U.S. ANTARCTIC PROGRAM, 2004–2005

As part of the U.S. Antarctic Program, nearly 700 researchers and special participants will conduct 139 projects during the 2004–2005 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 U.S. year-round 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 icebreaking research ships—*Nathaniel B. Palmer* and *Laurence M. Gould*.

Ground crews fill a long-duration, high-altitude balloon at Williams Field, the U.S. skiway near McMurdo Station on the Ross Ice Shelf. The balloon takes advantage of the high-altitude wind currents that circle Antarctica, bringing the balloon back close to its point of origin, so that its payload can be retrieved. Instrument payload also sends data back to ground receivers. These instruments enable researchers to collect data about cosmic rays, electron precipitation from Earth's radiation belts, and other similar phenomena in near-space environments. (*NSF/USAP photo by Melanie Connor, Raytheon Polar Services Corp.*)

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. Besides research projects, NSF's Office of Polar Programs (OPP) and the Directorate for Human Resources support Teachers Experiencing Antarctica (TEA)/ARMADA (www.armadaproject.org). The ARMADA Project, which is administered by the University of Rhode Island's Office of Marine Programs, provides K–12 teachers with an opportunity to actively participate in ocean, polar, and environmental science research and peer mentoring. During this austral summer, as part of her professional development, Elizabeth Gibbs will work with benthic ecologist Stacy Kim of Moss Landing Marine Laboratories. Dr. Kim is studying the impact of human activities on McMurdo Sound. Another OPP program—the Antarctic Artists and Writers Program (NSF 04–558)—provides opportunities for painters, photographers, writers, and others to use serious writing and the arts to increase people's understanding of the Antarctic and America's heritage there.

The scientists conducting the projects come primarily from U.S. universities and have won NSF support by responding to the Antarctic Research Program Announcement and Proposal Guide (NSF 04–559; www.nsf.gov/pubsys/ods/getpub.cfm?nsf04559). Operational resources in Antarctica are also used to support scientists from other Federal agencies.

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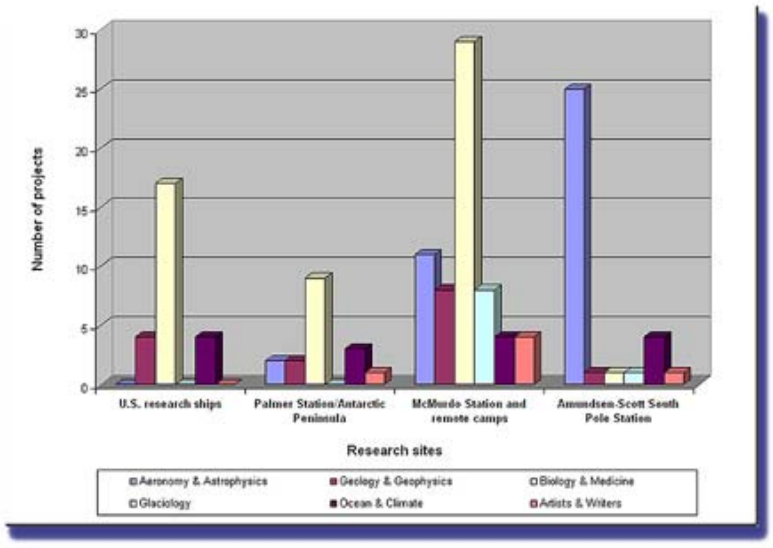
U.S. Antarctic Program Science Projects by Discipline and Research Site



During the 2004–2005 austral summer, 64 projects will be based at McMurdo Station or at remote field sites, 25 will be supported on research ships, 33 will work at Amundsen–Scott South Pole Station, and 17 will 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 www.nsf.gov/awardsearch/index.jsp. 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.

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Biology and medicine

- **Long-term ecological research (LTER).** Two sites in Antarctica—one in the McMurdo Dry Valleys (NSF/OPP 98–10219) and the other along the west coast of the Antarctic Peninsula centered on Palmer Station (NSF/OPP 02–17282)—are among the world's 25 NSF-sponsored LTER sites, which are being investigated to increase our understanding of ecological phenomena over long temporal and large spatial scales. All of the other sites except one are in the United States. (http://lternet.edu; Palmer LTER, http://iceflo.icess.ucsb.edu:8080/ice_hp.php; McMurdo LTER, http://huey.colorado.edu)

