

[National Science Foundation](#)  
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The Foundation's Information Center may be reached at 703-292-5111. The Telephonic Device for the Deaf is at 703-292-5090, and the Federal Information Relay Service phone is 1-800-877-8339.

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# U.S. ANTARCTIC PROGRAM, 2000-2001

During the 2000-2001 austral summer and the 2001 austral winter, the U.S. Antarctic Program supported more than 800 researchers and other participants in the U.S. Antarctic Program at three year-round stations (McMurdo, Amundsen-Scott South Pole, and Palmer), aboard two research ships (*Laurence M. Gould* and *Nathaniel B. Palmer*) in the Ross Sea and in the Antarctic Peninsula region, at remote field camps, and in cooperation with the national antarctic programs of the other Antarctic Treaty nations. 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 also supports research that can be best or only performed in Antarctica.

The scientists, conducting the projects, come primarily from U.S. universities and have won NSF support in response to the Antarctic Research Program Announcement and Proposal Guide (NSF 01-81; <http://www.nsf.gov/cgi-bin/getpub?nsf0181>). Operational resources in Antarctica also are used to support scientists from other Federal agencies.

## Highlights of the 2000-2001 austral summer research include:

- **Lake Vostok aerial survey.** The Support Office for Aerogeophysical Research, an NSF-funded project at the University of Texas at Austin's Institute for Geophysics, is using a specially equipped Twin Otter airplane to map a 205-by 102-mile grid over subglacial Lake Vostok. The lake, the size of Lake Ontario in North America, has been thousands of meters beneath the East Antarctic Ice Sheet for millions of years and may contain microbes different from known species. The radar survey is a necessary precursor to any international effort to explore the lake. A clean drilling technology would be required to prevent contamination. For additional information about the Lake Vostok project, visit the Lamont-Doherty Earth Observatory site at <http://www.ldeo.columbia.edu/.vostok/index.html>.
- **Degree Angular Scale Interferometer (DASI).** An interferometric array of 13 microwave antennas is measuring cosmic background radiation temperature variations in a fairly large area of the sky above South Pole. The results appear to have produced some of the most sensitive measurements ever made to help unravel mysteries of the early universe and the nature of the dark matter and energy that many scientists believe constitute most of the universe. For more information about the project, visit either the DASI site on the Center for Astrophysical Research in Antarctica web site at <http://astro.uchicago.edu/cara/research/cmbr/dasi.html> and the home site for the DASI project at <http://astro.uchicago.edu/cara/research/cmbr/dasi.html>.
- **Southern Ocean Global Ocean Ecosystems Dynamics (SO/GLOBEC).** Seventeen science teams are using NSF's icebreaking *Nathaniel B. Palmer* and ice-strengthened *Laurence M. Gould* research ships to study how marine animals respond to natural and human-caused climate change. During the 2001 austral winter, the ships are working in Marguerite Bay area near the Antarctic Peninsula from March to August. The study is quantifying processes controlling the flux of carbon and other biogenic elements and predicting the response of marine biochemistry to climate change. The Southern Ocean appears to have an extremely large role in this flux. Information about the Southern Ocean GLOBEC program can be at [http://www.ccpo.odu.edu:80/Research/globec\\_menu.html](http://www.ccpo.odu.edu:80/Research/globec_menu.html)
- **Iceberg B-15 investigations.** An expedition to iceberg B-15, twice the size of the state of Delaware when it calved from the Ross Ice Shelf in 2000, affixed sensors on the berg to study movement of ice in the Southern Ocean. NSF press releases about the project can be found at <http://www.nsf.gov/od/lpa/news/media/2000/ma0019.htm> and <http://www.nsf.gov/od/lpa/news/media/01/ma0104.htm>.
- **International Trans-Antarctic Scientific Expedition (ITASE).** Researchers conducted an overland crossing to study the massive West Antarctic Ice Sheet. The traverse is the U.S. part of an International Trans-Antarctic Scientific Expedition (ITASE), a multi-year project seeking to understand changes in the mass and the climate of the West Antarctic Ice Sheet and the climatic events recorded in the ice. Additional information about the project can be found at the University of Maine at <http://www.ume.maine.edu/USITASE>.

During the 2000-2001 austral summer, seven teachers from U.S. elementary, middle, and high schools joined

researchers on eight projects this austral summer as part of NSF's Teachers Experiencing Antarctica (TEA) project. TEA immerses teachers in research as part of their professional development and to create a polar learning community of teachers, students, school districts, and researchers. U.S. Antarctic Program investigators volunteer to include TEA participants in their field parties; NSF selects the teachers competitively.

