



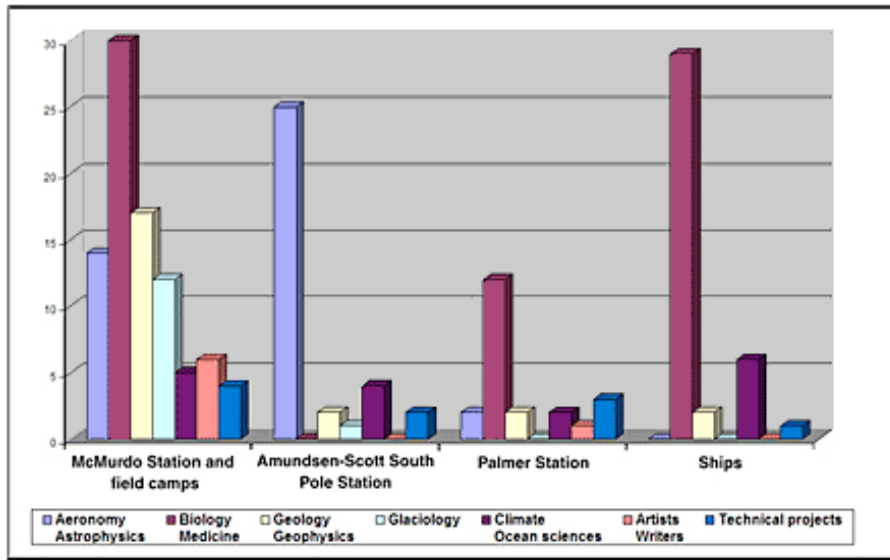
U.S. ANTARCTIC PROGRAM, 2005–2006

As part of the U.S. Antarctic Program, more than 800 researchers and special participants will conduct 165 projects during the 2005–2006 austral summer, with some projects continuing through the austral winter. Supported by over 2,000 civilian contract employees and U.S. military personnel, these researchers and special participants (writers, artists, and teachers) will work at the three year-round U.S. stations (McMurdo, Amundsen–Scott South Pole, and Palmer), at remote field camps, with other national antarctic programs at locations around Antarctica, and in the waters of the Southern Ocean aboard the U.S. Antarctic Program's two research ships—Nathaniel B. Palmer and Laurence M. Gould. These projects, funded and managed by the National Science Foundation (NSF), are part of the international effort to understand the Antarctic and its role in global processes. NSF supports research that can best be performed or can only be performed in Antarctica. The scientists conducting these projects come primarily from U.S. universities and have won NSF support by responding to the Antarctic Research Program solicitation (NSF 05–567; http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf05567&org=NSF). Operational resources in Antarctica are also used to support scientists from other Federal agencies.



The flags of the original 12 signatory nations of the Antarctic Treaty fly next to a bust of Admiral Richard Byrd at McMurdo Station. (NSF/USAP photo by Rob Jones)

U.S. Antarctic Program Science Projects by Discipline and Research Site



During the 2005–2006 austral summer, 88 projects will be based at McMurdo Station or at remote field sites, 38 will be supported on research ships, 34 will operate at Amundsen–Scott South Pole Station, and 22 will do work in and around Palmer Station.

Science highlights

The following projects are among those supported during this austral summer and winter. Where appropriate, links for additional information have been added. NSF-funded science awards can also be found in the online NSF awards database. To access this information, search the database at <http://www.nsf.gov/awardsearch/>. Each NSF award listed here, as well as in the other sections of this document, includes the award number, which can be used to do a keyword search.

