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Inside

A RADARSAT-2 Snapshot of Antarctica During the 2007–08 IPY

Yves Crevier, Gordon Rigby, Dirk Werle, Ken Jezek and Don Ball

Antarctica remains one of the least known regions of Earth. A new image map of the southern continent (Fig. 1) now provides scientists with an opportunity to study Antarctic geology and glaciology in exceptional detail, and with a new suite of imaging tools. The map, constructed by MacDonald Dettwiler and Associates Ltd. of Vancouver, B.C., is a composite of synthetic aperture radar (SAR) scenes captured during the 2007–08 International Polar Year (IPY) by Canada's RADARSAT-2 (R2) satellite. For the first time, data capture included high-resolution polarization information over much of the continent. The image map is a Canadian contribution to the IPY.

Strategic planning for this Antarctic mapping was coordinated by the IPY Space Task Group (STG; 2010); a group that includes representatives from the national space agencies of Brazil, Canada, China, France, Germany, Italy, Japan, the Russian Federation, the United Kingdom, the United States, and both the European Space Agency (ESA) and the European Organization for the Exploitation of Meteorological Satellites; the latter two alone representing 26 nations. The STG was established in response to a request from the World Meteorological Organization (WMO) and ICSU (the International Council of Scientific Unions) for space agencies to provide coordinated synoptic remote-sensing data from space-based sensors (IGOS, 2007). The operating strategy for the group was to satisfy IPY science requirements by distributing the acquisition burden across the various space agencies while respecting the operational mandates governing their activities. The STG was guided by the scientific objectives and requirements of

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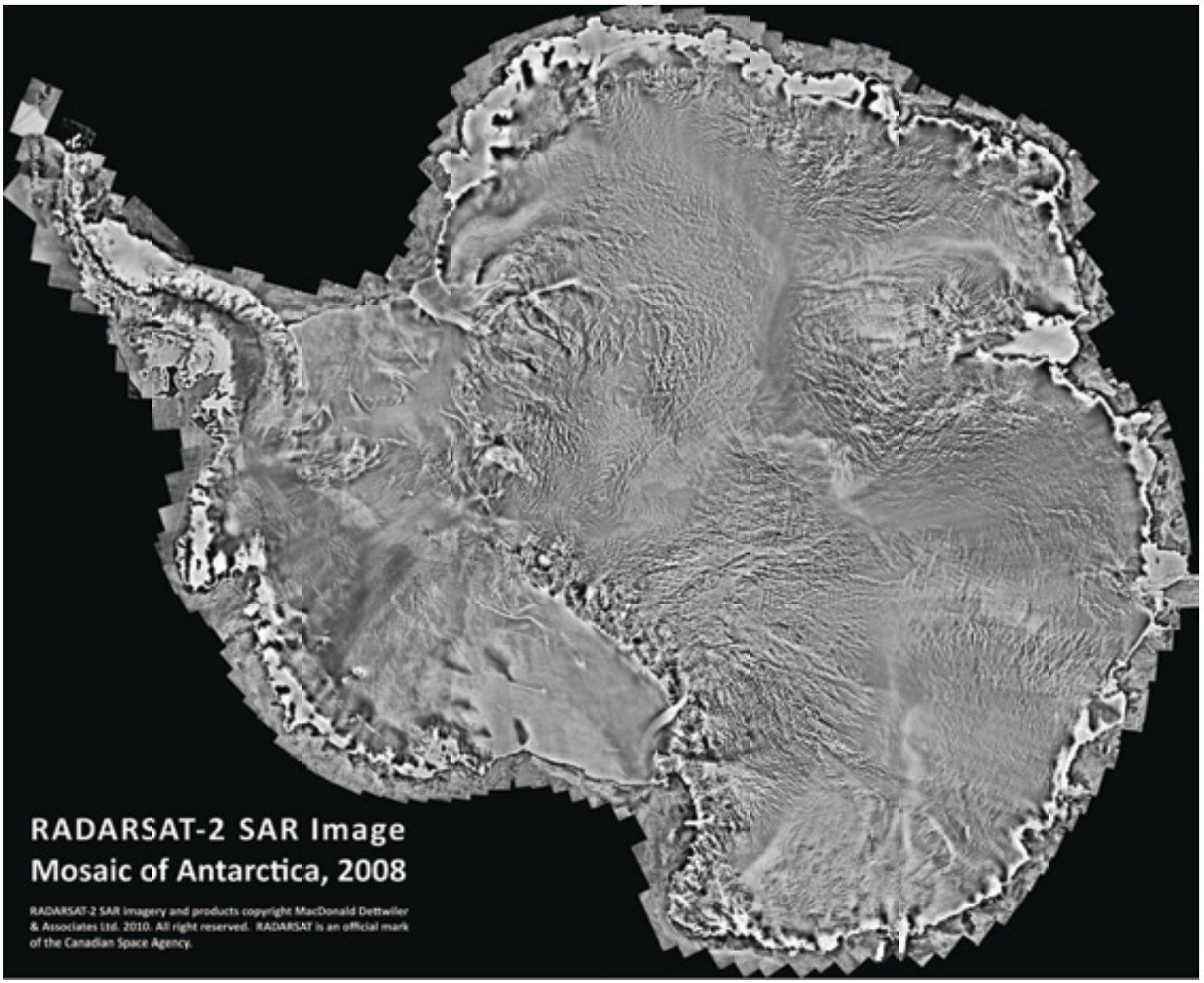