The Antarctic Artists and Writers Program provides opportunities for painters, photographers, writers, and others to use serious writing and the arts to increase understanding of the Antarctic and America's heritage there. The 2000-2001 austral summer participants included two painters, an underwater photographer, and a naturalist writing an illustrating a book on birds in Chile and the adjacent Antarctic.

Logistics to support these projects includes heavy-lift, ski-equipped C-130 airplanes operated by the New York Air National Guard, ski-equipped Twin Otter airplanes chartered from a Canadian firm, and C-141 and C-5 air-planes provided by the U.S. Air Force between New Zealand and McMurdo Station. Contract helicopters are headquartered at McMurdo to provide operational and close science support. Ground vehicles operated and maintained by an NSF contractor, provide specialized science support and other services. Annually, a U.S. Coast Guard icebreaker opens a channel to McMurdo and provides science support. A tanker and a cargo ship, operated by the Military Sealift Command, bring fuel, cargo, and equipment each January.

Modernization and improvement of the 25-year-old Amundsen-Scott South Pole Station continued. In the last 3 years a new fuel storage facility and a new garage and shop have been erected. During the 2000-2001 austral, a new electric power plant became operational. Modernization of the core station has begun with construction of a tower up from the subsurface new power plant, garage/shop, and fuel facilities. Steel construction of housing and food-service wings of the new elevated station started this summer. The wings will be completed in the austral winter. The project will be completed in 2005. The South Pole Safety and Environmental Project (a \$25-million undertaking) and the South Pole Station Modernization Project (a \$128-million initiative) will replace the existing station by 2005.

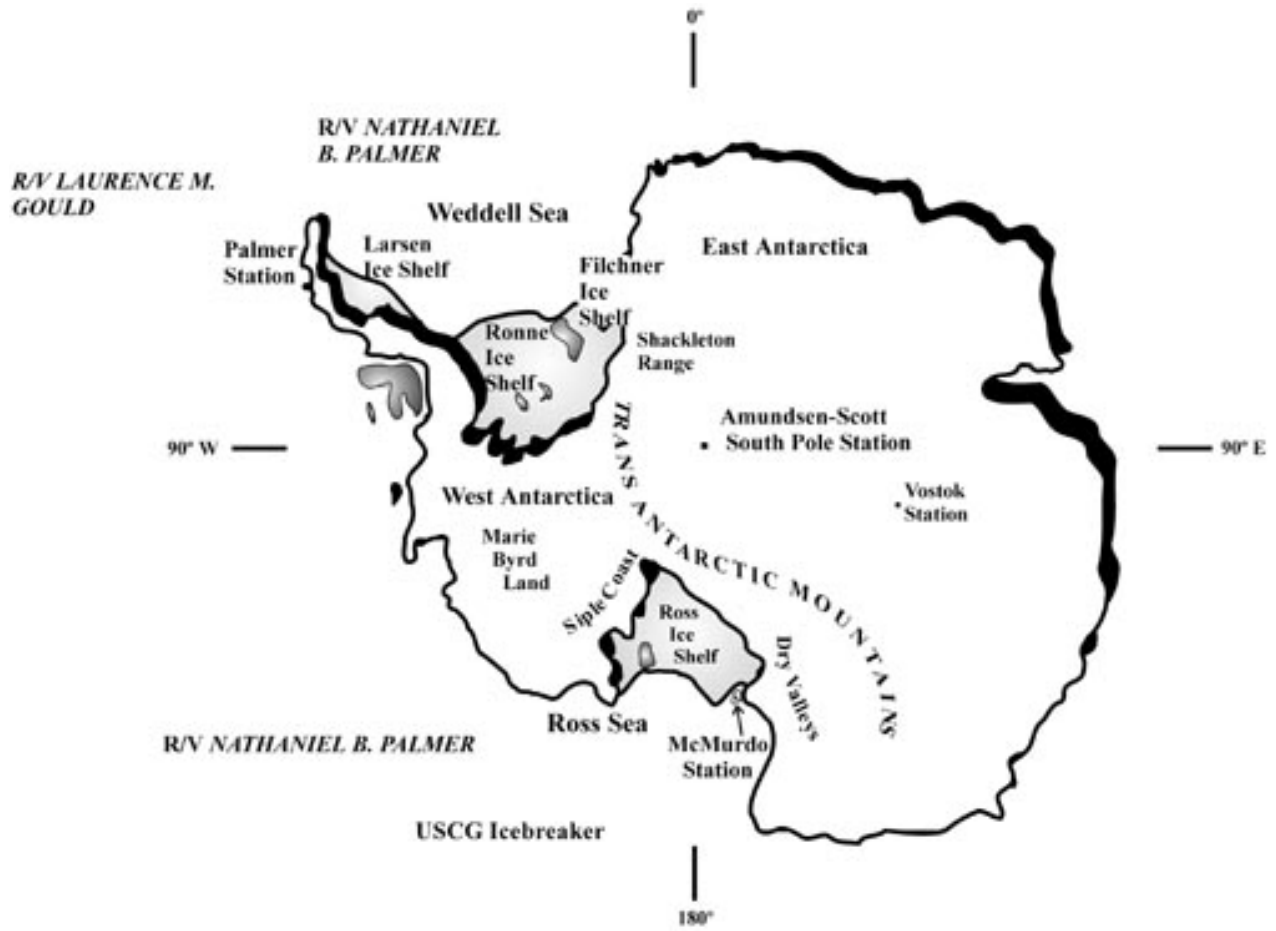
This document is arranged by scientific discipline, except for sections focused on multi-investigator, multi-disciplinary research projects. The order reflects the organization of the Antarctic Sciences Section of NSF's Office of Polar Programs, which funds projects in biology, medical research, ocean sciences, climate studies, geology and geophysics, glaciology, aeronomy, astronomy, and astrophysics.