Biology and medicine

- International Graduate Training in Antarctic Biology.** This month-long NSF-sponsored international course will be held at McMurdo Station, starting in January 2006. Up to 20 graduate students, postdoctoral fellows, and other research scientists interested in studying extreme environments and the biology of antarctic organisms will participate. The course emphasizes integrative biology, with laboratory- and field-based projects focused on adaptations in an extreme polar environment. A diverse teaching faculty will offer students the chance to work on a wide range of antarctic organisms (bacteria, algae,

invertebrates, and fish) and at several levels of biological analysis (molecular biology, physiological ecology, species diversity, and evolution). (NSF/OPP 05-04072; <http://antarctica.usc.edu/>)

- **Weddell seal population dynamics.** The Weddell seals that live in McMurdo Sound have been studied since 1968 in one of the longest intensive field investigations of long-lived mammals anywhere. More than 15,000 animals have been tagged, and 145,000 resightings have been recorded. This project is a resource for understanding the population dynamics not only of Weddell seals, but also of other species of terrestrial and marine mammals. New work this season includes assessing the role of food resources in limiting the population. (NSF/OPP 02-25110; www.homepage.montana.edu/~rgarrott/index.htm)
- **Genomic study of invertebrates.** Cold-ocean ecosystems constitute 72 percent of the Earth's biosphere by volume, yet they are sparsely inhabited and relatively unexploited. Environmental adaptations of the few animals that manage to exist on this verge of intracellular freezing are ideal subjects for exploring at the genomic level. This project is quantifying gene expression in sea stars and sea urchins to determine whether it is more or less difficult for an organism to grow in a polar extreme. To interest students in the developing field of environmental genomics, the project has an internship program for minority students and a K-12 education program. (NSF/OPP 02-38281; <http://marsh.cms.udel.edu/~amarsh>)

Ocean and climate systems

- **Maud Rise Nonlinear Equation-of-State Study.** When layers of sea water with similar densities but strong contrasts in temperature and salinity interact, a number of possible nonlinear instabilities can convert existing potential energy into turbulent energy. In the Weddell Sea, a cold surface mixed layer is often separated from the underlying warmer, more saline water by a thin, weak pycnocline (a layer of water where density changes rapidly with depth due to changes in temperature or salinity), making the water column particularly susceptible to an instability associated with thermobaricity (the process by which the thermal expansion coefficient increases with depth). The project is a collaboration between New York University, Earth and Space Research, the University of Washington, the Naval Postgraduate School, and McPhee Research Company. The investigation will contribute to understanding the Weddell Polynya, a 300,000-square-kilometer area of open water that existed within the seasonal sea ice of the Weddell Sea from approximately 1975 to 1979. This polynya has not recurred, although indications of much smaller and less persistent areas of open water do occur in the vicinity of the Maud Rise seamount. (NSF/OPP 03-37159; www.oc.nps.navy.mil/~stanton/thermo/Maudness/MaudnessMainHome.html)
- **Surface carbon dioxide in the Drake Passage.** The Southern Ocean is an important part of the global carbon budget, and the Drake Passage is the narrowest place through which the Antarctic Circumpolar Current goes. This chokepoint is an efficient site to measure the latitudinal gradients of gas exchange, and the ice-strengthened research ship Laurence M. Gould will support a project to measure dissolved and total carbon dioxide, providing data that, together with satellite images, will enable estimates of the net production and export of carbon by oceanic biota. (NSF/OPP 03-38248; www.ldeo.columbia.edu/res/pi/CO2)

