

# Cover Photos

## Top Photo

This photo shows the launching of a tethered, helium-filled balloon attached to an instrument that measures the characteristics of water vapor at different altitudes above the South Pole. By attaching this instrument to a tethered balloon, the instrument can be sent to different altitudes and readily recovered.

The building from which the tethered balloon and instrument are being launched in this photo is a temporary facility located adjacent to the Clean Air Sector boundary at the South Pole. The trench in front of this building provides a location for the balloon to be stored between launch periods. (Photo by Jeff Inglis)

## Bottom Photo

This photo shows the launching of a balloon and accompanying ozone sonde from the VXE-6 platform at McMurdo Station. The balloon-borne measurements provide good methods to measure the detailed altitude structure of ozone and Polar Stratospheric Clouds (PSCs) from the ground up to the lower stratosphere, where the bulk of ozone exists and where PSCs form. (Photo by Ginny Figlar)

**This *Science Planning Summary* publication  
was prepared by the Science Support Division  
of Raytheon Polar Services Company  
Under contract to the National Science Foundation  
OPP-0000373**



# Foreword

This United States Antarctic Program (USAP) *Science Planning Summary* contains a synopsis of the 2000-2001 season (i.e., from mid-August 2000 to mid-August 2001) for the USAP. This publication is a preseason summary (i.e., prior to the 2000-2001 austral-summer season); it contains the current information available as of early September 2000. Some of this information may change throughout the austral summer and winter-over periods as project planning evolves.

There are three basic sections in this publication.

## 1) Front Matter

The Front Matter contains overviews of the USAP stations and research vessels. Also, there are research objectives for the Southern Ocean Global Ocean Ecosystems Dynamics (SO GLOBEC) projects, since there are not individual project write-ups for these projects as detailed information was not available at the time of publication. Information about the following USAP programs/events is also in the Front Matter: Technical Events; Media Visitors; Writers & Artists; Teachers Experiencing Antarctica; Environmental, Health, and Safety Initiatives; and the Science Event Numbering System.

In previous versions of the *Science Planning Summary*, there were various schedules and aircraft flight hour information in the Front Matter. They are not in this year's publication. The flight hour information is not available at the time of publication. The research vessel schedules can be found on the Web, and the Web addresses for these schedules are included in the research vessel overviews. The continental airlift and sealift schedules can be found on the Web at [http://www.polar.org/internet\\_jdocs/usapservices\\_/calendars\\_/toc.htm](http://www.polar.org/internet_jdocs/usapservices_/calendars_/toc.htm).

## 2) Individual Research Project Write-Ups

There are 133 research project write-ups in this year's hard-copy *Science Planning Summary*. Please note that several more projects could become active during the 2000-2001 season as time progresses. If additional projects become active, they will be added to the *Science Planning Summary* Web Site at <http://www.polar.org/sciprosu.htm>. This Web Site is password protected as this information is only available to USAP participants. If you, as a USAP participant, wish to access this Web Site, then contact the Raytheon Polar Services Webmaster at (303) 790-8606 or at [webmaster@polar.org](mailto:webmaster@polar.org) to receive the password information.

Individual research project write-ups are arranged by Antarctic Program:

- Aeronomy & Astrophysics
- Biology & Medicine
- Environmental Monitoring
- Geology & Geophysics
- Glaciology
- Oceans & Climate Systems

Within each program section, the individual write-ups are arranged alphabetically by the first two letters of the Science Event Number (SEN), then numerically by the internal 3 digits of the SEN. (**Note:** A description of the SEN system is on page F-37)

### 3) Appendixes and Index

There are four appendixes and one index at the back of this publication that reflect information published in this hard-copy *Science Planning Summary*:

- Appendix A: Alphabetical List of Deploying Project Team Members' Names
  - Appendix B: Alphabetical List of Principal Investigators' Names
  - Appendix C: Alphabetical List of Principal Investigators' Home Institutions/Affiliations
  - Appendix D: List of Research Projects by Location
- AND
- Index of Project Write-ups in ascending numerical order of the internal 3 digits of the SEN

**Note:** Here are explanations of several acronyms used in this book:

TBD = To be determined

NA = Not available

R/V = Research Vessel

### Philatelic Mail

Philatelists (stamp collectors) are interested in receiving mail from Antarctica, and the National Science Foundation has a procedure (see below) to support philately at a level not to interfere with the science mission.

While in Antarctica, you may receive unsolicited philatelic mail from collectors. The Foundation discourages this unauthorized philatelic activity, and you will be entirely within your rights in declining to respond to such unsolicited requests. Please discard the material in the appropriate recycling container. If you receive large amounts of unsolicited philatelic mail, bring it to the attention of the station manager or the NSF Representative.

