For each landing a small group of students was selected to don these two pieces of equipment in unison, so that what they saw (and whether or not it piqued their interest enough to affect their heart rate) could be recorded and analyzed long after the landing itself was over.

Being able to experience the Antarctic through courses such as these was an incredibly unique and rewarding opportunity, one that I am extremely grateful to have been a part of. I'm sure the same could be said for all student participants of the expedition. I believe that in many ways it helped us better to understand Antarctica for what it is – a beautiful,

Figure 2
Examining water samples on Paulet Island, 19 February.

diverse and relatively untouched environment that is governed by nature. It is a place dedicated entirely to science and learning, where the current research being done may have striking global consequences. The better we understand the Antarctic, the further we come to understanding our complex world as a whole. This is by itself important, simply for sake of scientific knowledge, but when taking into consideration the current situation of global warming it becomes more important than ever.

Cassandra Budd (cnb@shaw.ca) is a 4th year student in Astrophysics and Geophysics at the University of Alberta who has also been working as an intern with EBA, a consulting engineering company in Edmonton (www.eba.ca/news.asp?a=451).

Lazarev Sea Krill Survey (LAKRIS)

Between 2004 and 2008, Drs Brian P.V. Hunt (bhunt@eos.ubc.ca) and Evgeny A. Pakhomov (epakhomov@eos.ubc.ca), of the University of British Columbia, participated in the Lazarev Sea Krill Survey (LAKRIS), a component of the German Southern Ocean GLOBEC program. Although LAKRIS focused on krill, macrozooplankton samples were collected during each of the four surveys. As far as is known, these are the first detailed seasonal data for macrozooplankton collected in this region of the Southern Ocean. A report has been prepared on the abundance, distribution and reproductive biology of the salps, *Salpa thompsoni* and *Ihlea racovitzai,* and implications for the long-term establishment of *S. thompsoni* in the high Antarctic. During 2007–08 a total of 88 Continuous Plankton Recorder tows were conducted over 23 transects in the Southern Ocean by eight vessels from seven nations. There is no large-scale longitudinal separation of regions, and latitudinal biogeographic zones in general show circum-Antarctic consistency. A manuscript on these results is in preparation, and the detailed analytical outputs are to be used to inform bioregionalization networks for the Southern Ocean.

Antarctic Research at ISMER

Drs Émilien Pelletier (emilien_pelletier@uqar.qc.ca) and Serge Demers (serge_demers@uqar.qc.ca), from ISMER of the Université du Québec à Rimouski, in a joint project with colleagues from the Instituto Antártico Argentino (Drs Walter P. Mac Cormack and Antonio Curtosi), are assessing anthropogenic activities and environmental effects at Argentine stations, and the role of the permafrost layer as a frontier to the mobility of pollutants in Antarctic soils. Other colleagues, Drs Irene R. Schloss (irene_schloss@uqar.qc.ca) and Gustavo A. Ferreyra (gustavo_ferreyra@uqar.qc.ca), are studying the impact of glacier melting on phyto-, microzoo- and zooplankton in coastal waters off the Antarctic Peninsula.

Update: Sander Geophysics Explores the Antarctic

Stefan Elieff

Sander Geophysics (SGL) successfully completed its participation in the data-acquisition phase of Antarctica's Gamburtsev Province Project (AGAP) which was part of the International Polar Year. During December and January, over 50,000 line kilometres of high-resolution airborne gravity data were collected by the AIRGrav system mounted on board a US Antarctic Program Twin Otter aircraft.

Installation and testing of the AGAP instruments, including the AIRGrav system, took place at Williams Field near McMurdo station in November and December. SGL data processing manager Dr Martin Bates, senior geophysicist Stefan Elieff, and technician Daniel Geue, worked alongside the international AGAP science team, led by Dr Robin Bell and Dr Michael Studinger, from Lamont-Doherty Earth Observatory of Columbia University, who were installing ice-penetrating radar, laser scanner, and magnetometer systems in the same Twin Otter aircraft. Once the installation was complete and logistics were in place, Dr Martin Bates returned to Canada while Stefan Elieff and Daniel Geue mobilized with the rest of the science team to the remote field camp, AGAP-South. A similar British Antarctic Survey Twin Otter aircraft operated from a second field camp named AGAP-North.

