International Collaboration in the Antarctic for Global Science

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ABSTRACT. Article III of the Antarctic Treaty outlines the way in which international cooperation, established during the International Geophysical Year, should be continued. Exchanges of scientists have occurred among many nations over the last 50 years, but increasing planning and logistics collaboration have marked the achievement of many major scientific goals possible only through multinational activity. The recently completed International Polar Year provides clear evidence of how well this is succeeding in Antarctic science for the twenty-first century, and the publication record clearly reflects this pooling of talent.

INTRODUCTION

The International Geophysical Year of 1957–1958 was a major milestone in many ways. Not only did it provide an opportunity for wide-scale international cooperation in physical sciences, but its Antarctic activities provided motivation for an international treaty setting the continent aside for peace and science. In negotiating the treaty the diplomats were at pains to ensure that the requirement for international collaboration was written into the text. Articles II and III of the Antarctic Treaty lay out the principles of freedom of scientific investigation, international cooperation, and the free availability of results and data.

This paper highlights several recent exemplars of the international research in Antarctica that, in practical terms, a single nation could not have undertaken on its own. Much of this science is currently helping to explain the Antarctic region's involvement in global change, a central research question of our age. This research echoes the themes of the Antarctic Treaty Summit: science interacting with diplomacy, science as a source of policy issues, science as an early warning, and science as a quest for fundamental knowledge.

Researchers themselves are attentive to these broad points. On a recent visit to the National Science Foundation a polar ecologist remarked "we are ethically obligated to stay ahead on climate change." She is looking beyond her science to the broader communities' need to understand the science and to take action based on those scientific findings.

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INTERNATIONAL RESEARCH COLLABORATION

The Antarctic Treaty did not invent international science, but its provisions have fostered international science in powerful ways. During the Cold War in the 1950s and later, the United States and the Soviet Union exchanged scientists in the Antarctic. At first they simply traded personnel. But international projects now involve detailed planning, shared logistics, and interactive science.

In 1981 the Soviet icebreaker *Mikhail Somov* was the research platform for 13 Soviet scientists and 13 U.S. scientists. The ship went far into ice-infested regions of the Weddell Sea, the first deep penetration since Shackleton's famous voyage on *Endurance* in 1915–1916. The result was the first comprehensive data set obtained in winter sea ice. A decade later, the Russian icebreaker *Akademik Federov* and the U.S. icebreaker *Nathaniel B. Palmer* collaborated in the same region to establish a drifting camp on the sea ice. Seventeen American and 15 Russian scientists collected data for four months regarding the Weddell Gyre, which is a key constituent of the global climate system, sending cold, dense Antarctic waters throughout the world's ocean. The Soviet Union transformed itself into the Russian Federation while the ship was deployed, but the Antarctic research was completed as planned.

Experience and the ever-present Antarctic Treaty gave its member nations the confidence to do complex international projects like these, requiring the full commitment of each partner for project success. The achievements for science are irrefutable. As the number of Treaty Consultative Parties roughly doubled from the original 12 to 28 nations, Dastidar and Ramachandran (2008) showed that published international Antarctic papers with coauthors from two or more nations increased from 15 papers in 1980 to 190 international papers in 2004 (Figure 1). This accomplishment is significantly greater than for world science as a whole. The bibliographic record also shows that other scientists cite the international papers more than they cite the single-nation papers, proof that international cooperation increases the progress of science and enables research that otherwise would be expensive or infeasible.

INTERNATIONAL POLAR YEAR PROGRESS

In the years since 2004, my counterparts heading Antarctic programs in the other treaty nations will likely agree

