Poles Apart, Science Thrives on Thin Ice

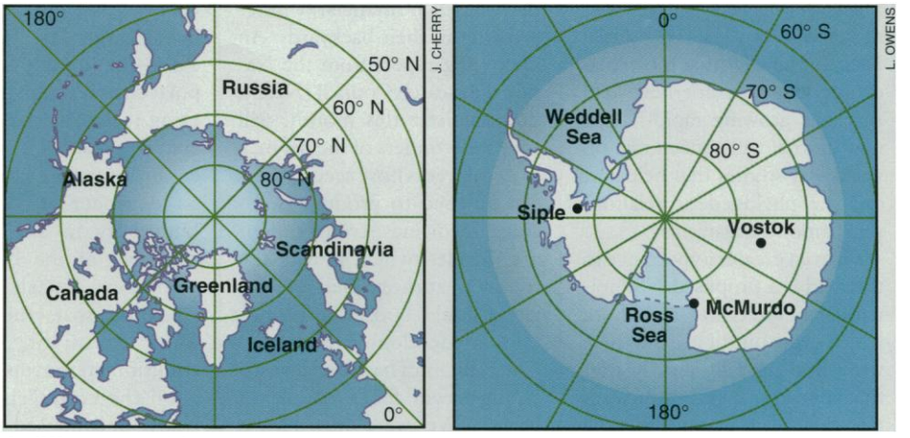
Environmental constraints, the demise of the USSR, and cost-cutting have threatened Arctic and Antarctic science, but for now research at the poles is going strong

NEXT MONTH A TEAM OF 30 SCIENTISTS AND technicians will try something unique. Living in a temporary camp on the ice sheet covering the Weddell Sea in Antarctica, the team will drift north, measuring the salinity, gas composition, and temperature of the ice and the water beneath it. Their goal, which is supported by funding from the National Science Foundation (NSF) is a better understanding of the ocean-ice-atmosphere interactions in a part of the planet that has never been explored. Says oceanographer Arnold Gordon of Lamont-Doherty Geological Observatory, one of the principal investigators, "It's an exciting piece of science and also an adventure."

Polar research has always been a mix of science and adventure that for centuries has served as a siren call to researchers and explorers. But the adventure has frequently been pursued in combination with geopolitical interests. For the United States, the demise of the Soviet Union has removed the strategic imperatives that assured national support for polar science. In the north, the need for a strong military presence is gone, weakening many of the obvious rationales for military and civilian research alike. Also damaging has been the loss of the Soviet Union as a powerful collaborator in what was planned to be a major thrust to gain a better understanding of the Arctic ecosystem.

A similar situation exists at the South Pole. While the Soviets never posed a military threat necessitating a U.S. presence in Antarctica, there was a geopolitical imperative stating that wherever the Soviet Union went, the United States went, too. Now that imperative is gone. In addition, the political muscle of environmental groups has put an end to the days when research could be carried out without thinking about its environmental consequences, and that has put tight constraints on research at the South Pole.

The news for polar research is by no means all bad, however. Ironically, the same environmental concerns that can be confining are also stimulating new interest in the poles—not least because of the ozone hole discovered over Antarctica. Both poles contain a valuable record of how the earth responded to past climate changes, and both will provide clues about how it can be expected to change in the future. And despite the political turmoil, some projects with scientists from the former Soviet Union are going forward. The following report, based on visits to both Greenland and the South Pole during the past 8 months and on extensive interviews, suggests that there are many exciting projects in full bloom, and many others that will soon get under way despite the uncertain role Arctic regions will play in the emerging world order.



A different world. *For polar researchers, this is how to look at the earth.*

Both the promise and the uncertainty of polar research is demonstrated by the Weddell Sea ice camp. It was intended as a joint U.S.-USSR activity, with half the funding and half the crew of 30 scientists and technicians to come from former Soviet states. So Lamont-Doherty's Gordon was naturally concerned that the hard currency needed to sustain the operation might be hard to come by. But despite the political icebergs, the project remains afloat. The ice breaker *Akademik Federov* is scheduled to leave Montevideo, Uruguay, later this month carrying Russian helicopters and Russian-made buildings that will be used to set up the camp. So far, everything seems to be keeping to schedule, prompting Gordon to say that he's "amazed [the Russians] are moving ahead with that program in view of their problems back home."