The journey into East Antarctica included a stopover at Amundsen–Scott South Pole station for altitude acclimatization before heading higher up the ice sheet to the field camps. The first survey flight by the AIRGrav system began at Amundsen–Scott station, which meant accurately aligning the gravity system while parked only a few hundred metres from the geographic South Pole. This unique capability was one of several improvements made to the AIRGrav system in preparation for this challenging project.

Despite unpredictable weather, freezing temperatures, thin air, and other difficulties associated with operating from an isolated camp situated 3500 m high on the East Antarctic ice sheet, the AIRGrav system functioned flawlessly and the planned flight program was completed in mid-January. A detailed view of the rugged Gamburtsev Subglacial Mountains, hidden beneath kilometres of ice, emerged, including the detailed gravity map generated by the AIRGrav system. Preliminary results will be published by the AGAP science team in the months ahead.

NSF press release on the 2008–09 AGAP fieldwork: www.nsf.gov/news/news_summ.jsp?cntn_id=114172&org=NSF&from=news

AGAP outreach site: www.ldeo.columbia.edu/res/pi/gambit/

Gallery of images from the field season: www.cbc.ca/photogallery/technology/2031/

Stefan Elieff (selieff@sgl.com) is a senior geophysicist with Sander Geophysics Limited of Ottawa. He is a graduate of St. Francis Xavier University with an M.Sc. in Astronomy from Saint Mary's University.

Editorial Note

Recognition of the significant contribution being made to AGAP by this Canadian company was accorded through the addition of the Canadian flag to the project logo that includes the flags of all the other partner nations.

Initial results were reported at the International Glaciological Society's meeting on Glaciology in the International Polar Year at Northumbria University, Newcastle, UK from 27–31 July 2009. Additional presentations will be made at the Fall AGU meeting in San Francisco (Abstracts C43A-0484, C53B-08 and G52B-03).

The value of the AIRGrav system to AGAP has resulted in an invitation to SGL to participate in NASA's Ice Bridge project (www.espo.nasa.gov/oib). Stefan Elieff and Sean O'Rourke will be helping bridge the gap in observations of land and sea ice anticipated in the time between ICESat-I failing (probably this year) and the launch of ICESat-II in about 2014.

Sedna IV Mission in the Western Antarctic Peninsula: First Results from Winter 2006

Sébastien Moreau, Gustavo A. Ferreyra and Serge Demers

The Western Antarctic Peninsula (WAP) has experienced one of the most rapid warmings over the last 50 years (Turner and others, 2005, 2009). In this region, air (Turner and others, 2005) and sea (Gille, 2002; Meredith and King, 2005) temperatures have risen significantly, resulting in a decrease of sea-ice cover extent and duration (Stammerjohn and others, 2008). On the other hand, the WAP has also been exposed to the "ozone hole"; a strong reduction in the concentration of stratospheric ozone over Antarctica that has occurred every spring for the last 30 years (McKenzie and others, 2007). In spring, ozone concentrations can fall below 50% and even 30% of normal (*i.e.,* 300 Dobson Units, DU). This phenomenon increases the intensity of ultraviolet B radiation (UVBR, 280–320 nm) that reaches WAP surface waters and potentially harms marine organisms (Häder and Sinha, 2005).

In the past (*i.e.,* 1980s), the ozone hole occurred in September, the period of greatest sea-ice extent over the WAP (Stammerjohn and others, 2008), and sea-ice acted as a barrier to light, minimizing the penetration of UVBR within the water column (Lesser and others, 2004). Therefore, the ozone hole did not represent a threat to marine organisms in the WAP in the 1980s.

However, sea-ice extent and duration in the WAP have decreased over the last decades due to global warming (Stammerjohn and others, 2008; Vaughan and others, 2003). Indeed, sea-ice cover in the WAP has decreased by 40% in the last 26 years due to its decreased duration. More importantly, sea-ice has been retreating earlier each spring (Stammerjohn and others, 2008).