Aeronomy and astrophysics

- **Infrared measurement of the atmosphere.** Winter measurements of atmospheric chemistry are providing data for predicting ozone depletion and climate change. Since most satellites do not sample the polar regions in winter, these ground-based measurements are expected to make an important contribution. (NSF/OPP 02-30370)
- **A 10-meter telescope for South Pole Station—South Pole observations to test cosmological models.** Much of the mass in the Universe is made up of dark matter, which emits little or no light or other electromagnetic radiation and makes its presence known only through the gravitational force it exerts on luminous matter. The University of Chicago will lead a consortium of six institutions to design and operate a 10-meter off-axis telescope located at Amundsen-Scott South Pole Station to survey galaxy clusters. Such a survey will allow them to study integrated cluster abundance and its red shift evolution and will give precise cosmological constraints, completely independent of those from supernova distance and cosmic microwave background anisotropy measurements. A foundation was built for the new telescope at the South Pole during the 2004-2005 austral summer. Construction of the support facility for the telescope will continue during this austral summer. (NSF/OPP 01-30612)
- **IceCube.** Work will continue on the world's largest neutrino detector, which—after 6 years of work—will occupy a cubic kilometer of ice beneath South Pole Station. The detector will deploy 4,800 photomultiplier tubes into holes created in the ice by a hot water drill. Neutrinos are special but hard to detect astronomical messengers that can carry information from violent cosmological events at the edge of the Universe or from the heart of black holes. The history of astronomy indicates that work in new energy regions has invariably led to the discovery of unexpected phenomena. By peering through a new window on the universe, IceCube could open new frontiers of understanding. During the 2005-2006 austral summer, participants will drill 10 ice holes and deploy 10 IceCube strings and 20 Ice-Top tanks. (NSF/OPP 03-31873; <http://icecube.wisc.edu/>)
- **Cosmic microwave background (CMB) polarization measurements.** The combined QUEST/DASI (or QUaD), a major upgrade to the DASI (degree angular scale interferometer) telescope, is a bolometric array receiver that is being used to search for polarization in the CMB. The spatial distribution of polarization contains important information about cosmological parameters and about the origin of temperature anisotropies (variations) in the CMB. Although the signal is tiny (1 to 10% of the temperature fluctuations), the scientific rewards are great. A measurement of polarization has the potential to distinguish between inflationary models by measuring the amount of primordial gravitational waves that are a relic of the inflationary epoch. The South Pole site for QUaD offers the advantages of altitude and cold that lead to little overhead water vapor, atmospheric stability that allows long observation periods, the ability to perform observations of the same areas of the sky throughout the year, and limited interference by the Sun and Moon. (NSF/OPP 03-38138, NSF/OPP 03-38238, and NSF/OPP 03-38335; <http://astro.uchicago.edu/dasi> and www.stanford.edu/~schurch/quad.html)

Glaciology

- **West Antarctic Ice Sheet divide.** This 5-year science program, involving a dozen research teams, will develop a detailed record of greenhouse gases for the past 100,000 years, determine whether changes in the Northern and Southern Hemispheres initiated climate changes over the past 100,000 years, investigate past and future changes in the West Antarctic Ice Sheet, and study the biology of deep ice. During the 2005-2006 austral summer, the camp infrastructure for the drilling program will be assembled at a site on the West Antarctic Ice Sheet divide. Construction crews will establish a skiway and a camp capable of supporting the science and drilling teams (approximately 45 people) that will collect a 3,400-meter ice core

to bedrock. A 200-foot steel arch will be constructed to house the drilling and core processing facilities for this deep drilling project. (NSF 04-40817; NSF/OPP 04-40759, NSF/OPP 04-40498, NSF/OPP 04-40509, NSF/OPP 04-40602, NSF/OPP 04-40615, and NSF/OPP 04-40701; <http://waisdivide.unh.edu/>)

- **A mobile sensor web for Polar Ice Sheet Measurements (PRISM).** PRISM research aims to develop innovative sensors (imaging and sounding radars), supported by wireless communications, intelligent systems, robotics, and ice-sheet modeling, to image the ice-bedrock interface, measure ice thickness, and map internal layers in the ice to provide key measurements for studying the contribution of the polar ice sheets to the rise in sea level. Researchers integrate and operate the sensors from an autonomous rover and a tracked vehicle equipped with communication and navigation systems. An intelligent system determines an optimum sensor configuration for imaging the ice-bedrock interface and the operational requirements for the rover. (NSF 01-22520; <http://www.ku-prism.org/>)
- **Tidal influence on ice stream flow.** Ice from the West Antarctic Ice Sheet flows to the sea through a number of ice streams, but the factors controlling the flow of these streams are not well understood. Earlier work at the Whillans Ice Stream on the Siple Coast demonstrated that their flow is surprisingly sensitive to changes in the tide beneath the Ross Ice Shelf. By measuring the rise and fall of the tide, researchers hope to improve their understanding of the controls on ice streams and gain information important for modeling the ice sheet. (NSF 02-29629; www.geosc.psu.edu/~sak/Tides)