But there are financial problems on the home front, too. Although the budget for the U.S. Antarctic program grew from $175 million last year to $193 million this year, $30 million of that is destined for environmental cleanup and protection. Take away another $105 million for the U.S. Navy, which maintains McMurdo base and flies the NSF's fleet of ski-equipped cargo planes, plus another $55 million or so for NSF's own logistical support in New Zealand and McMurdo and now you're looking at a much smaller program.

Increasing the financial worries is the added cost to research from environmental restraints. At a meeting in Madrid last October, the signatories to the Antarctic Treaty adopted strict measures to protect the Antarctic environment and to delay for 50 years any mineral development on the continent.

Environmental groups were delighted. "It was a huge victory," says Jim Barnes, executive director and general counsel of the Antarctic and Southern Oceans Coalition. But Barnes admits the new protocols will make conducting research more difficult. Not only are there environmental impact statements to file, but there are also rules on treatment of indigenous wildlife, prohibitions on the importation of alien species to the continent (no more sled dogs, for example), and rules on waste disposal. "It means that science, and logistics for the science, will be more expensive," says Barnes. "It means that they have a lot more hoops to go through in terms of planning projects." The Senate must still ratify the protocols, and new legislation will be required to define how they will be

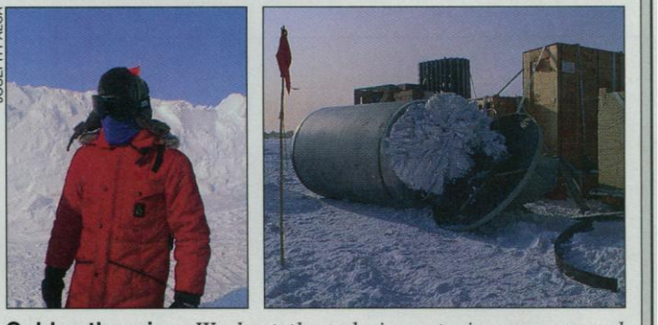
Hot Research in a Cold Climate

Amundsen-Scott South Pole Station—Science at the South Pole is no picnic. It's hard on people and on equipment. Everybody knows about the cold (average temperature -56° C). What most people don't know is the altitude: 9000 feet above sea level. The first few days at the pole are often accompanied by altitude sickness. The symptoms are usually mild—headaches and difficulty sleeping—but they can be severe, even life-threatening. Equipment suffers, too. Of the first three airplanes that landed here at the end of October to relieve the over-winter crew and start bringing in people and supplies for the summer season, two broke down for cold-related reasons.

Yet each year more researchers clamor to get to the South Pole. That's because astronomers, astrophysicists, atmospheric chemists, and climatologists have all come to realize that the South Pole provides a unique platform for research. Right now some of the most exciting work is being done by astrophysicists. George Smoot and his colleagues from the University of California at Berkeley and Jeffrey Peterson from Princeton University were among the first to arrive at the pole this year to set up their experiments to study the cosmic background radiation. Both are looking for "lumpiness" in the early universe—some irregularity in the soup of particles that existed after the Big Bang around which stars and galaxies could form. Both conduct work at other locations on Earth, but they are drawn to the pole because of its uniquely favorable conditions: thin atmosphere, extremely low water vapor in the atmosphere, and the fact that since they are sitting on the earth's axis, they can keep the same object in view for days or weeks at a time. Smoot's group isn't saying for sure, but they think they've found a crucial piece of evidence for cosmic lumpiness, and if this season's observations confirm earlier results, it could be the clearest evidence so far of structure in the early universe.

Also this year, a site was selected for the new Center for Astrophysical Research in Antarctica (CARA)—one of the National Science Foundation's Science and Technology Centers. CARA will support three major instruments: a 1.7-meter-diameter submillimeter telescope, a 60-centimeter diameter near-infrared telescope, and an instrument to study the cosmic background. In addition, astrophysicists from the University of Wisconsin at Madison, and the University of California campuses at Berkeley and Irvine are launching an exotic scheme to see if the polar ice cap can be used as a giant neutrino detector. The researchers are trying to capture those elusive subatomic particles that theorists say are pouring out of the interiors of pulsars, quasars, and black holes. If the optical qualities of the ice are appropriate, collisions between neutrinos and ice particles will generate Cerenkov light that can be detected with photomultipliers buried in the ice.

