U.S. ANTARCTIC PROGRAM, 2003–2004

As part of the U.S. Antarctic Program, nearly 700 researchers and special participants will conduct 156 projects during the 2003–2004 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*.

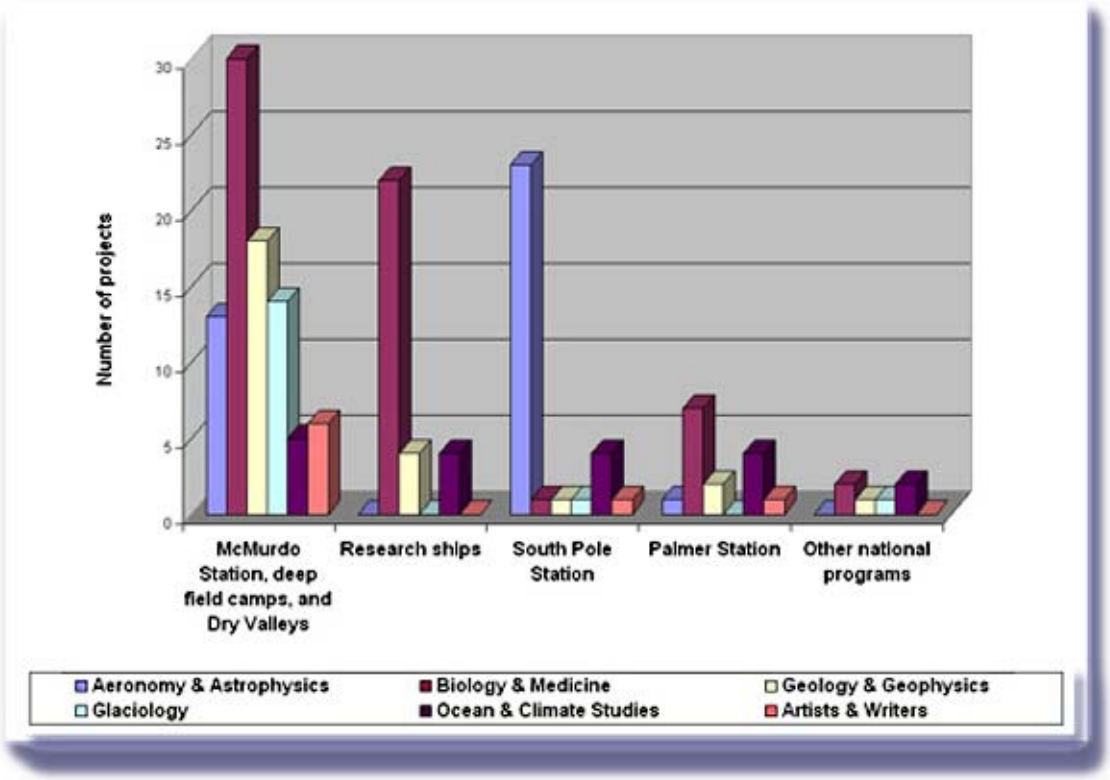
Dr. Ian Hawes begins to drop into the dive hole in Lake Hoare in the McMurdo Dry Valleys to collect algae samples from the lake floor. He is a New Zealand scientist with the National Institute of Water and Atmospheric Research, working with U.S. scientists participating in the McMurdo Dry Valleys Long Term Ecological Research (LTER).

NSF/U.S. Antarctic Program photo by Kristan Hutchison, Antarctic Sun, RPSC.

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) supports Teachers Experiencing Antarctica and the Arctic (TEA), which strives to create a polar learning community of teachers, students, school districts, and researchers. During this austral summer, as part of their professional development, six competitively selected teachers will work with six research teams headed by U.S. Antarctic Program investigators who have volunteered to include TEA participants in their field parties. Another OPP program—the Antarctic Artists and Writers Program—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 03–551; http://www.nsf.gov/pubsys/ods/getpub.cfm?nsf03551). Operational resources in Antarctica are also used to support scientists from other Federal agencies. U.S. antarctic policies, facts about Antarctica and the U.S. research program, and details and statistics about 2003-2004 U.S. operations in Antarctica are described at http://www.nsf.gov/od/opp/antarct/treaty/opp4001/nsf04013.htm.