**Related information products that are produced or funded by NSF include:**

- Press releases issued by the Foundation's Public Affairs Office to describe specific research progress. See the NSF World Wide Web page at <http://www.nsf.gov> or call 703-292-8070.
- The Antarctic Sun, which Raytheon Polar Services staff produce in Antarctica during the austral summer for USAP participants. It is funded by NSF and distributed outside of Antarctica from RPSC's web site at <http://www.polar.org/AntSun/index.htm>. Copies from past season are also available.

# U.S. Antarctic Program, 2000-2001

## Sites of major activities



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## AERONOMY AND ASTROPHYSICS

The polar regions have been called Earth's window to outer space. Originally, this term applied to aurora and other dynamic events staged as incoming solar plasmas encountered the Earth's geomagnetic fields. Because of its unique properties, the polar upper atmosphere becomes a virtual screen on which the results of such interactions can be viewed (and through which evidence of other processes can pass). More recently, this concept has been extended to refer to the "ozone hole" in the polar atmosphere. As scientists have verified an annual loss of ozone in the polar stratosphere, a window previously thought "closed" (stratified ozone blocking the sun's ultraviolet rays) is now known to "open" in certain seasons.

For astronomers and astrophysicists, the South Pole presents unique opportunities. Thanks to the relative lack of environmental pollution and anthropogenic "noise," the unique pattern of light and darkness, and the geomagnetic force field properties, scientists staging their instruments here can probe the structure of the sun and the universe with unprecedented precision. Studies supported by the Aeronomy and Astrophysics program probe three regions:

- The stratosphere and the mesosphere: In these lower regions, current research focuses on stratospheric chemistry and aerosols, particularly those implicated in the ozone cycle.
- The thermosphere, the ionosphere, and the magnetosphere: These higher regions derive many characteristics from the interplay between energetically-charged particles (ionized plasmas in particular) and geomagnetic/geoelectric fields. The upper atmosphere, particularly the ionosphere, is the ultimate sink of solar wind energy transported into the magnetosphere just above it. This region is energetically dynamic, with resonant wave-particle interactions, and Joule heating from currents driven by electric fields.
- The universe beyond, for astronomical and astrophysical studies: Many scientific questions extend outside the magnetosphere, including a particular interest in the sun and cosmic rays. Astrophysical studies are primarily conducted at Amundsen-Scott South Pole Station or on long-duration balloon flights launched from McMurdo.

All research projects sponsored by this program benefit from (indeed most require) the unique physical conditions found only in the high latitudes, yet their ramifications extend far beyond Antarctica. High-latitude astrophysical research contributes to the understanding of Antarctica's role in global environmental change, promotes interdisciplinary study of geosphere/biosphere interactions in the middle and upper atmosphere, and improves understanding of the critical processes of solar energy in these regions. Life exists on earth in a balance – not only because of the critical distance from the sun – but also because of numerous chemical and atmospheric phenomena peculiar to our atmosphere. The 20th century expansion of traditional astronomy to the science of astrophysics, coupled with the emerging discipline of atmospheric science (See also the Ocean and Climate Systems program), is nowhere better exemplified than in Antarctica.

(AA-130-O)

### **AMANDA - Antarctic Muon and Neutrino Detector Array.**

*Robert Morse, University of Wisconsin.*

Neutrinos are elementary particles. They are believed to have very little or no mass, no electrical charge, and can take any of three forms. Coursing through the universe, they interact only rarely with other particles. AMANDA's primary objective is to discover the sources - both within our galaxy and beyond - of the shower of very-high-energy neutrinos descending on (and usually passing through) the Earth.