The Southern Ocean accounts for 20% of the global ocean CO_2 uptake (Takahashi and others, 2002) and is therefore an important CO_2 sink. Moreover, the coastal WAP waters are among the most productive waters of the Southern Ocean (Ducklow and others, 2006). We hypothesize that, because of earlier sea-ice retreat, the rich WAP marine microbial community is now subjected to harmful UVBR during the ozone-hole period. Consequently, the effectiveness of the coastal WAP as a CO_2 sink may decrease.

Figure 1
Sedna IV wintering at Melchior station.

In this context, the goal of the *Sedna IV* sailboat scientific mission was to study the seasonal dynamics of the microbial community (bacterioplankton, phytoplankton and microzooplankton) in the northern coastal WAP under global warming and with increased UVBR reaching the surface waters. This mission was performed from the austral fall 2005 to spring 2006.

During fall and winter, sea ice covered the water column and no measurable light could be recorded. Under these inhospitable conditions, the abundance and biomass of microbial organisms were particularly low. Sea ice retreated early in spring (*i.e.,* mid-October), letting light penetrate the water column and a shallow upper mixed layer develop. At

this time, the biomass of all organisms started to increase immediately following the retreat of sea ice (Fig. 2). However, despite these favourable growth conditions, the increase in biomass was small compared to the high levels of productivity usually witnessed in the WAP. Instead, a strong bloom developed later in the season (*i.e.,* December) when the ozone hole had recovered.

The retreat of sea ice early in the spring allowed increased UVBR to reach the water column. Based on our results, it seems that the microbial community abundance and biomass are indeed affected by this harmful radiation. Moreover, the abundance and biomass of the microbial community were dominated by small cells (bacterioplankton, pico- and nanophytoplankton). A microbial food-web type of ecosystem dominating the coastal WAP waters in spring. Given that the development of such a type of community leads the ocean to act as a source of CO_2 to the atmosphere, its presence within the WAP waters in spring is a major concern regarding the role of the coastal WAP as a CO_2 sink.

On the other hand, our results are consistent with previous investigations that indicate the WAP acts as a source of CO_2 to the atmosphere in winter and a moderate sink in spring. Hence, the WAP waters are not behaving as the one-way CO_2 sink previously hypothesized for marginal sea-ice zones. Finally, the net community production in spring was mainly partitioned to dissolved organic carbon accumulation and the downward export of particulate organic carbon (POC) rather than POC accretion in the surface mixed layer (Wang and others, in press).

Another objective was to study the correspondence between the retreat of sea ice and the occurrence of the ozone hole during the last 30 years (1978–2008), and whether this is a threat to the coastal WAP microbial community. To do so, long-term data series for ozone thickness and sea-ice cover for the coastal WAP will be studied along with surface water temperature and climatic indices (El Niño–Southern Oscillation and the Southern Annular Mode). We hope to determine if this coincidence has an influence on the accumulation of biomass in this region. Satellite-derived chlorophyll-*a* concentration will be used to determine this influence.

The *Sedna IV* mission was part of a collaborative effort between Canada (Institut des sciences de la mer de Rimouski and the University of Victoria) and Argentina (Instituto Antártico Argentino). The project was funded by the Natural Sciences and Engineering Research Council, by the Ministère du Développement Économique, de l'Innovation et de l'Exportation du Québec and by the Economic Development Agency of Canada (respectively NSERC, MDEIDE and EDAC), and by the Dirección Nacional del Antártico (Argentina).

Figure 2
Sébastien Roy (left, ISMER) and Dr Damián López (Instituto Antártico Argentino) taking samples.

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Aurora over the South Pole

Donald J. McEwen

Is there anywhere on Earth that one can observe the aurora 24 hours a day? Surprisingly, yes there is. Aurora can be seen continuously from central Antarctica during winter: if one avoids frostbite while exposed to the frigid −75°C temperatures there!

The southern lights (Aurora Australis) are the mirror image of the northern lights (Aurora Borealis) and they sit like a halo over Antarctica, rarely seen by humans except by early explorers and crews of whaling ships circling the continent. The International Geophysical Year (1957–58) changed that with the establishment of several research stations in Antarctica. Many of those stations have continued operations until now. One such station is the American Amundsen–Scott research station at the South Pole, which is ideally located for viewing the aurora. The dark winter night begins at the March equinox and continues for six months until September. And with desert-like conditions there (minimal snowfall) the skies are clear most of the time.