Figure 1

the Global Interagency IPY Polar Snapshot Year (GIIPSY), an IPY flagship project. GIIPSY developed high-priority science requirements for consideration by the STG, which then adopted the following four primary goals: (1) Pole-to-coast multi-frequency InSAR measurements for ice-sheet surface velocity; (2) repeated fine-resolution SAR mapping of the entire Southern Ocean sea-ice cover for sea-ice motion; (3) one complete high-resolution visible and thermal infrared snapshot of circumpolar permafrost; and (4) pan-Arctic high- and moderate-resolution snapshots of freshwater (lake and river) freeze-up and break-up in the visible and infrared spectrums (Jezek and Drinkwater, 2010).

Two of the four STG goals directly identified synthetic aperture radars as essential instruments. Recognizing that the SAR acquisition and processing burdens levied by the science objectives could overwhelm any single agency, acquisition

plans and acquisition scenarios were divided amongst the STG partners. In essence, independently operated SAR satellites were to be used in a coordinated fashion to form a virtual polar observing constellation (Drinkwater and others, 2008). To facilitate planning for this complex operation, a SAR Coordination Group was established chaired by the Canadian Space Agency and including representatives from the German Aerospace Organization (DLR), the Italian Space Agency (ASI), the Japanese Aerospace Exploration Agency (JAXA), ESA and NASA. Its goals were: to identify high-priority science objectives addressable with SAR; to identify which SAR systems could best fulfill particular objectives; and to develop acquisition and processing plans that distributed the workload while recognizing the mandates and operational constraints of each participating agency. The primary objectives selected at the conclusion of the first SAR working group meeting held in Montréal in 2008 were:

1. C-band coverage (3-day snapshots) for the Arctic Ocean during the remainder of IPY (as part of ongoing background missions and operational data acquisitions, etc.).
2. Pole-to-coast interferometric SAR (InSAR) coverage of the Antarctic continent during winter in high-resolution imaging mode (3–4 consecutive data-acquisition cycles in ascending and descending orbits).
3. InSAR acquisition over Greenland and the major Canadian icefields during winter in high-resolution imaging mode (over 3–4 consecutive cycles).
4. SAR coverage of 'supersites' (using existing data where possible), with selected acquisition parameters (frequency, resolution, etc.) for multipolarization and polarimetry data collection.

With respect to these objectives, RADARSAT-2 was identified as being particularly appropriate for obtaining a new, C-band, high-resolution, multipolarization map of Antarctica and selected InSAR coverage. This was because of its multiple polarization channels, its high-resolution, wide swath, imagery, and the ability to steer the beam to the right and left of the flight track. Other instruments were available to complement R2 data acquisitions. For example, TerraSAR-X and Cosmos-Skymed acquire very high-resolution X-band images, but can only capture selected parts of Antarctica because of the very high data-rate demand on those satellite resources. The Envisat ASAR and the JAXA PALSAR provide C-band and L-band coverage, but views are limited to the northern parts of the continent. Given the available resources, R2 was selected to acquire data for the image map and contribute to the velocity mapping. CSA accepted the challenge.

The RADARSAT-2 SAR image mosaic of the entire Antarctic continent is shown in Figure 1. The data were acquired during three orbital cycles between 14 October and 3 December 2008. The digital processing task was completed by MDA in Canada during the spring of 2010. It involved merging more than 270 passes, or the equivalent of 1788 individual scenes to form a cohesive and balanced composite of both the horizontally polarized C-band SAR data (C-HH) and the cross-polarized C-band SAR data (C-HV) at a spatial resolution of 25 m. The R2 mosaic of 2008 matches the extent and scope of the RADARSAT-1 C-HH SAR mosaic acquired during the RADARSAT Antarctic Mapping Project (RAMP) in 1997. Figures 2 and 3 show selected portions of the dual-polarized R2 red-green-blue colour composite imagery of HH-HH-HV transmit-receive polarizations.

The RADARSAT-2 mosaic (Fig. 1) offers an exceptional opportunity for researchers from fields such as glaciology, hydrology, climatology, geology, geomorphology, and coastal processes. The new dataset will allow them to advance their studies of Antarctica at a synoptic continental scale, in high spatial detail and in conjunction with RAMP data collected a decade earlier. This will set the stage for a series of change-detection exercises, the refinement of previous survey work, and will likely open the door to new inquiries. A first-order assessment of the R2 C-HH data shows such improvements in the clarity and detail of the subglacial topography that structural as well as morphological features can be investigated.