Speaking of ice, many researchers head south to study the commodity the continent specializes in. By early November, this year, McMurdo was filled to overflowing with scientists unable to get to field camps because of problems with ski-equipped cargo planes. A virtual Who's Who of Antarctic glaciology cooled their heels in crowded barracks, debating the role that the giant rivers of ice they were waiting to study play in the movement of ice from Antarctica into the sea. By now, all are deep into their projects with only a month or so left before the Antarctic summer is over.



Colder than ice. *Work at the pole is a strain on man and machine. This liquid nitrogen tank couldn't take it.*

Also on hold in November were several teams participating in CASERTZ, an acronym standing for Corridor Aerographics of the Southeast Ross Transect Zone, which is performing a high-resolution aerial survey of a portion of the west Antarctic ice sheet. The CASERTZ team is using a chartered Twin Otter airplane to make gravity and radar measures of the land underneath the ice sheet. Geophysicist Donald Blankenship of Ohio State University is convinced that the CASERTZ measurements—which will provide a better picture of the bedrock underlying the west Antarctic ice sheet—will be even more informative than the glaciologists' measurements in predicting when and if the ice sheet will fall into the sea, causing a catastrophic rise in sea level around the world.

One particularly interesting McMurdo-based project that wasn't ready to fly this year but is scheduled to get under way in 1993 is the International TransAntarctic Scientific Expedition. "The plan is to do a multidirectional traverse over several parts of Antarctica, and every 50 to 100 kilometers to plunk down a core that would go back in time about 200 years," explains Paul Mayewski, a glacial geochemist at the University of New Hampshire. Those cores, he adds, "would provide a 200-year baseline, background environmental map of Antarctica." With virtually all of the continent free from any human disturbance, Antarctica is one of the last places on Earth such a map can be constructed. ■ J.P.

administered. Insiders project a larger role for the Environmental Protection Agency (EPA) and the National Oceanic and Atmospheric Administration (NOAA), two federal agencies with more experience and a better track record than NSF in protecting the environment.

If the new rules will make problems in the future, for the present research in Antarctica is thriving, as *Science* found out in a recent trip there. The South Pole has recently become one of the hottest spots for astronomical observations, and astronomers have chosen a site at the pole for a new NSF-sponsored astrophysical observatory that will operate year round (*Science*, 14 June 1991, p. 1494).

Astrophysics isn't the only science that's booming. At the western edge of the Ross Sea, two dozen glaciologists and geophysicists are trying to understand the dynamics of the west Antarctic Ice Sheet. Their interest is more than academic: If the ice sheet is destined to break off into the ocean—as it apparently has during previous interglacial periods—sea level could rise around the globe by as much as 6 meters. Some 1000

kilometers away, at McMurdo base on the edge of the Ross Sea, NSF last November opened the $23-million Crary Science and Engineering Center, whose computers and biology laboratories will allow data to be processed at McMurdo rather than waiting until scientists get home.

For the Arctic, the logistical problems are similar. In the days when the far north constituted a true defense perimeter, U.S. scientists were able to piggyback on military operations. For example, glaciologists and climatologists have been able to take advantage of military flights to Sonderstromfjord, Greenland, in order to supply GISP, the Greenland Ice Sheet Project. Aiming to create a 200,000-year climate record using ice cores from the 3000-meter-thick Greenland ice cap, GISP reached a milestone this year, drilling ice cores down to a level of 1510 meters. Next year, geologists intend to reach their goal. But the Air Force, which used Sonderstromfjord as a staging point for supplying missile radar stations, will close the base, since the radars have been decommissioned. Without the Air Force support, the project may end next season whether or not the drillers reach bedrock.