USAP science projects by discipline and research site



During the 2003–2004 austral summer, 86 projects will be based at McMurdo Station or at remote field sites, 30 will be supported on research ships, 31 will work at Amundsen-Scott South Pole Station, 15 will work in and around Palmer Station, and 6 will be supported by other nations.

Science highlights

The following projects are among those supported in Antarctica during this austral summer and winter. Where applicable, 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.fastlane.nsf.gov/a6/A6AwardSearch.htm. 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.

Aeronomy and astrophysics

- **Ten-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 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)

- **IceCube.** During this austral summer, a consortium led by the University of Wisconsin–Madison will begin building 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 be used during the austral summers over 6 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)

Artists and writers program

- **Antarctic Artists and Writers Program.** NSF's Antarctic Artists and Writers Program (NSF 03-030; http://www.nsf.gov/od/opp/aawr.htm), 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 have six projects. Among them, Edward J. Larson, Russell Professor of History at the University of Georgia–Athens, will conduct field research leading to a book-length history of antarctic science. Professor Larson's articles have appeared in *Nature, Scientific American,* the *Wall Street Journal,* and elsewhere. His recent books include *Evolution's Workshop: God and Science in the Galapagos Islands* (2001) and *Summer for the Gods: The Scopes Trial and America's Continuing Debate Over Science and Religion* (1997), which won the Pulitzer Prize. (W–221–M)
- **Teachers Experiencing Antarctica and the Arctic.** Six K–12 teachers will spend a month each with NSF-funded antarctic research projects to improve classroom science by integrating research and education. The teachers, from schools around the Nation, competed for these opportunities in a program, *Teachers Experiencing Antarctica and the Arctic*, supported by OPP and NSF's Division of Elementary, Secondary, and Informal Education. (http://tea.rice.edu/tea_meetteachers.html)

TEA participants and associated science projects				
Teacher	**School**	**Event Number**	**Principal Investigator**	**Project**
Michael Lampert	West Salem High School Salem, Oregon	A-131-M	Terry Deshler	Measurements addressing quantitative ozone loss, polar stratospheric Cloud Nucleation, and large polar stratospheric particles during austral winter and spring
Andres Sajor	Peru Central School Peru, New York	G-298-M	William Hammer	Vertebrate Paleontology of the Triassic to Jurassic Sequence in the Beardmore Glacier Area of Antarctica
Coleen Brogenski	St. John's School Houston, Texas	G-081-M	Philip Kyle	Mount Erebus Volcano Observatory and Laboratory (MEVOL)
Robin Ellwood	Rye Junior High School Rye, New Hampshire	B-426-M	Peter Doran	McMurdo Dry Valleys LTER: The role of natural legacy on ecosystem structure and function in a polar desert
Amy Stoyles	Harlee Middle School Bradenton, Florida	B-019-M	Laurie Connell	Yeasts in the Antarctic Dry Valleys: Biological Role, Distribution, and Evolution
Susy Ellison	Yampah Mountain High School Glenwood Springs, Colorado	B-009-M	Bob Garrott	Patterns and Processes: Dynamics of the Erebus Bay Weddell Seal Population

- Scouting in Antarctica. Eagle Scout Brad Range is working in the U.S. Antarctic Program for 8 months to learn more about career choices in the sciences and engineering and to communicate his experiences to his fellow Boy Scouts (and others) in a Web site. A nationwide Boy Scouts of America competition led to his selection, which will involve a year's absence from his studies at the Georgia Institute of Technology. Girl Scouts of the USA and NSF partner in a similar program. (**http://www.scouting.org/nav/enter.jsp?c=xds&terms=antarctic&x=29&y=5**)

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 24 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/)

- **Response of terrestrial ecosystems along the Antarctic Peninsula to a changing climate.** Striking increases in air temperatures and ultraviolet-B radiation (UV–B) documented along the west coast of the Antarctic Peninsula over the past 50 years represent a profound climatic change.