The dual-polarization capability of the R2 SAR sensor system is likely to improve single polarization detection and differentiation of snow- and ice-related features vis-à-vis subglacial morphology at scales and over much larger areas than

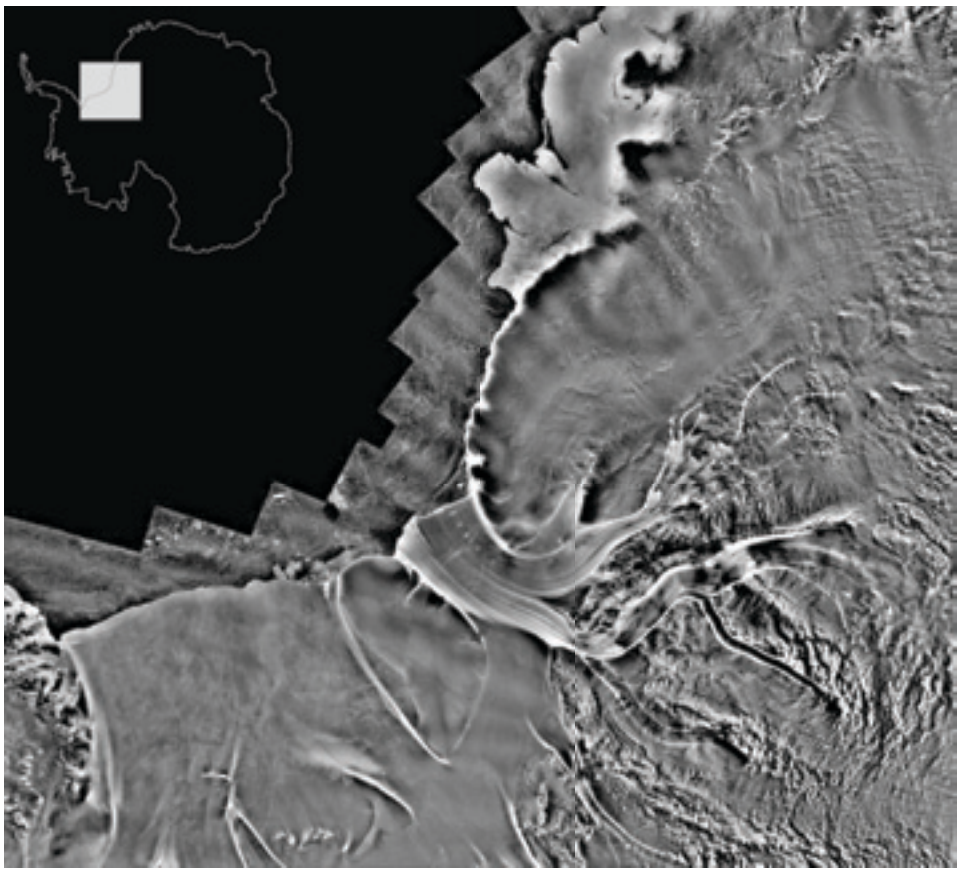

Figure 2
RADARSAT-2 dual-polarization C-band SAR composite imagery of the Filchner–Ronne Ice Shelf region, the Recovery Glacier system, and Coats Land. (Original image in colour, image ©MDA, 2010)

previously seen. This is illustrated by the sample imagery of the Ronne and Filchner Ice Shelves, the Recovery Glacier system and Coats Land (Fig. 2), where the veil-like radar signatures of ice and ice-flow dynamics are in evidence, frequently attenuating other signatures that appear to be linked to subglacial morphology. On a regional and local scale, InSAR data analysis of ice-flow dynamics, as well as comparisons with a legacy of other IPY radar datasets, will offer additional dimensions for geoscientific research and discovery.

Furthermore, comparison of high-resolution dual-polarized R2 SAR data with archival satellite data of similar spatial detail, collected over Antarctica in the 1970s and 1980s, presents further options to extend time series of satellite imagery for environmental-change studies. The composite image of R2 (2008) and optical Landsat-2 RBV (1980) coverage of the Lillie Glacier system is a case in point (Fig. 3). On a continental scale, the combination of the 2008 R2 mosaic and existing geospatial information present opportunities for studying the complementary nature of these datasets.

The new RADARSAT-2 map of Antarctica, and associated dual-polarization imagery, is an important IPY legacy dataset for monitoring the state of the entire ice sheet, exploring the land below it, and assessing the coastal environments of the continent. It represents a key milestone and follows the high-resolution SAR mapping of Antarctica in 1997 by RADARSAT-1. The technological enhancements of RADARSAT-2 also mean that the product is intrinsically new and will contain new surprises for the scientific community. The map will be openly available to the science community through agreements between CSA and MDA.