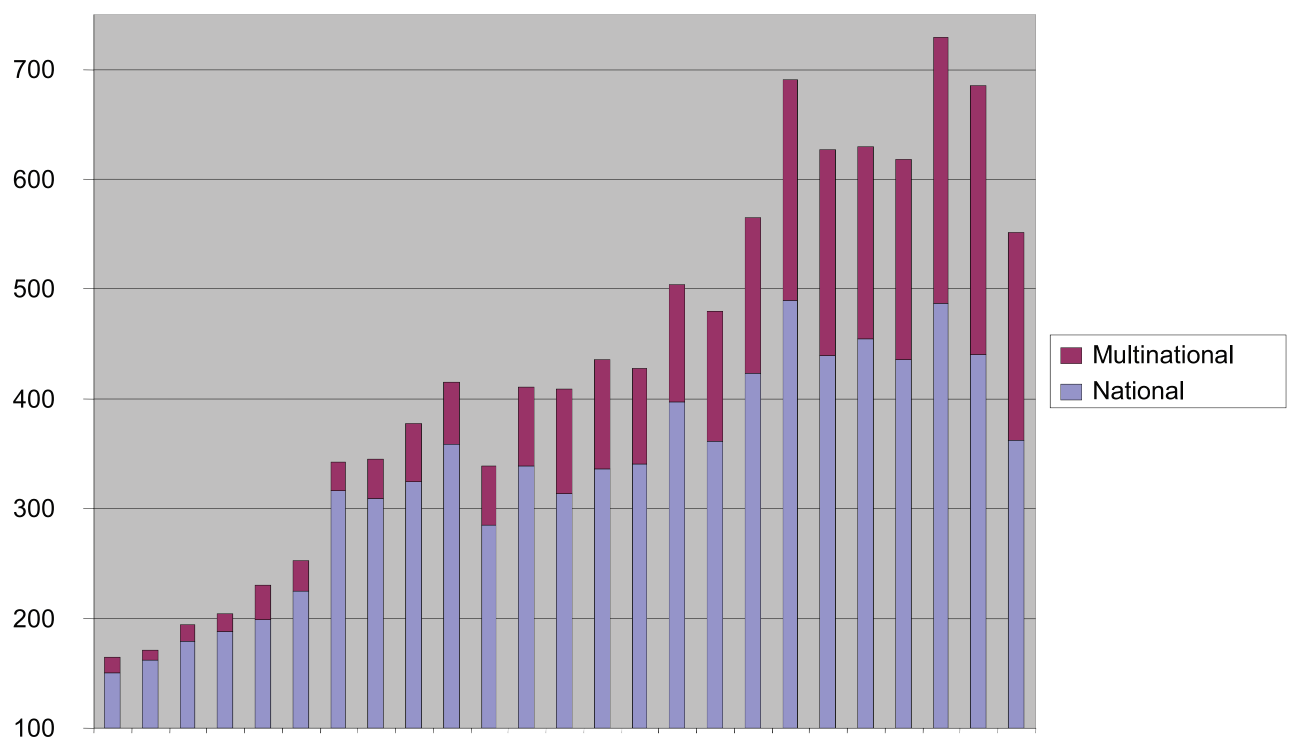

FIGURE 1. Antarctic paper publications from 1980 to 2004.

that the recently concluded field phase of the International Polar Year of 2007–2008 is resulting in dramatic advances in understanding this important part of the world. The rise in polar climate papers has been particularly steep.

Countries are working together to describe current and potential future events impacting the Antarctic ice sheet. Only through such a broad effort involving China, the United Kingdom, France, the United States, and other countries can we hope to reduce uncertainties in the Intergovernmental Panel on Climate Change (IPCC) estimates of long-term global sea level rise. The goal is to determine the rates of loss of ice from the main drainage basins (Figure 2) and how the rates depend on bed lubrication, topography, and ocean temperature.

The Antarctica's Gamburtsev Province (AGAP) project is an IPY effort involving the United States, the United Kingdom, Russia, Germany, China, and Australia that discovered river valleys in the Gamburtsev Mountains under the Antarctic ice sheet. This is the location of the first Antarctic ice sheet (~34 MYA) and thus represents potentially very old ice and a tectonic enigma. The effort gave us a first detailed look at what that part of the continent, as big as the Alps, might have been like before it was covered in ice. This project involved close international collaboration in science, technology, and logistics.

An IPY signature project, the Larsen Ice Shelf System, Antarctica (LARISSA; Figure 3), is a collaboration by Argentina, Belgium, South Korea, Ukraine, and the United States to study a regional problem with global change implications. The abrupt environmental change in Antarctica's Larsen Ice Shelf system was investigated using marine and Quaternary geosciences, cryosphere and ocean studies, and research into marine ecosystems. In an example of IPY's education and legacy roles, a two-week course in the United States in July 2010 under the auspices of the Australia-based International Antarctic Institute used recently acquired marine data, sediment cores, and imagery.