In addition, annual precipitation and the depth of the winter snow pack appear to be increasing. These rapid changes in climate provide a unique opportunity to examine the effects of climate change on terrestrial ecosystems. Building on past work focused on the impact of warming and UV–B on terrestrial vascular plants on the Peninsula, a research team will examine how climate change alters nutrient pools and cycling among plants, litter, and soils in vascular-plant-dominated communities, with the goal of predicting long-term effects on plant productivity. (NSF/OPP 02–30579)

- **Culture and health in Antarctica.** In many ways, the emergence of a long-term population in space will parallel the emergence of a sustained population in Antarctica. Such organizational and cultural merging in restricted environments undoubtedly creates new cultural landscapes that could influence health and health behavior. The study of cultural emergence in Antarctica as an analog to space could help planners develop models of health and health behavior in an isolated confined environment and structure such environments to reduce health risks and identify factors that predispose people to those risks. (NSF/OPP 01–25893)

- **Interactive effects of ultraviolet radiation and vertical mixing on phytoplankton and bacterioplankton in the Ross Sea.** UV radiation influences plankton in the near-surface waters of most ecosystems. Southern Ocean ecosystems are particularly vulnerable in the austral spring, when UV radiation is enhanced by ozone depletion. While progress has been made in estimating the impact of UV radiation on antarctic marine bacteria and phytoplankton, important issues remain. Little is known, for example, about how the dominant phytoplankton in the southern Ross Sea (*Phaeocystis antarctica)* responds. Open water at a far southerly location within the ozone hole in the spring, together with continuous daylight with implications for DNA repair, makes the Ross Sea of intense interest. Several studies suggest that vertical mixing significantly modifies the impact of UV radiation, but the few measurements that have been done on turbulence intensity in the surface layer have not been integrated with parallel studies of the effects of UV radiation on phytoplankton and bacterioplankton. To address these issues, three research teams will focus on vertical mixing and UV radiation in the Ross Sea and characterize phytoplankton and bacterioplankton responses in both laboratory and solar incubations. (NSF/OPP 01–27022, NSF/OPP 01–27037, and NSF/OPP 01–25818; http://www,serc.si.edu/uvb/Ross_Sea_index.htm; http://uwf.edu/wjeffrey/rosssea.html)

Geology and Geophysics

- **Beardmore Glacier and Moody Nunataks regions investigations.** Earth science research in the central and southern Transantarctic Mountains during the past four decades has provided a wealth of new information on the geologic evolution of the Ross Sea sector of the continent. Many of these advances, such as vertebrate faunas, anatomically well preserved plant fossils, and young fossiliferous glacial deposits indicating radically different climatic conditions, have been significant to the global geosciences community. During this austral summer, eight field teams will work from camps in the Beardmore Glacier region and in the Moody Nunatak area. Their research will focus on Late Paleozoic–Mesozoic fauna, environment, and climate; Permian and Triassic floras; geophysical mapping of the East Antarctic shield; the evolution of Triassic vegetation; the terrestrial paleoecology and sedimentary environment of the Beardmore Glacier region; Triassic to Jurassic vertebrate paleontology; and Permian-Triassic mass extinction. (NSF/OPP 01–26146, NSF/OPP 01–26230, NSF/OPP 02–30280, NSF/OPP 02–29877, NSF/OPP 02–30696, NSF/OPP 02–29757, NSF/OPP 02–29698, and NSF/OPP 02–30086)