The South Magnetic Pole is displaced from the geographic pole by some 16 deg. So, at the geographic pole (74 deg. magnetic latitude) the southern auroral oval is within view at most times through each winter. Characteristically,

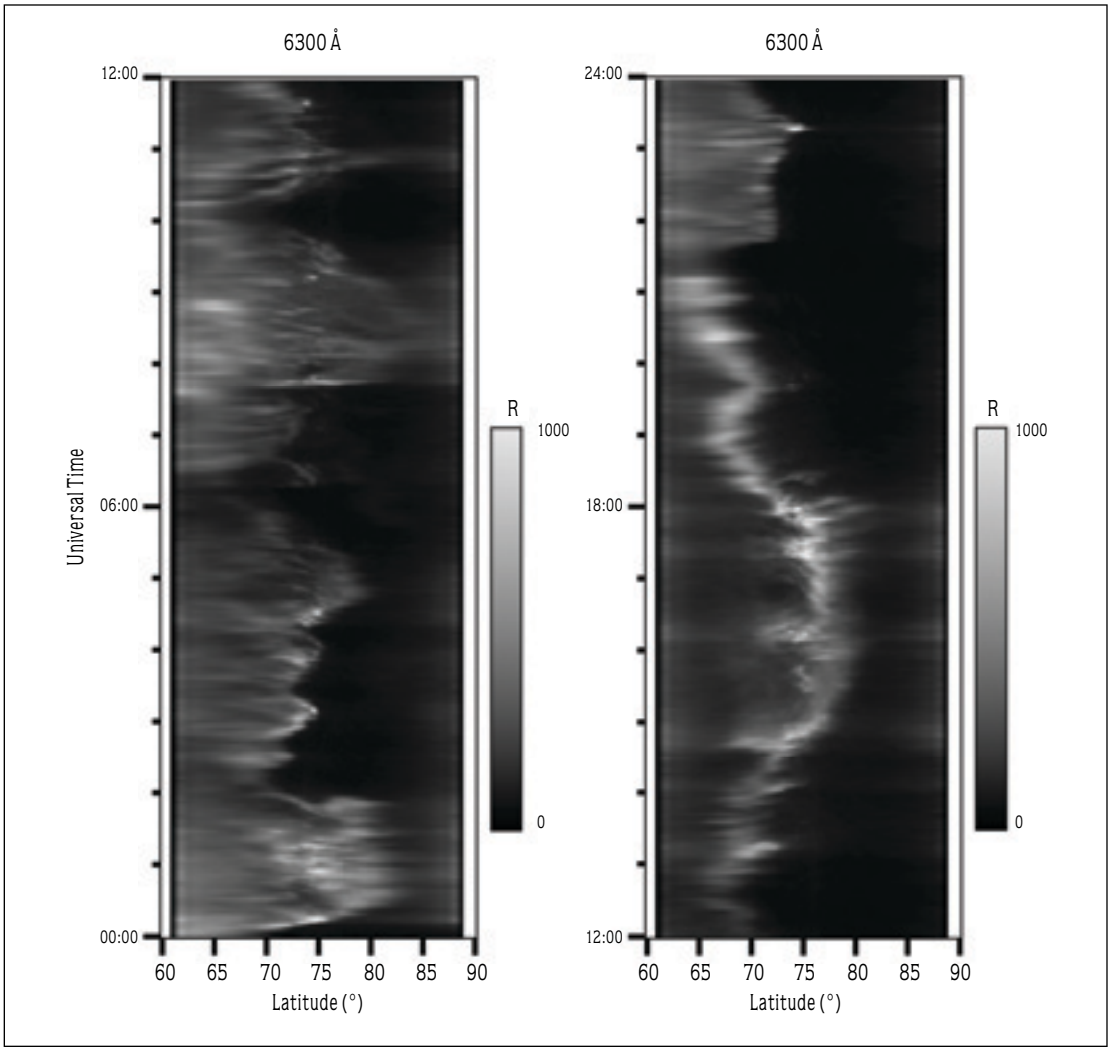

Figure 1
Aurora recorded at the South Pole on 23 May 2007.

the bright green (nightside) auroras are seen equatorward of overhead while the feebler red (dayside) auroras are seen somewhat poleward of the station. Optical instruments at the Pole with an all-sky view, such as cameras or imagers, do record these emissions literally the full 24 hours on many days. A photometer which scans along the magnetic meridian through the zenith can continuously monitor the aurora, while accumulating much less data.