Twenty-eight countries are collaborating in the Polar Earth Observing Network (POLENET) to map uplift of the Antarctic crust resulting from a decreased mass of the

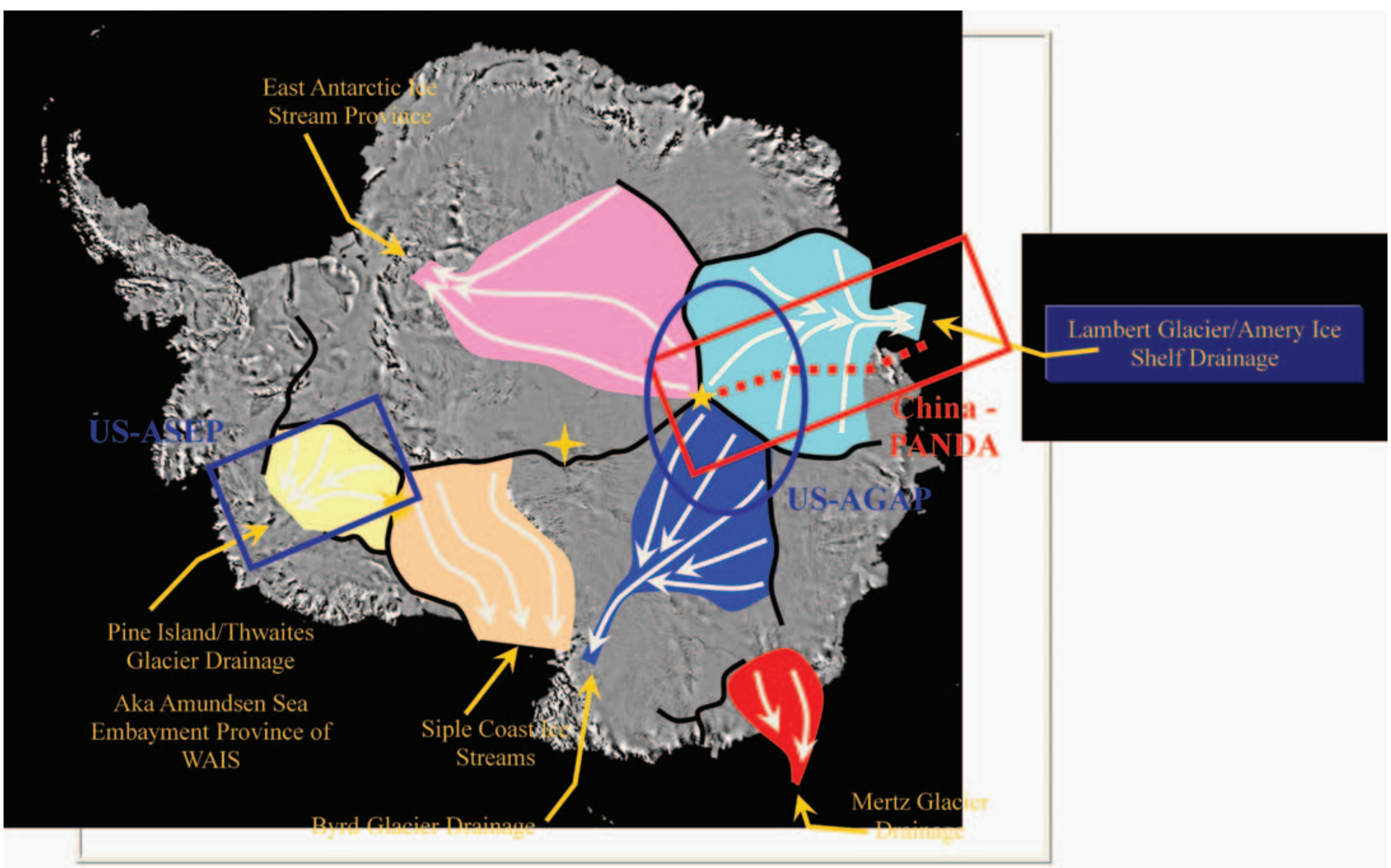

FIGURE 2. Antarctic ice sheet drainage.