- **West Antarctica GPS Network (WAGN).** This season, researchers will deploy a series of GPS transceivers across the interior of the West Antarctic Ice Sheet—an area approximately the size of the contiguous United States from the Rocky Mountains to the Pacific coast. The ability to measure the motion of the Earth's crust in the bedrock surrounding and underlying the West Antarctic Ice

Sheet is critical to understanding the past, present, and future dynamics of the sheet and its potential role in future global change scenarios, as well as improving our understanding of Antarctica's role in global plate motions. WAGN will complement existing GPS projects by filling a major gap in coverage among several discrete crustal blocks that make up West Antarctica—a critical area of potential bedrock movements. (NSF/OPP 00–03619; http://www.ig.utexas.edu/wagn/index.htm)

- **Transantarctic Mountains Deformation Network: GPS measurements of neotectonic motion in the antarctic interior.** Using the GPS, a research team will measure bedrock crustal motions in an extension of the Transantarctic Mountains Deformation Network (TAMDEF) to document neotectonic displacements caused by tectonic deformation within the West Antarctic Rift or mass changes in the antarctic ice sheets. These measurements—along with those from other U.S. and Italian GPS networks, from other programs on the ice sheets, and from ongoing structural and seismic investigations in Victoria Land—will provide data for modeling glacio-isostatic adjustments due to deglaciation and to modern changes in the mass of the ice sheets. The integrative and iterative nature of this modeling will yield a holistic interpretation of neotectonics and ice sheet history that will help discriminate tectonic crustal displacements from viscoelastic/elastic glacio-isostatic motions. (NSF/OPP 02–30285 and NSF/OPP-02–30356; http://www.geology.ohio-state.edu/TAMDEF)

- **TAMSEIS: A broadband seismic experiment to investigate deep continental structure across the east-west antarctic boundary.** How were the Transantarctic Mountains formed? Many theories, ranging from delayed phase changes to transform-flank uplift, have been proposed. All of these make various assumptions about the structure of the upper mantle beneath and next to the rift-side of the mountain front. East Antarctica has a bedrock continent-like foundation, while the ice sheet over West Antarctica covers a series of islands. West Antarctica shares a geologic history with the South American Andes Mountains, the result of plates colliding and subducting. East Antarctica is more like a large coherent chunk that broke free of the supercontinent Gondwanaland and drifted to a new position at the bottom of the world. At the boundary between these two regions, called the east-west antarctic boundary, the crust and upper mantle reveal many important distinctions that tell the basic story of the tectonic development of Antarctica. Collecting seismic data over three austral summers, one research team will evaluate geodynamic models for the tectonic development of Antarctica and develop new maps of the variation in crustal thickness, upper mantle structure, anisotropy, and mantle discontinuity topography across the boundary of East and West Antarctica. (NSF/OPP 99–09603; http://levee.wustl.edu/seismology/TAMSEIS)

Glaciology

- **Snow megadunes.** Megadunes of the East Antarctic Ice Sheet are subtle features 2 to 4 meters (6.5 to 13 feet) high, 2 to 5 kilometers (1 to 3 miles) apart, and as much as 100 kilometers (62 miles) long. Extending over 500,000 square kilometers, the dunefields may have been even more extensive in the past and may affect the interpretation of climate in deep ice cores. Investigators are conducting ground-penetrating radar and global positioning surveys, collecting firn cores, sampling snow in pits, installing automatic weather stations, and studying snow permeability to determine the physical and chemical characteristics of the dunes and understand their significance, including their effect on ice cores. Megadunes, a manifestation of an extreme terrestrial climate, may provide insights into past terrestrial climate or processes active on other planets. (NSF/OPP 01–25570, NSF/OPP 01–25276, NSF/OPP 02–25992, and NSF/OPP 01–25960; http://nsidc.org/antarctica/megadunes/)