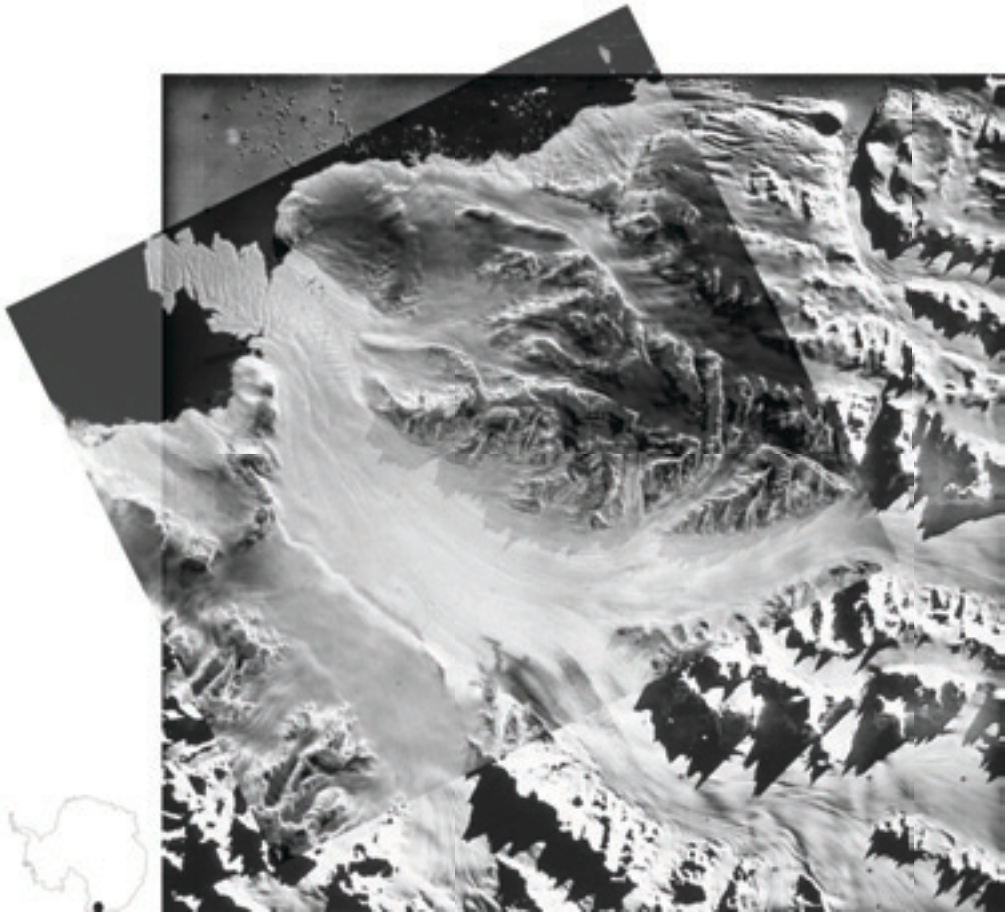

Figure 3
Composite image of the Lillie Glacier system, showing RADARSAT-2 dual polarized C-band SAR acquired in 2008 superimposed on Landsat-3 RBV imagery acquired in 1980. (Original RADARSAT imagery in colour, image ©MDA, 2010; Landsat imagery courtesy of the US Geological Survey).

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Message from CCAR's Chair

Marianne Douglas

The Antarctic plays a fundamental role in the Earth's global systems, affecting not only climate (air and oceanic currents) and sea levels, but also as a primary focus for scientific discovery and research relevant to Canada. Canada's interests in Antarctica should be a natural reflection of its status as a polar nation and its responsibilities in active global stewardship.

The Canadian Committee on Antarctic Research (CCAR) reports to the Canadian Polar Commission (CPC). Its responsibilities include providing advice to CPC on Antarctic and bipolar scientific matters, fostering and facilitating cooperation among Canadian scientists working in Antarctica, and serving as a communications link between Canadian scientists and international Antarctic science communities. In addition, CCAR coordinates and reports on Canadian activities in the Scientific Committee on Antarctic Research (SCAR) working groups and reviews proposals for the Polar Continental Shelf Program's Canadian Arctic and Antarctic Exchange Program. In essence, its mandate is to promote Canadian participation in Antarctic science.

It is not unusual for a northern nation to be heavily involved in Antarctic research. In fact, the opposite is unusual. Of the eight Arctic Council nations, only Canada and Denmark do not have national Antarctic programs. Canada could (should) play a more significant role in the stewardship of the Antarctic. Canada ratified the Antarctic Treaty (AT) in 1988 as a non-consultative party. As a non-consultative member, it does not have a vote at the annual Antarctic Treaty Consultative Meeting (ATCM), the international body that makes decisions concerning the management and protection of the Antarctic. To reach full consultative status, Canada would have to demonstrate significant activity within the Antarctic, such as maintaining a research base or endorsing a national research program.

There have been calls for a Canadian Antarctic Research Program (CARP). In 2003, the CPC hosted an international workshop in Edmonton, at the University of Alberta, to develop such a program. Entitled *Polar connections: planning Canadian Antarctic research* (www.polarcom.gc.ca), the main objective was to develop the program that had been recommended in *Antarctic Science and BipolarLinkages: a Strategy for Canada* (www.polarcom.gc.ca) published a year earlier by the CPC. In consultation with other nations possessing national Antarctic programs, a framework for CARP was developed.

What would be the benefits of a CARP to Canada? As listed in *Antarctic Sciences and Bipolar Linkages: a Strategy for Canada,* a national program would help Canada meet its international science and research obligations. Canada would play a greater role in international science and contribute increasingly to important issues of global significance. A CARP would provide a focus and coordination for Canadian Antarctic research. It would generate scientific knowledge important to Canada and contribute to polar technological innovations. Canada would be able to actively set the research agenda at the international level. Canadian researchers are sought out by international colleagues for their polar expertise. Many nations are expressing interest in setting up exchange programs with Canada to build up their own bipolar programs. By developing synergistic partnerships with other Antarctic national research programs, the CARP could be achieved quite economically. However it has never been further developed or resourced.

The past two years saw an increase in funding and activity in the polar regions as a result of the 4th International Polar Year. Canada committed $156M through its Federal IPY office ($150M) and NSERC ($6M) programs to the IPY. However, the bulk of these funds ($150M) could not be used to support Antarctic research. Canada lost an opportunity to make a significant contribution to Antarctic research and pro-

mote and develop a CARP. Had it done so, Canada could have moved its AT membership to full consultative status and had a voice at the table.