- **Weddell seal population dynamics.** Weddell seals have been studied in McMurdo Sound since 1968; this constitutes one of the longest intensive field investigations of long-lived mammals anywhere. More than 16,800 animals have been tagged, and almost 162,000 resightings have been recorded. The 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)

- **Before-and-after study of a sewage outfall site.** The human impact on Antarctica is small and generally highly localized, with one measurable point being the former sewage outfall at McMurdo Station. This project collected "before" data in 2002 and earlier while the outfall was still operating and is collecting "after" data this season and next following the January 2003 completion of McMurdo's new sewage treatment plant. While organic input to the seafloor dropped immediately and dramatically, the cold water is expected to recover more slowly than temperate water would. The project seizes this unique opportunity to understand anthropogenic impacts in a polar environment. A seventh-grade science teacher has joined the team to learn firsthand how the research is done and to transfer the process and outcomes of polar science to the classroom. (NSF/OPP 01–26319; http://benthic.mlml.calstate.edu, click on Antarctic

Research, then Aspire; TEA/ARMADA, http://tea.rice.edu/tea_gibbsfrontpage.html)

- **McMurdo Dry Valleys as an analog for Martian environments.** Endolithic microbial communities (those terrestrial flora living just below the surface of rocks) inhabit harsh environments that may represent the closest analog to the environment on Mars. As part of a study of the chemical signatures of endolithic microbes in hot and cold deserts, biologists will test a unique set of portable, nondestructive instruments in the McMurdo Dry Valleys. These instruments do not need to touch the rocks that host the organisms in order to detect the subtle chemical biosignatures associated with life. The instrument suite, called SPISE3, is composed of a spectroradiometer, a portable gas chromatograph, and an ultraviolet visible light wavelengths fluorescence spectrometer and imager. The project is part of an NSF–National Aeronautics and Space Administration (NASA) collaborative program called Astrobiology Science and Technology for Exploring Planets (ASTEP). (NASA award 02–0040–0014)

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Ocean and climate systems

- **Surface carbon dioxide in the Drake Passage.** The Southern Ocean is an important component of the global carbon budget. Low surface temperatures with consequently low vertical stability, ice formation, and high winds produce a very active environment for the exchange of gaseous carbon dioxide between the atmospheric and oceanic reservoirs. The Drake Passage is the narrowest point through which the Antarctic Circumpolar Current and its associated fronts must pass. This chokepoint is an excellent site to measure the latitudinal gradients of gas exchange. The research icebreaker *Laurence M. Gould* will support a project to measure dissolved and total carbon dioxide, providing data that, with satellite images, will enable researchers to estimate the net production and export of carbon by oceanic biota. (NSF/OPP 03–38248 and NSF/OPP 03–38155; www.ldeo.columbia.edu/res/pi/CO2)

- **AnSlope, cross-slope exchanges at the Antarctic Slope Front.** What is the role of the Antarctic Slope Front and continental slope morphology in the exchanges of mass, heat, and freshwater between the shelf and oceanic regimes, particularly those leading to outflows of dense water into intermediate and deep layers near deep basins and world ocean circulation? AnSlope, a multiyear experiment, focuses on these cross-slope exchanges between the Antarctic Shelf and the deep ocean. Although scientists understand the role that cold-water masses originating in the Antarctic play in global ocean circulation and climate, the processes by which these masses enter deep ocean circulation are not well understood. The primary goal of AnSlope is to identify the principal physical processes that govern the transfer of shelf-modified dense water into intermediate and deep layers of the adjacent deep ocean, as well as to understand the compensatory poleward flow of waters from the oceanic regime. (NSF/OPP 01–25172, NSF/OPP 01–25521, NSF/OPP 01–25523, NSF/OPP 01–25084, NSF/OPP 01–25431, and NSF/OPP 01–25602; www.ldeo.columbia.edu/res/fac/physocean/anslope)

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Aeronomy and astrophysics

- **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 use a 10-meter off-axis telescope located at Amundsen–Scott South Pole Station to survey galaxy clusters. This 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. (NSF/OPP 01–30612; http://astro.uchicago.edu/scoara/may2004workshop/TALKS/spt-carlstrom)