Philatelists may obtain a maximum of two covers (self-addressed stamped envelopes) a year by writing to the postal clerks (addresses below) at the three year-round U.S. Antarctic stations.

1. No more than two covers per person per station per year.
2. Covers will be processed for personal (that is, noncommercial) use of individuals only.
3. U.S. correspondents use domestic first-class postage for the APO addresses (below) and international first-class or air mail postage for the Palmer Station address.
4. Non-U.S. correspondents use international first-class or airmail postage.

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Amundsen-Scott South Pole Station, Antarctica  
PSC 468 Box 400  
APO AP 96598-5400

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Av. Independencia 772  
Casilla 60-D  
Punta Arenas, Chile

Covers are not processed if these guidelines are not followed. Information in this *Science Planning Summary* is not to be used to circumvent the above policy.

Philatelic mail is processed and returned to senders as soon as possible, but the processing is in addition to regular duties of station personnel. Some processing is done during the austral winter, when antarctic stations are isolated, resulting in year-long (or longer) delays in mailing covers back to the collectors.

**United States Antarctic Program  
Science Planning Summary  
2000-2001 Field Season**

**Table of Contents**

McMurdo Station Overview ..... F-1

    McMurdo Station Opening & Closing Dates and Population ..... F-1

    McMurdo-Based Air Operations ..... F-1

    McMurdo Station Research Facilities ..... F-2

    Major Field Camps for McMurdo-Based Researchers ..... F-4

South Pole Station Overview ..... F-5

    South Pole Station Opening & Closing Dates and Population ..... F-5

    South Pole Research Sectors/Facilities ..... F-5

Palmer Station Overview ..... F-6

    Palmer Station Opening & Closing Dates and Population ..... F-6

    Palmer Station Research Facilities and Local Research Areas ..... F-6

R/V *Laurence M. Gould* Overview ..... F-7

R/V *Nathaniel B. Palmer* Overview ..... F-13

Southern Ocean Global Ocean Ecosystems Dynamics (SO GLOBEC)

    Research Objectives ..... F-19

Technical Events ..... F-25

Media Visitors to U.S. Antarctic Research Stations ..... F-29

Antarctic Artists & Writers Program ..... F-31

Teachers Experiencing Antarctica (TEA) ..... F-33

USAP Environmental, Health, and Safety Initiatives ..... F-35

USAP Science Event Numbering System ..... F-37

<b>Overview of the Antarctic Aeronomy and Astrophysics Program .....</b>	<b>1</b>
AMANDA-Antarctic Muon and Neutrino Detector Array AA-130-O: Dr. Robert Morse .....	2
Long Duration Balloon Program AB-145-O: Mr. Steven Peterzen .....	4
TopHat LDB 2000-2001 Antarctic Campaign AB-147-O: Dr. Stephan Meyer .....	6
Advanced Thin Ionization Calorimeter (ATIC) Scientific Balloon Payload AB-149-O: Dr. John Wefel .....	8
Center for Astrophysical Research in Antarctica (CARA) AC-370-0: Mr. Robert Pernic AC-371-0: Dr. Antony Stark AC-372-0: Dr. John Storey AC-373-0: Dr. John Carlstrom AC-374-0: Dr. Robert Loewenstein AC-375-0: Dr. Jeff Peterson AC-376-0: Dr. Giles Novac AC-378-0: Dr. John Ruhl .....	10
Continuation of Magnetometer Data Acquisition at McMurdo and South Pole Stations AO-101-O: Dr. Louis Lanzerotti .....	18
High Latitude Magnetic Pulsations AO-102-O: Dr. Mark Engebretson .....	20
Antarctic Auroral Imaging AO-104-O: Dr. Steven Mende .....	22
Global Thunderstorm Activity and its Effects on the Radiation Belts and the Lower Ionosphere AO-106-P: Dr. Umran Inan .....	24
Global Thunderstorm Activity and its Effects on the Radiation Belts and the Lower Ionosphere AO-106-S: Dr. Umran Inan .....	26
Study of Polar Stratospheric Clouds by Lidar AO-107-O: Dr. Alberto Adriani .....	28