Nonetheless, Canada still plays an important role in the stewardship of Antarctica. In 2003, the House of Commons passed Bill C-42, an Act Respecting the Protection of the Antarctic Environment, thereby complying with the Madrid Protocol (Protocol on Environmental Protection to the AT) that it had played a role in drafting. This is the strongest international environmental protection law and is responsible for managing environmental impacts on one sixth of the Earth's area. The Canadian government also co-chaired the Convention on the Regulation of Antarctic Mineral Resource Activities (CRAMRA). So, while Canada does not have a vote at Antarctic Treaty Consultative Meetings, it is still a player. I just wonder why it doesn't move up to join the A-team as a full consultative member.

The 50th anniversary of the Antarctic Treaty was commemorated in Washington, DC, in December 2009. Celebrations highlighted the effectiveness of this international treaty for the stewardship of the continent. It will be interesting to see what the next 50 years bring. Perhaps full consultative status for Canada? There have been repeated calls for Canada to adopt a polar policy that would effectively ensure stewardship of Canada's polar regions and facilitate sustained research support (England, 2010). When Canada moves in this direction, I hope that it will consider both polar regions in its polar policy.

At this time, I take the opportunity to recognize the efforts of Wayne Pollard, professor at McGill University, for his work as CCAR chair (2001–08). Through his efforts, CCAR moved forward with *Polar Connections* (see above). In addition, and I speak on behalf of all CCAR committee members, a special recognition to CCAR secretary Simon Ommanney for his tireless work in maintaining such a thorough record of Canadians involved in Antarctic research. This requires hours spent scouring library records and other sources. With no national Antarctic program in place, no other records of Canadian government, academic and private sector activities in Antarctica exist. Yet CCAR remains the only place where these data can be obtained. For example, when a federal librarian needed information about federal Canadian involvement in Antarctic research, Simon was able to report that based upon a literature survey from 2000–09, 189 Environment Canada scientists had Antarctic connections, and that 75 papers had either been published or presented over that period. Another interesting statistic is that in 2008–09 scientists with Canadian affiliations authored 129 papers that were either published or presented at conferences. Many thanks to both Wayne Pollard and Simon Ommanney for their significant contributions towards sustaining Canadian Antarctic activity.

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Canada's Approach to Antarctica: Arctic State and Polar Player?

Anita Dey Nuttall

Canada and the Antarctic Treaty

Canada acceded to the Antarctic Treaty in 1988, 27 years after its enforcement – the last Arctic state to do so. It is a major Arctic country that operates as a non-consultative party member outside the decision-making machinery of the Antarctic Treaty System (ATS). The ATS comprises four key agreements (www.ats.aq; accessed 7 June 2010): the Antarctic Treaty itself, the Convention for the Conservation of Antarctic Seals (CCAS, 1972), the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR, 1980), and the Protocol on Environmental Protection to the Antarctic Treaty (1991), also known as the Madrid Protocol. Canada became a party to CCAMLR in 1988, to CCAS in 1990, and ratified the Madrid Protocol in 2003. Since the Antarctic Treaty came into force in 1961, 35 nations have acceded to it, 16 of which became consultative parties of the Treaty thus conferring on them decision-making powers. As the pursuit of science remains the main currency of authority in Antarctica's political setting, the price of acquiring consultative status, or full membership of the Antarctic Treaty, requires that countries operate and support permanent long-term scientific programs in Antarctica.

Notably, Canada is one of only four non-consultative parties of the Antarctic Treaty that are full members of the Scientific Committee on Antarctic Research (SCAR), the remaining three being Denmark, Romania and Switzerland. SCAR is an organization independent of governments and provides scientific advice to the ATS. Full membership in SCAR requires that a country have an active research program in Antarctica. After four years as an associate member of SCAR, Canada was unanimously admitted as a full member in 1998. In many respects, Canada's membership in SCAR can be seen as an endorsement of its reputation as a country that produces high-quality science and cutting-edge technology relevant to the polar regions. Yet, Canada has chosen not to participate as a decision-maker within the ATS. This has reduced the need for a political commitment to direct resources towards the establishment of a Canadian Antarctic Research Program (CARP). Recent political attempts to emphasize that Canada is an Arctic nation, and to raise its stature internationally in that respect – as well as its involvement in Antarctic affairs as outlined above – suggests that Canada would find some obvious benefit from being an active player in both polar regions. However, Canada's late entry into the Antarctic Treaty System, and its absence from the group of consultative party members, seem to indicate that Canada views Antarctica as marginal to its political and scientific interests.

Hesitation and Reluctance: Canada's Historical Connection to Antarctica

A number of sources provide accounts of Canadians who have been involved in every phase of Antarctic exploration and research since 1898 (Beeby, 1954; Hattersley-Smith, 1986). On account of its historical ties with Britain and its geopolitical relationship with the USA, Canada has the longest history of being closely involved in multilateral discussions on Antarctic matters of any non-consultative party. Beginning in the 1920s, Canada participated in all the Imperial Conferences as a member of the British government's Polar Committee (1921, 1926, 1930, and 1937), and later participated in the post-1945 Commonwealth prime ministers' conferences (Beck, 1995). The country enjoyed access to confidential information and briefing documents about multilateral exchanges conducted on Antarctica as top secret papers were forwarded to Ottawa by the United States and by Commonwealth governments. This privileged position allowed Canada to view developments in Antarctica in the context of its own strategies and policies regarding the exercising of its own sovereignty in the Arctic.