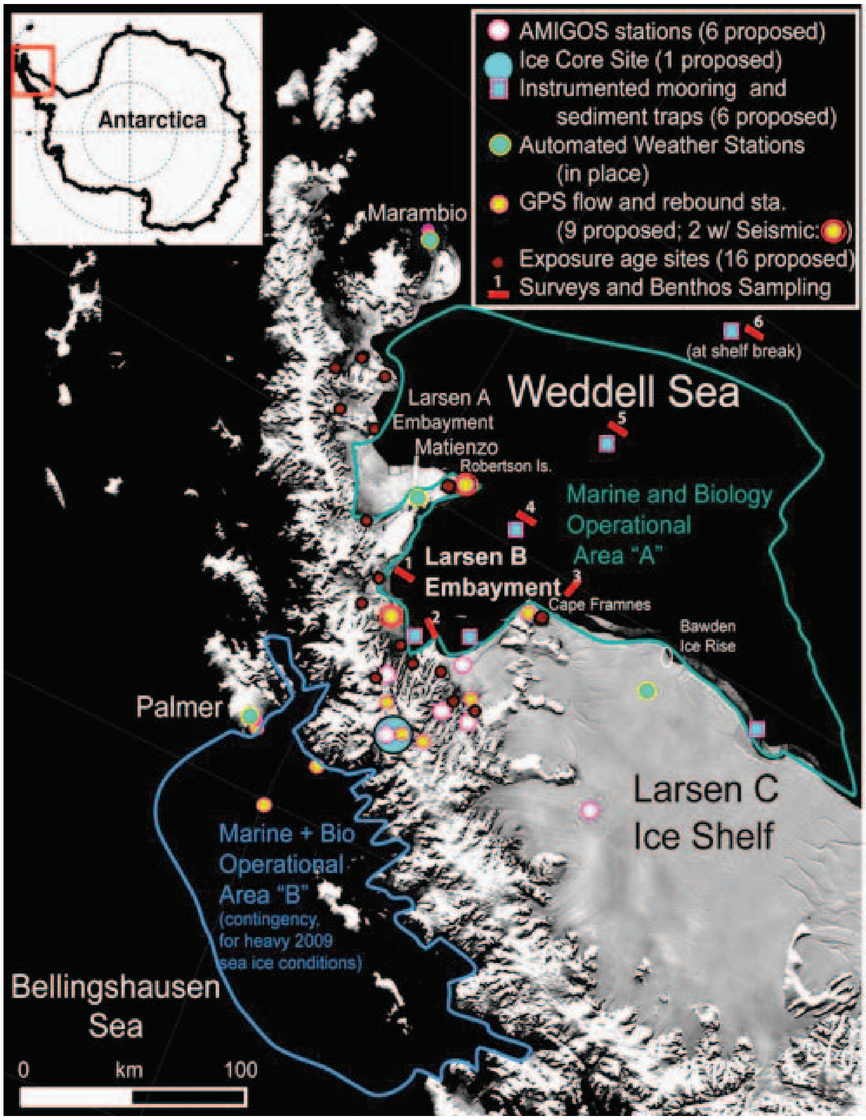

FIGURE 3. LARISSA study area.

covering ice sheet. Data from new GPS and seismic stations spanning much of the Antarctic and Greenland ice sheets are used to model how much ice was lost over the 10,000 years since the last major ice age. These data, taken with information gathered by satellites, help in determining where, and at what rate, the ice sheets are changing in response to recent climate change. The measurements are critical in refining estimates of future global sea level rise. The collaborations have led to new technology for continuous measurement at autonomous observatories operating in polar conditions and have provided a legacy framework for ongoing international geophysical observations.

Thirteen countries are participating in the International Trans-Antarctic Scientific Expedition (ITASE), which is collecting ice core samples that provide signatures of how constituents of the atmosphere have changed since the beginning of the industrial revolution. The ITASE is an existing project (begun in 1990) that matches IPY goals and that flourished during the IPY period. Like the ice sheet drainage collaborations shown in Figure 2, ITASE has tended to distribute its goals geographically among the involved nations. A workshop identified tasks for national participants, and the Scientific Committee on Antarctic Research (SCAR) Global Change Program provides coordination.

Germany, Italy, New Zealand, the United Kingdom, and the United States contributed to the Antarctic Geological Drilling Program (ANDRILL) and obtained deep sediment cores from the sea bed that show Earth's climate 15–30 MYA. These paleoclimate perspectives increase confidence in the ability to predict future change. Using the McMurdo Ice Shelf as a drilling platform, the project found new evidence that even a slight rise in atmospheric carbon dioxide affects the stability of the West Antarctic Ice Sheet.