In 2004, I was invited by Professor Abas Sivjee of Embry Riddle Aeronautical University, Daytona Beach, Florida, USA, to join in his aeronomy research program at the South Pole station. The plan was to install a 6-wavelength meridian scanning photometer (MSP) to record the activity of the southern lights. This was an instrument I had used for Arctic auroral studies for several years previously. It had operated outside through Arctic winters, but the harsh winter conditions in the Antarctic were too much for its scanning system and major changes were required. It was necessary to install a spherical dome on the roof of the Aeronomy Laboratory near the South Pole station and re-position the MSP inside, oriented to scan horizon-to-horizon through the zenith. Since the instrument was now inside, the detector required cooling! Lastly, provision for full winter data recording on interchangeable hard drives was needed. These changes were all completed and the MSP began continuous operation at the South Pole through the 2006 winter.

The aurora recorded through a full 24 hours on 23 May 2007 is shown in Fig. 1. It shows the oxygen red-line emission at 630 nm detected by the MSP through the latitude region from 60 deg. to the magnetic pole. The intensity is depicted in grey scale up to 1000 Rayleighs brightness. Several substorms can be seen somewhat equatorward of the station through local midnight (0330 UT). And active aurora shows near zenith (74 degrees magnetic latitude) through mid-day (1530 UT). Of special note is the fact that there is aurora within view for the full 24 hours!

Access to the South Pole station is by air and only during the austral summer from November to February. The embarkation point is Christchurch, New Zealand, and the first leg of the flight is across the Antarctic Ocean to the large US coastal base at McMurdo station. After briefings there and an overnight stay, travel continues on to the South Pole. On my first trip to the pole the station was being rebuilt and with all the extra workers there were over 300 on hand, with many sleeping in tents. About 250 personnel can now be accommodated in the completed new station and during the summers there are usually over 200 there, many of them scientists installing or maintaining equipment. The station is maintained throughout the winter by 50–60 personnel, some of whom are science technicians overseeing the operation of the many research instruments there.

The Embry Riddle aeronomy program there has continued since the 1990s with the support of the US National Science Foundation. The auroral component of this program was expanded in 2006 with the addition of my MSP. This instrument has continued in operation there through each of the past four winters, with several new findings. We have seen some notable differences between the southern and northern lights; there are deviations from the mirror-image concept, in the spectral character and intensity of the two auroras. The study has continued through the recent solar minimum extending from 2007 into 2009 and has given interesting results on quiet auroras. What the new solar cycle will exhibit in future winters remains to be seen! The program is planned to continue until 2012.

I will return to the South Pole in December, my fifth trip there, to check and re-calibrate my auroral scanner. Each trip is a new experience with some surprises. Most of the personnel there each year are newcomers on one year postings, but some like me seem to keep coming back!

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News in Brief

Dr Kathy Conlan, Canadian Museum of Nature (kconlan@mus-nature.ca), Ottawa, is the new Chief Officer of SCAR's Standing Scientific Group on the Life Sciences.■

Dr Steven D. Siciliano (steven.siciliano@usask.ca) and colleagues, of the Department of Soil Science at the University of Saskatchewan (UofS), have developed an instrument that provides real-time information on greenhouse gases. It has been used to assess the geospatial dependency of the gases and microbial populations in polar ecosystems. In 2008, Dr Ian Snape of the Australian Antarctic Division tested it on Maclaurie Island. Scientists at UofS continue to process samples collected in 2005, 2006 and 2007.■

Dr Jack Terhune (terhune@unbsj.ca), of the Department of Biology at the University of New Brunswick, is examining underwater Weddell seal vocalizations previously recorded near Mawson (2002), to determine the source levels (amplitudes) of the different call types.■