Despite its historical connection to Antarctic matters and being the second largest Arctic country, Canada's interest in Antarctica has been indirect, sporadic and limited compared to the other Arctic states. Many of its Antarctic activities have been driven by individual scientists rather than by any sustained and concerted Canadian government ambition to participate in Antarctic affairs. Canada's approach to Antarctica appears to be defined more by the political calculations it has felt it has always needed to make with regard to its relations with its "powerful southern neighbour, Commonwealth loyalties, the Cold War, hemispheric and Latin American links, and bipolar interconnections" rather than from dedicated scientific and political interest in Antarctica alone (Beck, 1995).

In 1939, the five countries that claimed territory in the Antarctic (Britain, New Zealand, Australia, France and Norway) mutually recognized each other's claims. Until then, claims to Antarctica had been dominated by Europe (the claims of New Zealand and Australia were made by Britain on their behalf). But after 1939, the revival of Chilean and Argentine political interests in the Antarctic, as well as the growing interest that countries such as Germany, Japan, the USA and the Soviet Union had in the continent's resource potential, began to change the political dynamics.

During the Cold War, the maintenance of spheres of influence in the South Atlantic and the establishment of security zones were primarily American concerns. The signing of the Inter-American Treaty of Reciprocal Assistance (Rio Treaty) in September 1947, for example, can be regarded as an attempt by the USA to establish a continental security zone. Signed by 21 American countries, it represented the beginnings of hemispheric solidarity − Parties to the Treaty agreed that an armed attack by any State against an American State should be considered an attack against all American States. Article IV defined the region covered by the Treaty as extending to the South Pole. Canada was included in that region but, significantly, did not sign the Treaty. The reason for not joining had been articulated by the Under-Secretary of State for External Affairs, Mr N.A. Robertson, to Ambassador Lester Pearson in the United States in a correspondence dated 7 January 1946 (DEA/7305-A-40):

> *We think it would be particularly difficult to enter into regional treaty negotiations with the other American countries at the present time when there has been no exchange of views between British Commonwealth countries regarding the post-war defence arrangements. The question would at once be raised, both in Canada and elsewhere in the Commonwealth, why we could sign an inter-American treaty and could not do the same with a Commonwealth agreement.*
>
> *It would not be easy to explain our reluctance to the State Department or to the public, since our principal reasons for hesitation are a belief that an inter-American treaty would be largely meaningless in terms of defence advantages and liabilities, and an unwillingness to complicate the problem of Commonwealth defence relationships.*

The significance of this Treaty with regard to Antarctic politics is illustrated by the establishment of Argentine and Chilean stations in areas already claimed by Britain. The relations of both countries with Britain reached a critical point in 1947−48. Notably, the US refused to recognize the application of the Rio Treaty in this situation. It can be argued that the US interpretation of "an armed attack by any State against an American State" applied in the context of Cold War politics had meaning mainly in relation to the Soviet Union. Moreover, as Britain was a North Atlantic ally, the US could ill afford to take sides. Yet, Argentina and Chile were major South American allies for the US and the Americans took the initiative to open discussions over the sovereignty problem with all claimant countries. In 1948, the US suggested an internationalization of Antarctica in the form of a trusteeship of all interested countries under the United Nations (UN). It did not garner much support, due primarily to the fact that the trusteeship system assumed the development of the political, economic, social and educational advancement of the inhabitants of trust territories. Antarctica did not qualify because of the absence of indigenous peoples.

Attempts at a Canadian Policy on Antarctica

Without completely abandoning the trusteeship idea, another alternative developed by the US Department of State in July 1948 was the formation of an eight-power condominium. This provided for the eight nations to "merge and join their claims ... and interests in the special regime here established" (Bush, 1988, p. 464). Britain asked the Canadian Government for any comments it had on the proposal, and so Canada found itself in a delicate position. As a young nation that had acquired legislative independence from the UK Parliament with the Statute of Westminster of 1931, and feeling that its own sovereignty over the Arctic Archipelago was no longer disputed by other states, Canada may have reflected that it should tread carefully in protecting its Arctic sovereignty and maintaining relations with several countries over the question of an Antarctic regime.

The first official document that attempted to articulate a Canadian policy on Antarctica is the Department of External Affairs' memorandum of 30 July 1948 to Lester Pearson, then Secretary of State for External Affairs. It laid out general principles to guide Canada's position on Antarctica. Even though Canada regarded Antarctica as remote and marginal to its geography and political interests, it was forced to adopt a particular policy position towards the continent owing to four key political developments. These were a change of US policy on Antarctic claims, claims made by Argentina and Chile counter to British claims in the Antarctic Peninsula, an extension of claims by Norway and France, and the desire of both the USA and the Soviet Union to influence the political development of Antarctica. The mounting tensions between the USA and the Soviet Union, and the territorial rivalry between Britain, Argentina and Chile, forced Canada to tackle its official position on the continent. The 1948 memorandum noted *inter alia* (DEA/3397-40):

> *It is possible, but not probable, that any international regime set up to administer the Antarctic might be considered a precedent for the establishment of a similar regime in the Arctic. The cases are not, of course, parallel and any attempt to treat them as such should be vigorously resisted... The possibility, moreover, that any international organization for the Antarctic might be exploited to [Canada's] disadvantage as regards the Arctic, makes it advisable for [Canada] to take no active role in the settlement of the Antarctic dispute.*

A decade later, Canada was kept abreast of secret negotiations that eventually led to the Antarctic Treaty negotiations. But Canada chose to remain on the sidelines and did not involve itself even after the Treaty came into force in 1961. The freezing of the claims by the Antarctic Treaty perhaps made Canada view the agreement as being potentially unsustainable and divisive.