- **IceCube.** During the 2004–2005 austral summer, a consortium led by the University of Wisconsin–Madison will begin drilling into the ice sheet for the IceCube Observatory at the South Pole. IceCube is a neutrino telescope that will be buried 1.4 to 2.4 kilometers under the ice and will be used during the austral

summers over 5 years. The detector will consist of 4,800 optical modules deployed on 80 vertical strings. AMANDA (antarctic muon and neutrino detector array) is the prototype for this international collaborative effort. Using neutrinos as cosmic messengers, IceCube will open unexplored wavelength bands and will answer such fundamental questions as what the physical conditions in gamma ray bursts are and whether the photons originating in the Crab supernova remnant and near the supermassive black holes of active galaxies are of hadronic (derived from subatomic particles composed of quarks) or electromagnetic origin. The telescope will also be used to examine the particle nature of dark matter, aid in the quest to observe supersymmetric particles, and search for compactified dimensions. (NSF/OPP 02–36449; http://icecube.wisc.edu)

- **Cosmic microwave background (CMB) polarization measurements.** Scientists will mount QUEST, a 2.6-meter Cassegrain telescope equipped with a next-generation polarization-sensitive bolometer array, on the existing degree angular scale interferometer (DASI) platform at South Pole Station. They will use the combined system, which will operate over two austral winters, to make maps of the polarization of the CMB—the faint, relic heat from the Big Bang—which offers a snapshot of the Universe at the point where it transitioned from hot plasma to neutral gas. The statistics of the expected sky pattern for a given cosmological theory can be accurately calculated, and a host of experiments have now measured the variation of CMB's total intensity, or temperature. Taken together, these measurements have begun to reveal the origin, composition, evolution, and ultimate fate of the Universe. The QUEST system will provide measurements at an unprecedented sensitivity and angular resolution. (NSF/OPP 03–38138, NSF/OPP 03–38238, and NSF/OPP 03–38335; http://astro.uchicago.edu/dasi)

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Glaciology

- **Airborne geophysical survey of the Amundsen Sea embayment.** The Amundsen Sea embayment is the third major drainage basin of the West Antarctic Ice Sheet after the Ross and Weddell Sea embayments. Far from logistics centers, it is comparatively unstudied. However, recent satellite data and the limited amount of existing ice thickness data indicate that it has the largest ice flux in West Antarctica. Moreover, it is the only drainage basin exhibiting significant change in elevation during the era of satellite observations. The University of Texas and the British Antarctic Survey are making a comprehensive aerogeophysical survey of the embayment's major drainages—Pine Island Basin and Thwaites Glacier Basin. Geophysical maps resulting from these surveys will guide future surface-based research. (NSF/OPP 02–30197; www.ig.utexas.edu/research/projects/agasea)

- **West Antarctic Ice Sheet stability.** The Bottleneck—a unique, relatively narrow passage in the Transantarctic Mountains connecting the West and East Antarctic Ice Sheets—is located at the Ohio Range near the head of Mercer Ice Stream in West Antarctica. The glaciers in this area are sensitive to changes in snow accumulation and predominant wind direction. When compared with the record of the fluctuations of the adjacent ice sheet, the timing of alpine glacier advance will yield information that can be used to test climate reconstructions based on antarctic ice core records. In addition, the glacial record in the Bottleneck reflects the history of the interaction of the West Antarctic and East Antarctic Ice Sheets and can be used to test hypotheses regarding the collapse of the former during the Pleistocene (10,000 to 1.8 million years ago). (NSF/OPP 03–38189)

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Geology and geophysics

- **Buried ice in the western Dry Valleys, Antarctica—An analog for Martian ice?** Buried ice deposits may potentially contain a far-reaching record of Earth's atmosphere and climate extending back many millions of years. These deposits are terrestrial analogs to widespread and young buried ice on the Martian surface as identified by recent data from Mars Odyssey. Just as earlier researchers asked whether a climate record was stored in the modern ice sheets of Antarctica and Greenland, scientists are now asking whether ancient, debris-covered glaciers in the western Dry Valleys hold similar records of temperature and atmospheric change, but on time scales that are perhaps greater than those for the deepest existing ice core. The ice to be examined is over a million years old, making it by far the oldest ice yet known on Earth. A better understanding of surface processes

above buried ice will enable researchers to access a record of atmospheric and climate change that could well cover intervals that predate Quaternary time (11,000 to 1.8 million years ago). Since the conditions in the Dry Valleys are analogous to those found on Mars, extending the results could bring valuable insight into studies on the potential for life on Mars. (NSF/OPP 03–38291; http://people.bu.edu/marchant/themesBuriedIce2.htm)