Geology and geophysics

- **Old buried ice.** Ice has covered Antarctica for millions of years, but the ice itself is not that old; most of it arrives as snow and leaves as icebergs within a few hundred thousand years. Buried ice in the McMurdo Dry Valleys is thus a rare archive of atmosphere and climate potentially extending back millions of years. This project will study the surface processes that preserve ice, test ways of dating tills above buried ice, assess ways to date buried ice, and use these data to help resolve a debate over whether the deposits are as old as some scientists think they are. (NSF 04-40711; <http://people.bu.edu/marchant/themesBuriedIce2.htm>)
- **ANDRILL—Investigating Antarctica's role in Cenozoic global environmental change.** ANDRILL, an international program representing over 150 scientists from Germany, Italy, New Zealand, the United Kingdom, and the United States, is focused on Antarctica's role in Cenozoic global environmental change. Over the course of the project, ANDRILL researchers will obtain a record of important Eocene, Neogene, and Holocene stratigraphic intervals in high southern latitudes to address four themes—the history of the antarctic climate and ice sheets, the evolution of polar biota, antarctic tectonism, and Antarctica's role in the Earth's ocean-climate system. During this field season, teams will collect data to identify sites in southern McMurdo Sound for drilling. Field activities include an over-ice seismic survey to collect 20 kilometers of new seismic data, a transect of sea-floor sediment samples gathered by using a grab sampler, and an over-ice gravity survey along the seismic survey line. The teams will also use two Acoustic Doppler Current Profiling devices to make oceanographic measurements and will obtain data on currents to model sea-rise behavior at the probable drilling sites. (NSF 03-42484; <http://andril.org/>)
- **Shallow drilling along the antarctic continental margin (SHALDRIL)—Demonstration ocean-bottom drilling in the James Ross Basin.** Scientists exploring the shallow shelves along the margins of Antarctica have been consistently frustrated by the inability to penetrate through the overcompacted glacial diamictons found at shallow sub-bottom depths. Advanced seismic reflection techniques show that older sections of Neogene and Paleogene sequences lie just beneath this thin veneer of diamictons. Four years of testing have demonstrated that a diamond coring system can be used on the U.S. research ship Nathaniel B. Palmer for drilling along the antarctic continental margin. During this austral summer, the research team will conduct a demonstration cruise near Seymour Island on the west coast of the Antarctic Peninsula. Here, the well-defined geologic section is estimated to range in age from Eocene to Quaternary, spanning the "Greenhouse-Icehouse" transition of global climate change. If successful, the mobile drilling system will be available to the scientific community for further exploration of the continental shelves. (NSF/OPP 01-25922, NSF/OPP 01-25480, and NSF/OPP 01-25526; <http://www.shaldril.rice.edu/> and www.arf.fsu.edu/shaldril.cfm)
- **Seismograph.** The world's quietest earthquake detector lies 300 meters beneath the surface of the ice sheet 8 kilometers from the South Pole. Completed in 2002, the station is detecting vibrations four times smaller than those recorded previously. Other seismographs have been there since 1957, and long-term, high-latitude data have helped prove that the Earth's solid inner core spins faster than the rest of the planet. Also, Antarctica is the continent with the fewest earthquakes, so the new station will record small regional earthquakes, thereby leading to new insights into the Antarctic Plate. (NSF/EAR 00-04370; www.iris.washington.edu/about/GSN)