Canada as Mediator in Antarctic Affairs

In the mid-1970s, a growing international political awareness of Antarctica's resource potential and of its role in environmental processes led the original 12 Antarctic Treaty members to begin negotiations on the marine resources of the Antarctic, in order to ensure the establishment of their own resource arrangements. In 1977, they called for "a definitive regime for the Conservation of Antarctic Marine Living Resources". The 1980s witnessed even greater international interest in Antarctica, a trend that reflected the "impact of changing political and legal attitudes that was related to the democratization of international relations and the application of the common heritage of mankind principle, and the concern to safeguard the last great wilderness on earth" (Beck, 1989, p. 65). A major catalyst for such developments was the start of Antarctic Treaty consultative party negotiations in 1982 for a minerals regime. This attracted the attention of the UN, particularly in relation to the conclusions reached by UNCLOS III the same year. According to this, "the sea bed and ocean floor, beyond the limits of national jurisdiction, as well as the resources of the area, are common heritage of mankind". With the development of the notion of a common heritage, developing states could put forward an argument

that, because it is part of the common heritage of mankind, Antarctica is already, or should become, *res communis*. Attempts on the part of non-Treaty members to include Antarctica as a common heritage of mankind had been unsuccessful. But these changing political and legal attitudes manifested themselves in the annual debates on the region conducted by the United Nations since 1983. Malaysia's initiative in bringing the "Question of Antarctica" to the UN General Assembly in 1983 created a sharp division between the ATCP (Antarctic Treaty Consultative Parties) and the international community, comprised mainly of developing countries. Malaysia argued Antarctica was a global common, similar to the deep-sea bed, and should be managed by the UN for the good of mankind.

Due largely to pressure from environmental groups and a general world-wide environmental campaign, the Convention on the Regulation of Antarctic Mineral Resource Activities (CRAMRA) did not come into force. However, an important element of CRAMRA was that it took into account the changing international order that had brought about a new interest group among the ATCPs. Never before in any of the earlier Conventions negotiated by the consultative parties had there been a special role or privilege for the developing countries. Articles 29 (3) (b) of CRAMRA provided for 'adequate and equitable representation of developing country members of the Commission, having regard to the overall balance between developed and developing country members of the Commission, including at least three developing country members of the Commission'. Moreover, with regard to decision-making in the Regulatory Committee, it was agreed that the two-thirds majority should include at least one developing country (Article 32) (Final Report of the Fourth Special Antarctic Treaty Consultative Meeting 1988, p. 41).

Having assumed a role of mediator between the developed world and the developing countries, Canada was forced to take a position that not only defended the concerns of the developing countries, but also upheld the strengths of the Antarctic Treaty.

Canada and Polar Science

In 1987, at a time when countries such as Sweden, Brazil, Uruguay, South Korea, China, and India were sending expeditions to Antarctica, a report prepared for the Department of Indian Affairs and Northern Development (DIAND) remarked that:

> *Canada is the only northern circumpolar nation that does not adhere to the Antarctic Treaty nor participate formally in scientific investigations in Antarctica, and this presents a handicap for Canada's own northern interests. It excludes Canada from the general scientific community of polar nations, and allows other countries to take the initiatives in setting priorities for international polar studies vital to the Canadian north.*
>
> (Adams and other, 1987, p. ix)

A year after the publication of this report, Canada signed the Antarctic Treaty. Then-External Affairs Minister Joe Clark declared that "Canada is acutely aware of the uniqueness of Antarctica, and will, through accession to the treaty, be better able to work for the protection of its sensitive environment and dependent ecosystems." He claimed further that "Canada, as a leading Arctic state and a major player in polar science and technology, was taking its place among countries with a strong interest in Antarctic matters" (1988, p. 1 in Beck, 1991). Yet, more than 20 years on, the political support for maintaining a strong interest in Antarctica remains weak. Despite this, it can be argued that Canada has displayed a consistent approach to the Antarctic in relation to how it views it from the perspective of its Arctic sovereignty and the emphasis it has always placed on the distinctiveness of the two polar regions. It is important to note that this differs from the emphasis placed on bipolar linkages between the Arctic and the Antarctic by many Canadian scientists because of their relevance to Earth system science.

Canada's evolving approach to Antarctica can be seen as an interesting example of the interplay of its domestic and broader foreign policy issues. Embedded in that link is

Canada's strategy to utilize its expertise in polar science and technology as a means of not only developing its north, but also as a way of maintaining its scientific competence in polar affairs in the international context.