One potential advantage the northern scientists have over their southern compatriots is that environmental groups have not been as active in seeking controls on Arctic activities. Those environmental policies that do exist have largely been due to efforts by the Scandinavian countries, with the United States a sometimes unenthusiastic partner. The recently formed Arctic Monitoring and Assessment Program (AMAP) provides a good example of how environmental politics works inside the Arctic Circle. At the instigation of Finland, the eight countries whose territory falls inside the Arctic Circle—the United States, Canada, Russia, Iceland, Denmark, Finland, Norway, and Sweden—met in Rovaniemi, Finland, in 1989 to develop the Arctic Environmental Protection Strategy. The purpose of AMAP was to measure the "levels of anthropogenic pollutants and the assessment of their effects in relevant component parts of the Arctic environment." EPA was designated the lead U.S. agency for AMAP, but at the first AMAP organizational meeting held in Tromso, Norway, from 2-6 December, last year, the EPA did not send a representative.

An EPA official told *Science* that his agency was satisfied that U.S. interests would be adequately represented by NOAA and the State Department, both of which sent representatives. But EPA's decision not to attend ruffled some feathers in the State Department, and has raised concerns among scientists about the strength of the U.S. commitment to Arctic environmental research.

Despite the diffuse nature of the U.S. Arctic research program—spread over several federal agencies as opposed to the Antarctic program that is primarily administered by NSF—most Arctic research advocates believe the importance of the poles to understanding global climate will sustain research, even if the strategic importance of those areas has declined. The United States is poised to begin a major study of the Western Arctic ocean, several new studies of the Arctic stratosphere are either on the drawing board or under way, and there are several new Earth-observing satellites that will spend a substantial part of their operating time gazing down at the Arctic.

One reason it's likely that research at the poles will maintain its momentum is that there is something about polar research that captures the imagination. After all, research is constantly searching for new frontiers and, as the earth gets smaller, the poles remain one of the last of all the geographic frontiers. That alone should help keep the U.S. polar programs on track. ■ JOSEPH PALCA

Sitting on Top of the World

Summit, Greenland—Piled in a cave dug 15 feet into the ice that covers 84% of this island are dozens of rods of ice 18 feet long and 5.2 inches in diameter. These are the stored ice cores of the National Science Foundation (NSF)-sponsored GISP, the second Greenland Ice Sheet Project, which for 2 years has been drilling its way to the bottom of the 3000-meter ice cap that sits on top of Greenland. At present, most of this year's cores are too brittle to analyze, but next summer, when trapped gas bubbles have escaped, scientists will carve the rods up and read a record of ancient climates held in the layers of ice. Along with other cores from both the Arctic and Antarctica, scientists hope to have an accurate picture of how the earth's climate has changed in the days before human habitation had such a large impact.

What makes this project special is that GISP will provide the longest continuous record of climate change obtained in the northern latitudes. For glaciologists, the record will help them answer a question that will be of fundamental importance if global climate changes. As Richard Alley of Ohio State University puts it: "Will the ice sheets collapse and flood your favorite city?" The ice-core record will help establish "the balance of snow and flow," says Alley. Coupled with other physical characteristics of the ice such as the size of the ice grains and the composition of the dissolved gases, the cores should say a lot about how Greenlands's ice sheets behaved during past changes in global climate.


IMAGE BANK


JOSEPH PALCA

Tracking ice. *Polar researchers are interested in where Arctic ice is going and where it comes from. At the summit of the Greenland ice sheet, GISP* (above) *will give some answers.*

GISP is just one of the major U.S.-sponsored projects either under way or in an advanced state of planning. GISP is part of the NSF-sponsored Arctic System Science (ARCSS) program. As GISP winds down after this year, other ARCSS projects that will look at how ancient climate records are preserved in Arctic lakes and estuaries as well as how land, ocean, and ice interact with the atmosphere in the Arctic.

Unlike Antarctica, where research efforts are primarily sponsored by NSF, nearly a dozen federal agencies have significant activities in the Arctic. To coordinate that jumble, in 1984 Congress established the Arctic Research Commission, which was intended to recommend an integrated national Arctic research policy. This summer, in a move that should help put some order into the U.S. research presence in the Arctic, an interagency committee came up with a plan for four new projects: a study of the Western Arctic ocean, a study of the geodynamics of the Arctic basin, an Arctic environmental monitoring program, and an investigation of the Bering land bridge that once connected Alaska and Russia. ■ J.P.