  A second project will focus on a region of megadunes near Vostok Station (80º 78' S, 124º 50' E) in central East Antarctica to explore the chemical composition of air in the snow layer (firn) and test the hypothesis that a deep convective zone of vigorous, wind-driven mixing can prevent gas

fractionation in the upper one-third of the polar firn layer. In the megadunes, ultra-low snow accumulation rates lead to structural changes that make firn much more permeable to air movement. The unknown thickness of the convective zone has hampered the interpretation of ice-core nitrogen- and argon-isotope ratios that indicate past firn thickness—a key constraint on the climatically important variables of temperature, accumulation rate, and gas age–ice age difference. Studying this extreme end-member example will better define the role of the convective zone in gas reconstructions. (NSF/OPP 02–30452; http://icebubbles.ucsd.edu)

- **Tidal modulation of ice stream flow.** Ice from the West Antarctic Ice Sheet flows to the sea through a series of ice streams. Recent observations give a glimpse of the surprising sensitivity of these streams to tidal oscillations. Measuring ice stream response to the rise and fall of the tide is an excellent natural experiment that can improve scientific understanding of controls on the streams and improve models of the West Antarctic Ice Sheet. The goal for this field season is to deploy 20 global positioning system (GPS) receivers in arrays on ice streams E, D, C and the Whillans Ice Stream (B) and at fixed base stations to record vertical and horizontal ice stream motion and to correlate this motion to ocean tides in the Ross Sea. Passive seismic sensors will be deployed with the GPS units. Data will be collected at rates that allow the velocity variations of the ice streams to be measured over two tidal cycles. Improved knowledge of ice-stream behavior will help assess the potential for rapid ice-sheet change affecting global sea levels. (NSF/OPP 02–29629; http://www.geosc.psu.edu/~sak/Tides)

- **Refining a 500,000-year climate record from the Mount Moulton blue ice field in West Antarctica.** The summit crater of Mount Moulton contains a 600-meter-thick, horizontally exposed section of ice with tephra layers from nearby Mount Berlin inserted. Argon-isotopic dating of the thick, near-source tephra indicates that the age of the ice section ranges between 15,000 and 492,000 years. Thus, the Mount Moulton site offers an unparalleled repository of ancient West Antarctic snow and trapped air that can be used to investigate climate over much of the past 500,000 years. Data collected earlier suggest that there is a usable record of past climate extending back beyond 140,000 years. Research during this austral summer includes evaluating more thoroughly the integrity of the climatic record; improving the radioisotopic dating of specific tephra layers; obtaining baseline information about modern snowfall deposition, mean annual temperature, and wind pumping around the summit of Mount Moulton; and studying how firn densification differs when surface accumulation changes from net accumulation to net ablation. (NSF/OPP 02–30021, NSF/OPP 02–30348, and NSF/OPP 02–30316; http://www.geosc.psu.edu/~sowers/index.html)

Ocean and climate studies

- **Antarctic Troposphere Chemistry Investigation (ANTCI).** Working at Amundsen-Scott South Pole Station, seven research teams will study sulfur chemistry in the atmosphere to enhance our understanding of the processes controlling tropospheric levels of reactive hydrogen radicals, reactive nitrogen, sulfur, and other trace species and to improve the climatic interpretation of sulfur-based signals in antarctic ice-core records. The results from observing reactive hydrogen radicals, sulfuric acid and its sulfur precursors, and the flux of ultraviolet radiation will lead to a more comprehensive understanding of antarctic atmospheric chemistry, as well as the factors that influence the levels and distribution of climate proxy species in ice cores. (NSF/OPP 02–30246, NSF/OPP 02–29633, NSF/OPP 02–29605, NSF/OPP 02–30046, NSF/OPP 02–30051, NSF/OPP 02–30117, and NSF/OPP 02–30178; http://acd.ucar.edu/~mauldin/ANTCI_Web/ANTCI_Home.htm)

- **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 water 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; http://www.ldeo.columbia.edu/res/fac/physocean/anslope/)

U.S. Antarctic Program, 2003–2004
Sites of Major Activities