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Wilhelmina Roa Clavano – SCAR Fellow

Wendy Clavano, a postdoctoral fellow with the Arctic and Alpine Research Group at the University of Alberta, was the first ever from a Canadian institution to be awarded a Scientific Committee on Antarctic Research (SCAR) fellowship. She returned last February from visiting with Wolfgang Rack of Gateway Antarctica at the University of Canterbury in New Zealand. Wendy joined Wolfgang's team in November 2009, in the region around Scott Base, to fine-tune a method of determining the specific surface area of snow using an off-the-shelf digital SLR camera modified to be sensitive in near-infrared wavelengths. Later she switched to Pat Langhorne's (University of Otago) team and traversed across McMurdo Sound collecting ground-penetrating radar traces to determine snow depth over first- and multi-year sea ice. They were subsequently joined by Christian Haas of the University of Alberta who flew a helicopter-borne inductance meter that measures sea ice thickness and who co-supervised Wendy's work. The primary objective of the data collection effort is to help with validation activities for the European Space Agency's CryoSat-2 that was successfully launched on 8 April 2010. A report entitled *Snow over ice: ground measurements for satellite validation of snow layering over land ice and snow thickness over sea ice around McMurdo Sound, Antarctica* was submitted to SCAR and is available online (http://wrclavano.info/Public/SCAR_report_02f.pdf). Wendy would like to thank Martin Sharp for all the support he has provided. More information on her work can be found at www.wrclavano.info/Wendy_Clavano/SCAR/SCAR.html.

News in Brief

Dr Luke Copland (luke.copland@uottawa.ca), of the Department of Geography at the University of Ottawa, installed an automatic temperature sensor on a small low-elevation ice cap in the Wauwerman Islands on a visit with the Students on Ice (SOI) IPY University Expedition in 2009. In December 2010, data from the sensor were downloaded and revealed surprisingly warm winter conditions, with temperatures rarely below −10°C. The site will be revisited during the next SOI University expedition in February 2011.■

Sander Geophysics Limited (SGL; selieff@sgl.com), based in Ottawa, participated in NASA's 2009 IceBridge campaign in Antarctica, in partnership with the Lamont-Doherty Earth Observatory of Columbia University, New York. In October and November 2009, an SGL airborne gravity meter, onboard NASA's DC-8, surveyed 155,305 km of Antarctica. The mission is designed to monitor the health of sea ice and ice sheets in the region.■

Dr Christian Haas (chaas@ualberta.ca), of the Department of Earth and Atmospheric Sciences at the University of Alberta, in collaboration with Gateway Antarctica and the University of Otago, used airborne electromagnetic induction sounding and extensive ground-truthing to obtain the first ice-shelf thickness data close to the ice edge; an area where ground-penetrating radar does not work because of the presence of brine. The thickness of the sea ice and its underlying platelet layer could also be measured, providing new opportunities for studies of ice shelf–ocean–sea-ice interaction.■

From 2005–08, **Dr Allyson Hindle,** Postdoctoral Fellow with the Marine Mammal Research Unit of the University of British Columbia, was involved with a US NSF-funded investigation of Weddell seals in the McMurdo Sound area with scientists from Oregon State University, the University of Alaska Fairbanks and Texas A&M University. The study demonstrated that the morphology of swimming muscle displays senescent changes throughout adult life in this species. Physiological (ECG) and behavioural telemetry (dive depths, times, schedules) were collected from free-ranging females to consider any age-effects on these parameters.■

Dr Thomas James (tjames@nrcan.gc.ca), Geological Survey of Canada, Sidney, B.C. and **Karen Simon** (ksimon@uvic.ca), School of Earth and Ocean Sciences, University of Victoria, have evaluated the effects of ocean loading on models of glacial isostatic adjustment in Antarctica. The results will be used in the analysis of remote observations of Antarctic ice sheet change.■

Dr Jonathan Klassen (jlk3@ualberta.ca), Postdoctoral Fellow with the Department of Earth and Atmospheric Sciences at the University of Alberta, has identified bacterial strains previously isolated from the Victoria Upper Glacier, Antarctica, as five novel species of the genus Hymenobacter. They are notable for their pink-red colouration and have yielded insights into the nature of microbial carotenoid evolution.

Ashley Dubnick (adubnick@ualberta.ca), of the Department Earth and Atmospheric Sciences at the University of Alberta, in collaboration with John Orwin (University of Otago) and Jemma Wadham (University of Bristol) revisited Garwood Valley in January 2010.■

The SCAR Action Group preparing a code of conduct on guiding principles for subglacial aquatic environment exploration and research, chaired by **Dr Warwick F. Vincent** (warwick.vincent@bio.ulaval. ca), Director of the Centre d'études Nordiques at l'Université Laval, submitted the revised version to SCAR in April 2010. **Dr Vincent** also chairs the Canadian Interagency Polar Data Management Committee that oversees the Polar Data Catalogue (www.polardata.ca); a

data centre that describes and provides access to diverse Arctic and Antarctic datasets.■

Patrick T. Maher (maherp@unbc. ca), Associate Professor in the Outdoor Recreation and Tourism Management Program at the University of Northern British Columbia, Prince George, B.C., is co-editor of the following two books on polar tourism being published in 2010.

Lück, M., P.T. Maher and E.J. Stewart, *eds.,* 2010. *Cruise tourism in the polar regions: promoting environmental and social sustainability.* London, Earthscan Publications, 256 pp. (ISBN 9781844078486, £60.00, hardback).

Maher, P.T., E.J. Stewart and M. Lück, *eds.,* 2010. *Polar tourism: human, environmental and governance dimensions.* Elmsford, NY, Cognizant Communication Corp., In press (ISBN 978-1-882345-55-7, $110.00, softbound).■

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