Dr Warwick F. Vincent, Director of the Centre d'études Nordiques at l'Université Laval (warwick.vincent@bio.ulaval.ca), chaired the SCAR Action Group established to develop a *Code of Conduct for the Exploration and Research of Subglacial Aquatic Environments.* The final report to SCAR is now under consideration by the ATS.■

Dr Dermot Antoniades, a post-doctoral researcher in the Department of Biology at l'Université Laval (dermot.antoniades@cen.ulaval.ca), spent November 2008 working with the Spanish IPY Limnopolar program at Byers Peninsula on Livingston Island. He is investigated non-marine aquatic ecosystems to see how they respond to increasing temperature and precipitation likely to result from climate change.■

Dr Jörn Davidsen, of the Department of Physics and Astronomy at the University of Calgary (davidsen@phas.ucalgary.ca), has found that the volatility properties in the 5–200 ky temperature time series of ice-core records, from EPICA Dome C and Vostok, reveal a strong nonlinear component. Temperature increments over these time scales appear in clusters where a big (positive or negative) change is most likely followed by a big (positive or negative) change and a small change is most likely followed by a small change. This study into historic natural climate variability is being done in collaboration with scientists from the British Antarctic Survey.■

Dr Matt Dobbs (mdobbs@physics.mcgill.ca), and his team from the Department of Physics at McGill University, in collaboration with some eight institutions in the United States, continues his work with the newly constructed South Pole Telescope that has been instrumental in discovering new galaxy clusters through the Sunyaev-Zel'dovich (SZ) effect.■

Dr Christian Haas (chaas@ualberta.ca), of the Department Earth and Atmospheric Sciences at the University of Alberta, in collaboration with Drs Wolfgang Rack and Pat Langhorn, New Zealand, carried out an ice-thickness and platelet ice survey of fast ice in the Ross Sea. As co-ordinator of the SCAR/WCRP International Programme for Antarctic Buoys (IPAB), he is also helping maintain a network of drifting buoys in the Southern Ocean to provide meteorological and oceanographic data for real-time operational and research purposes (www.ipab.aq).■

This past austral summer, **Dr Rob Williams,** of the Marine Mammal Research Unit at the University of British Columbia (r.williams@fisheries.ubc.ca), was aboard the German R/V *Polarstern,* assisting Dr Meike Scheidat, of the Institute for Marine Resources & Ecosystem Studies in The Netherlands, with helicopter surveys of minke whales in the ice and the analysis of sightings data.

Ashley Dubnick (adubnick@ualberta.ca), of the Department Earth and Atmospheric Sciences at the University of Alberta, visited Garwood Valley with the New Zealand program in January 2009. She has reported on the characterization of organic matter from a global collection of snow, glacier ice,

basal ice and glacial runoff samples that included samples from the McMurdo Dry Valleys.■

On 30 March 2009, **Dr Kevin Hall** (hall@unbc.ca), of the Geography Program at the University of Northern British Columbia, left for his 14th Antarctic expedition, travelling 5–7 days by sea from Cape Town. In conjunction with the University of Pretoria, he led a team of geologists on behalf of the South African Antarctic Program to sub-Antarctic Marion Island (Prince Edward Islands) as a follow-up to his first visit 35 years ago and a subsequent visit in 1980. Glacial reconstructions and the glacio-isostatic hypothesis of interglacial volcanism were reviewed; made more exciting by the intervening loss of the ice cap which has exposed much new information regarding flow directions. In addition, studies were made of rock weathering, rock temperature, rock moisture and solar radiation. Lichens were collected from the recently deglaciated area for a study of biological weathering processes and rates. ■

Dr Alain A. Grenier (grenier.alain@uqam.ca), of the Département d'Études urbaines et touristiques at the l'Université du Québec à Montréal, hosts the International Polar Tourism Research Network (www.polartourismnetwork.uqam.ca). This was created in August 2008 by Canadian and international colleagues, including **Dr Patrick T. Maher** (maherp@unbc.ca), of the Outdoor Recreation and Tourism Management Program of the University of Northern British Columbia.■

CARN Newsletter

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