AMANDA uses an array of photomultiplier tubes (embedded between 1 and 2 kilometers into the ice) near the South Pole to create a Cherenkov detector out of the natural ice. Originally, 20 strings were installed in the ice, and last season 6 more strings known as the AMANDA-2 detector were added. This system detects high-energy neutrinos originating off the planet that have passed through Earth. Such sources of origin could be diffuse, made up of contributions from many active galactic nuclei (AGNI); or they could be point sources of neutrinos -

coming from supernova remnants (SNRs), rapidly rotating pulsars, neutron stars, individual blazars, or other extragalactic point sources.

Recently, new sources of high-energy gamma rays have been discovered, such as the source Mrk-421, discovered by NASA's Compton Gamma-Ray Observatory (CGRO) and Mt. Hopkins Observatory. AMANDA is designed to study just such objects, which are believed to emit high-energy neutrinos copiously. To date, neutrino astronomy has been limited to the detection of solar neutrinos, plus one brief, spectacular burst from the supernova that appeared in the Large Magellanic Cloud in February 1987 (SN-1987a). Only now is it becoming technically feasible to build large neutrino telescopes. As one of the first-generation detectors, AMANDA promises to make seminal contributions to this new branch of neutrino astronomy. (AA-130-O)

(AB-145-O)

**Long-duration balloon project.**

*Steven Peterzen, NASA/National Scientific Balloon Facility.*

Free-flying balloons possess many advantages as a means of high-altitude exploration; compared to satellites they remain much longer in a specific location, and cost a fraction to launch. The National Scientific Balloon Facility's (NSBF) effort in Antarctica, known as the Long-Duration Balloon (LDB) program, launches high-altitude balloons carrying scientific payloads into the stratosphere.

This season during a launch window from 15 December to 10 January, the LDB program will support two stratospheric flights from its facility at Williams Field (the Top Hat and ATIC projects). The balloons have a volume of 792.756 cubic meters (28.42 million cubic feet) and will ascend at a rate of approximately 275 meters per minute (900 feet per minute) to a float altitude between 3-4 mb (approximately 125kft). The launches will reach float altitude, circumnavigate the continent between 77°S and 80°S latitude (average) and are anticipated to terminate on the Ross Ice Shelf or polar plateau. In advance of these two major launches, up to five "pathfinder" balloons equipped with GPS transponders will be sent up to help determine the stratospheric conditions.

*TopHat:* This experiment (AO-147-O) will help researchers estimate the mass of the Universe (to at least the 10-percent level) by measuring variations in the cosmic microwave background radiation (CMBR). Instrument data will also provide a high precision map of the sky in the far-IR range for use in galactic studies.

*Advance Thin Ionization Calorimeter (ATIC):* This project (AO-149-O) involves a series of balloon flights from Antarctica (each from 10-14 days duration) to investigate the composition and energy spectra of galactic cosmic rays (GCR) at the highest energies accessible from balloon platforms. (AB-145-O)

(AB-147-O)

**Long-duration balloon program: TopHat 2000-2001 antarctic campaign.**

*Stephan S. Meyer, University of Chicago, Enrico Fermi Institute.*

The CMBR (cosmic microwave background radiation) is the name given to a class of radiation first detected in 1965, which, according to the big bang theory, provides evidence of the Universe's origin. About  $15 \times 10^9$  years ago, the entire Universe is believed to have consisted only of dense, glowing, hot matter; thus, with no empty space, the seminal explosion was of "space" itself. As the echo of this event, the CMBR proves that the Universe is expanding along with the volume of matter and radiation within it.

This project will conduct a program of complementary balloon-borne experiments to measure the anisotropy on certain angular scales. Such measurements have become increasingly important for providing information on the initial conditions from which the large-scale structure of the Universe has evolved. Measurements detected by COBE on large angular scales (and the results of our FIRS experiment) help to define the outer boundaries for CMBR anisotropy studies. We now enter a detailed measurement phase, which promises quantitative answers to some of the fundamental questions about how the structure of the Universe evolved.

To take advantage of new opportunities for long-duration circumpolar ballooning (LDB), we have developed TopHat. A novel instrument concept designed to provide reliable, quantitative measurements of the CMBR anisotropy, the TopHat instruments are optimized to reject both systematic and foreground spurious signals. By placing the telescope on top of the balloon, we can use an observing environment unequalled in any sub-orbital





































































































