- **Demonstration ocean-bottom drilling in the James Ross Basin.** Scientists will deploy a drill rig on the research icebreaker Nathaniel B. Palmer to test the feasibility of ship-based diamond coring along the antarctic continental margin. If successful, this SHALDRIL mobile system will be able to explore the no man's land between the nearshore (where the fast-ice-based Cape Roberts Project was successful) and the upper slope (where Ocean Drilling Project's Joint Oceanographic Institutions for Deep Earth Drilling Resolution becomes most efficient). (NSF/OPP 01–25922, NSF/OPP 01–25480, and NSF/OPP 01–25526; www.arf.fsu.edu/shaldril.cfm)

- **Seismograph.** The world's quietest earthquake detector is 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, leading to new insights into the Antarctic Plate. (NSF/EAR 00–04370; www.iris.washington.edu/about/GSN)

- **Magmatism in the Dry Valleys: A workshop.** The most challenging aspect of understanding magmatism is that so little of the integrated nature of the full cycle can be directly examined. Planetary magmatism is a multifaceted process involving a spectrum of interleaved chemical and physical processes responsible for the chemical transformation of the initial primitive magma into the final product. Each component can be found exposed somewhere on Earth, and each has been studied for nearly a century, but finding and studying any reasonable example of the entire process in a fully integrated context has proven singularly elusive. The Ferrar dolerites of the McMurdo Dry Valleys exhibit the three-dimensional structural evolution of an extensive magmatic system that formed 180 million years ago. This system contains all the essential features of major magmatic systems, which are seen only piecemeal elsewhere in the world. Because this unusual area is so inaccessible, geologists have chosen to hold a 2-week field workshop to introduce 20 to 25 researchers to the wonders of the McMurdo Dry Valleys, to stimulate cutting-edge research, and to delineate the unsolved problems posed by this magmatic system. This working conference will entail discussions and laboratory work at McMurdo Station and fieldwork in the Dry Valleys. (NSF/OPP 02–29306)

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Other programs

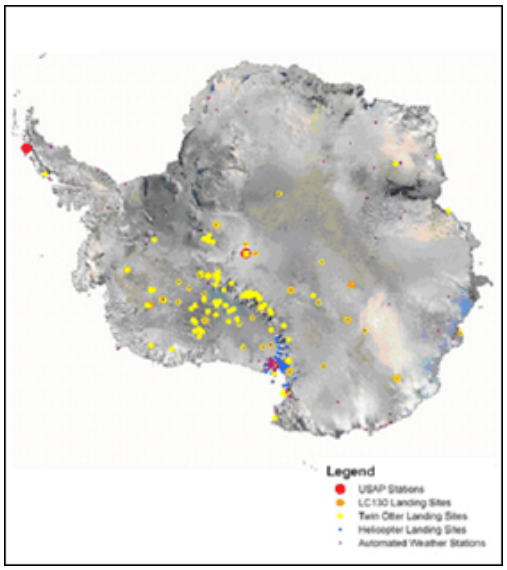
- **Antarctic Artists and Writers Program.** This program, which records the Nation's antarctic cultural heritage and extends understanding of the region and the U.S. Antarctic Program within the research community and beyond, will support the following six projects.

Artist / Writer	Project Title	Event Number
Yann Arthus-Bertrand	Mission Antarctica	W-27-M
Elena Glasberg	End as beginning: An American antarctic imaginary	W-219-M/S
Judith Nutter	Time, place, and imagination images and poems from Antarctica	W-220-P
Susan Fox Rogers	Antarctic anthology	W-216-M/S
Connie Samaras	*Vast Active Living Intelligence System:* Photographing the South Pole	W-221-S
Gabrielle Walker	*Antarctica: The Biography of a Continent*	W-223-M

- **Scouting in Antarctica.** In a nationwide competition, the Girl Scouts of the USA selected Senior Girl Scout Devon Vail of Fairbanks, Alaska, to participate in this

austral summer's field program in Antarctica. Ms. Vail, who is a biology major at the University of Alaska, will take time off from her studies to work with U.S. scientists based at McMurdo Station.

U.S. Antarctic Program, 2004–2005: Sites of Major Activities



McMurdo, Amundsen–Scott South Pole, and Palmer Stations operate year-round. During the 2004–2005 austral summer, four major field camps will operate in West Antarctica (Byrd Surface, Siple Dome, Thwaites Glacier, and Pine Island). Smaller camps will operate in the McMurdo Dry Valleys and Transantarctic Mountains regions. Six automated geophysical observatories and more than 100 automated weather stations operate year-round. The weather stations involve international collaboration with the Italian, German, Australian, and British programs. The map shows U.S. Antarctic Program locations during the 2004–2005 season. (*Data and map were prepared by Kelly Brunt, Raytheon Polar Services*.)

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