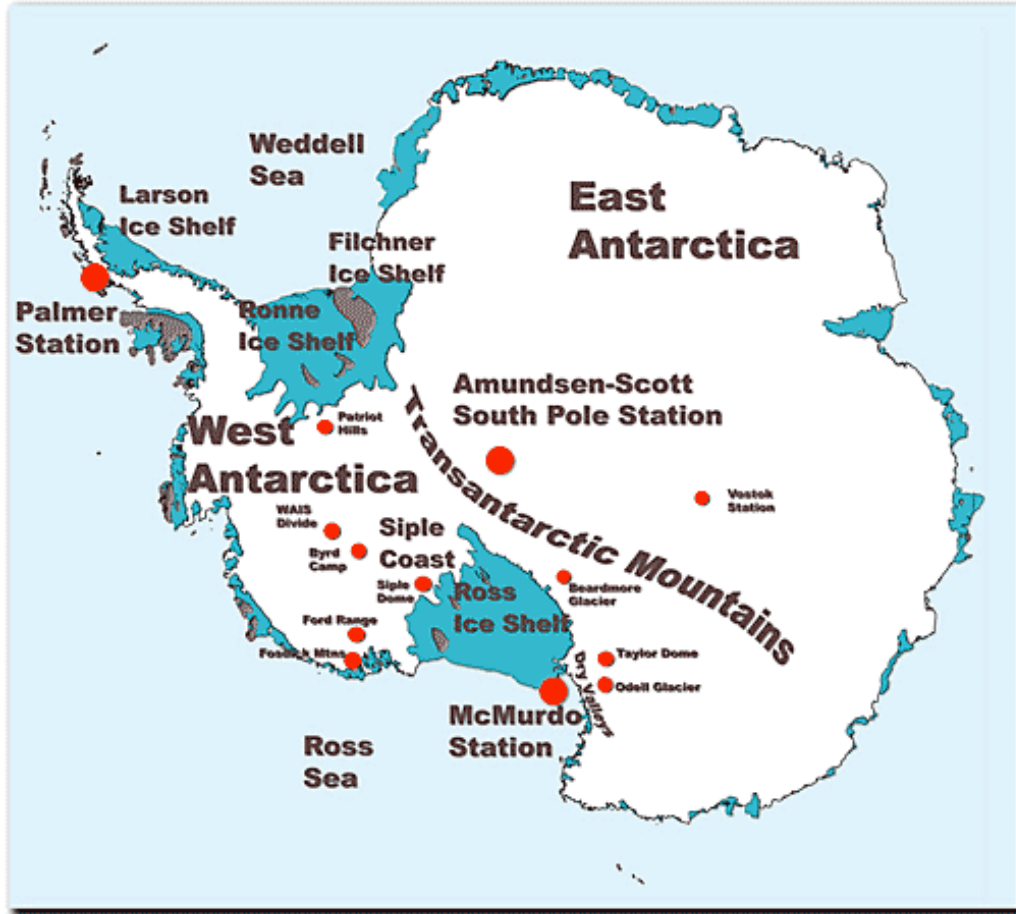
Artists and writers program

This program, which records the Nation's antarctic cultural heritage and extends understanding of the region and the U.S. Antarctic Program within the research community and beyond, will support the following eight projects.

Artist/Writer	Project Title	Event Number
Henry J. Kaiser	Shooting Video in McMurdo to Supplement a 2001 Project	04-39708
Kathleen M. Heideman	<i>The Scientific Method: Poems of Antarctic Inquiry</i>	04-40619
Joseph F. Montaigne	A Season at Palmer	04-40659
Sarah Andrews	<i>In Cold Pursuit</i> (working title)—A Science-Based Mystery Novel Set in the Antarctic	04-40665
J. Allan Campbell	Antarctica—Images from a Frozen Continent	04-40702
Gabriel P. Warren	Examination of Crevasses and Other Iceforms as Artistic Sources	04-41979
Lawrence J. Conrad and Ann Hawthorne	Field Guide to Antarctic Features: McMurdo Sound Region	no award number*
George Steinmetz	Antarctica: The Frozen Desert	no award number*

* These awards have no electronic record because they were made before proposals were submitted via FastLane to the Antarctic Artists and Writers Program.

U.S. Antarctic Program, 2005–2006: Sites of Major Activities



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