South Pole Air Shower Experiment - 2 (SPASE-2) AO-109-O: Dr. Thomas Gaisser .....	30
Austral High-Latitude Mesospheric and Thermospheric Dynamics and Thermodynamics AO-110-O: Dr. Gonzalo Hernandez .....	32
Riometry in Antarctica and Conjugate Regions AO-111-O: Dr. Theodore Rosenberg .....	34
Polar Experiment Network for Geophysical Upper-Atmospheric Investigations (PENGUIn) AO-112-O: Dr. Theodore Rosenberg .....	36
All-Sky Imager AO-117-O: Dr. Masaki Ejiri .....	38
Solar and Heliospheric Studies with Antarctic Cosmic Ray Observations AO-120-O: Dr. John Bieber .....	40
Antarctic Miniature Lidar / Automatic Weather Station Lidar AO-126-O: Dr. Jonathan A. Rall .....	42
Rayleigh and Sodium LIDAR Studies of the Troposphere, Stratosphere, and Mesosphere at the Amundsen-Scott South Pole Station AO-127-O: Dr. George Papen .....	44
Low Frequency / Medium Frequency / High Frequency (LF / MF / HF) Auroral Radio Noise Observations AO-128-O: Dr. James LaBelle .....	46
Spectroscopic and Interferometric Studies of Airglow and Auroral Processes in the Antarctic Upper Atmosphere over the South Pole Station AO-129-O: Dr. G. G. Sivjee .....	48
Measurements of Polar Stratospheric Clouds, Condensation Nuclei, and Ozone During the Austral Winter and Spring AO-131-O: Dr. Terry Deshler .....	50
Trace Gas Measurements over the South Pole Using Millimeter-Wave Spectroscopy AO-138-O: Dr. Robert deZafra .....	52

Dynamics of the MLT Region using Ground-Based Radar and TIMED Instruments AO-284-O: Dr. Susan Avery .....	54
<b>Overview of the Antarctic Biology and Medicine Program .....</b>	<b>57</b>
McMurdo Dry Valleys: A Cold Desert Ecosystem Long-Term Ecological Research (LTER) BM-042-D: Dr. Peter Doran BM-042-F: Dr. Andrew Fountain BM-042-L: Dr. W. Berry Lyons BM-042-M: Dr. Diane McKnight BM-042-P: Dr. John Priscu BM-042-V: Dr. Ross A. Virginia BM-042-W: Dr. Diana Wall .....	58
Antifreeze Proteins in Antarctic Fishes: Ecological and Organismal Physiology, Structure-Function, Genetics and Evolution BO-005-M: Dr. Arthur DeVries .....	66
The Use of a Long-Term Data Base and Molecular Genetic Techniques to Examine the Behavioral Ecology and Dynamics of a Weddell Seal ( <i>Leptonychotes weddellii</i> ) Population BO-009-O: Dr. Donald Siniff .....	68
Studies on the Impact of Sewage-Associated Microorganisms on Indigenous Seal and Bacterial Populations and Drinking Water Quality at McMurdo Station BO-024-O: Dr. John T. Lisle .....	70
The Biogeochemistry of Dimethylsulfide (DMS) and Related Compounds in a Chemically Stratified Antarctic Lake BO-025-O: Dr. John Priscu .....	72
Temperature Compensation in Antarctic Pteropods: An Integrative Approach BO-030-O: Dr. Robert Dudley .....	74
Factors Regulating Population Size and Colony Distribution of Adelie Penguins BO-031-O: Dr. David Ainley .....	76
Investigations of Abandoned Penguin Colonies in Antarctica BO-034-O: Dr. Steven Emslie .....	78

Proteins of Oxygen-Binding and Energy Metabolism in Muscles of Antarctic Fishes: Evolutionary Adjustments to Life at Cold Temperatures BO-036-O: Dr. Bruce Sidell .....	80
Structure, Function, and Expression of Tubulins, Globins, and Microtubule-Dependent Motors from Cold-Adapted Antarctic Fishes BO-037-O: Dr. William Detrich .....	82
Investigations on Deterioration in the Historic Huts of the Ross Sea Region of Antarctica BO-038-O: Dr. Robert Blanchette .....	84
Penguin-Krill-Ice Interactions: The Impact of Environmental Variability on Penguin Demography BO-040-O: Dr. Wayne Trivelpiece .....	86
Microbial Mediation of Trace Metal Cycling in Four Stratified Antarctic Lakes BO-041-O: Dr. William Green .....	88
The Influence of Seasonal Ice Cover on Pelagic and Benthic Communities: Long Time-Series Studies BO-050-O: Dr. Kenneth Smith .....	90
Diving Biology of Emperor Penguins BO-197-O: Dr. Paul Ponganis .....	92
The Role of Oceanographic Features and Prey Distribution on Foraging Energetics and Reproductive Success of Antarctic Fur Seals BO-267-O: Dr. Daniel Costa .....	94
Natural Product Drugs from Cold-Water Marine Organisms BO-282-O: Dr. Gregg Dietzman .....	96
A Training Program in Integrative Biology and Adaptation of Antarctic Marine Organisms BO-301-O: Dr. Donal Manahan .....	98
Benthic-Pelagic Coupling on the West Antarctic Peninsula Shelf: The Impact and Fate of Bloom Material on the Shelf Floor BO-303-O: Dr. Craig Smith .....	100
Control of Denitrification in a Permanently Ice-Covered Antarctic Lake: Potential for Regulation by Bioactive Metals BO-310-O: Dr. Bess Ward .....	102