France and the United States combined their capabilities in the Concordiasi project to develop a new way of measuring the constituents of the atmosphere, layer by layer, from top to bottom with new instruments that are dropped from long-duration stratospheric superpressure balloons deployed from McMurdo. Their data are coupled with surface observations at a number of Antarctic locations. This Concordiasi project is intended to reduce uncertainties in aspects of climate change that could change the mass balance of the Antarctic ice sheet. Figure 4 shows an instrument (dropsonde) launched on demand under a parachute to measure atmospheric parameters on the way down over Antarctica.

FIGURE 4. Dropsonde.

In biology a major impetus has been provided to marine scientists by the Census of Antarctic Marine Life (CAML). The Southern Ocean is around 10% of the world's oceans, and together with the Arctic Ocean, it is the least studied. It is a major carbon sink, and one of the globe's major ecosystems. This five-year CAML program involved 27 cruises on research vessels from the United States, United Kingdom, Australia, New Zealand, France, Russia, Belgium, Germany, Spain, Italy, Brazil, Chile, Uruguay, Peru, and Japan searching both the seafloor and the water column for new species, of which hundreds have already been identified.

These multinational research programs are conceived through a variety of mechanisms that include scientific workshops, meetings convened under science and technology agreements between and among nations, and, increasingly, electronic access to data of common interest. For over 50 years SCAR has provided a broadly international forum for identifying and building on common interests among scientists and building collaborations and plans for achieving them. Its major new programs on Antarctic climate evolution, biodiversity, subglacial lakes, and solar-terrestrial physics now involve more than 30 nations.

INFRASTRUCTURE AND LOGISTICS

Implementing these multinational projects is possible only because nations share access to their national infrastructures and logistics in Antarctica. The Council of Managers of National Antarctic Programs (COMNAP), which brings operational expertise to bear in all aspects of Antarctic support, is of particular importance in facilitating the range of logistic support needed in Antarctica to carry out these studies in a safe and environmentally responsible manner. The COMNAP members work closely with each other, with other governmental agencies in their nations, and with SCAR to match international logistic infrastructure to the needs of these international science collaborations.

The following are just a few examples of shared infrastructure:

- the French-Italian station at Dome C that hosts, among many other projects, a significant portion of the Concordiasi project;
- the Airbus A319 that is operated by the Australian Antarctic Program as an important component of the logistics pool, as are the wheeled and ski-equipped

C-130s that New Zealand and the United States operate; and

- the Swedish icebreaker *Oden* that hosts joint U.S.-Swedish research in the Southern Ocean and opens the channel through the sea ice that enables annual resupply of the U.S. research stations at McMurdo and the South Pole.

The flags of the 12 nations that brought the Antarctic Treaty into being are proudly arranged in front of the new Amundsen-Scott South Pole Station of the U.S. Antarctic Program that was dedicated in 2009 (Figure 5). This station hosts researchers from around the world in the tradition of partnership that so characterizes Antarctica.

FIGURE 5. The new Amundsen-Scott South Pole Station of the U.S. Antarctic Program that was dedicated in 2009. Flags of the 12 original signatory nations of the Antarctic Treaty are arranged in front.

Clearly, Antarctica, with its unique treaty and its long heritage of scientific research, remains a model of international cooperation, one with lessons for international science everywhere.

SUMMARY

Research at the frontier of science certainly can be performed and organized solely by individual scientists in two or more nations. But when complicated logistics partnerships are required, as are needed in supporting research in the huge and distant Antarctic, the legal framework provided by the Antarctic Treaty and the intellectual framework provided by the International Polar Year enable partnerships to develop and flourish over the several years required for planning, fieldwork, and follow-through in laboratories back home. The scientific value of the Antarctic will continue to increase as its role in Earth system science is more fully realized, and it is only through international collaboration that many of these pressing questions will be answered.

Acknowledgment

I am pleased to have this opportunity to thank and congratulate the International Council of Science and the World Meteorological Organization, together with the national IPY programs, for shouldering the critically needed responsibilities that made this fourth IPY a success.

LITERATURE CITED

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