Palmer Long-Term Ecological Research (LTER) on the Antarctic Marine Ecosystem: An Ice-Dominated Environment	
BP-013-O: Dr. William R. Fraser	
BP-016-O: Dr. Maria Vernet	
BP-021-O: Dr. Douglas Martinson	
BP-028-O: Drs. Langdon B. Quetin & Robin Ross	
BP-032-O: Dr. Raymond Smith	
BP-046-O: Dr. David Karl .....	104
<b>Overview of the Antarctic Environmental Monitoring Program .....</b>	<b>115</b>
Spatial and Temporal Scales of Human Disturbance -- McMurdo Station, Antarctica	
EO-318-O: Dr. Mahlon C. Kennicutt, II .....	116
<b>Overview of the Antarctic Geology and Geophysics Program .....</b>	<b>119</b>
GPS Measurement of Isostatic Rebound and Tectonic Deformation in Marie Byrd Land, West Antarctica	
GF-121-O: Dr. Bruce Luyendyk .....	120
2000-2001 Geodesy, Remote Sensing, and Digital Mapping Program	
GO-052-M: Dr. Jerry Mullins .....	122
Differential GPS Cores Base Station	
GO-052-P: Dr. Jerry Mullins .....	124
Maintenance of South Pole Geodetic Position	
GO-052-S: Dr. Jerry Mullins .....	126
Stability of Land Surfaces in the Dry Valleys, Antarctica: Insights Based on the Dynamics of Sub-Surface Ice and Sand-Wedge Polygons	
GO-053-O: Dr. Bernard Hallet .....	128
Response of the East Antarctic Ice Sheet to Middle Miocene Global Change	
GO-054-O: Dr. David Marchant .....	130
ANSMET: The Antarctic Search for Meteorites / NASA Robotics in Allen Hills	
GO-058-O: Dr. Ralph Harvey .....	132
Tracking the West Antarctic Rift Flank	
GO-059-O: Dr. Paul Fitzgerald .....	134

Global Climate Change and the Evolutionary Ecology of Antarctic Mollusks in the Late Eocene GO-065-O: Dr. Richard Aronson .....	136
Formation of the Dry Valleys, Antarctica: Linking Thermochronometric (U-Th/He) and Cosmogenic Constraints on Landscape Development GO-066-O: Dr. Martha House .....	138
Late Cretaceous and Cenozoic Reconstructions of the Southwest Pacific GO-071-O: Dr. Steven Cande .....	140
Bio-optical Properties of Southern Ocean Waters GO-073-A: Dr. Kevin Arrigo .....	142
Quaternary Glacial History and Paleoenvironments of the East Antarctic Margin GO-073-O: Dr. Amy Leventer .....	144
Dry Valleys Seismic Project GO-078-O: Mr. Kenneth W. Oliver .....	146
Mount Erebus Volcano Observatory: Gas Emissions and Seismic Studies GO-081-O: Dr. Philip Kyle .....	148
Global Positioning System Measurements of Crustal Motion in Antarctica GO-082-O: Dr. Carol Raymond .....	150
TAMSEIS: A Broadband Seismic Experiment to Investigate Deep Continental Structure Across the East-West Antarctic Boundary GO-089-O: Dr. Douglas Weins .....	152
Global Seismograph Station at Palmer Station, Antarctica GO-090-P: Dr. Rhett Butler .....	154
Global Seismograph Station at South Pole Station, Antarctica GO-090-S: Dr. Rhett Butler .....	156
Paleoceanography of Eocene Decapod-Rich Rocks in Antarctica and Southern South America GO-093-O: Dr. Rodney Feldmann .....	158
Collaborative Research: Permian-Triassic Basin History of Southern Victoria Land and the Darwin Mountains GO-094-O: Dr. John Isbell .....	160

A Broadband Seismic Experiment for the Study of the Tectonics and Structure of the Antarctic Peninsula and Scotia Plate GO-097-O: Dr. Douglas Wiens .....	162
Neogene-Quaternary Volcanic Alignments in the Transantarctic Mountains-Ross Sea Region GO-099-O: Dr. Terry Wilson .....	164
Geology and Geochronology of the Byrd Glacier Discontinuity, Antarctica: A Pilot Study GO-116-O: Dr. Edmund Stump .....	166
Antarctic Network of Unattended Broadband Integrated Seismometers (ANUBIS) GO-180-O: Dr. Sridhar Anandakrishnan .....	168
University NAVSTAR Consortium (UNAVCO) GPS Survey Support GO-295-O: Mr. Bjorn Johns .....	170
The Young Marginal Basin as a Key to Understanding the Rift-Drift Transition and Andean Orogenesis: OBS Refraction Profiling for Crustal Structure in Bransfield Strait GO-306-O: Dr. James Austin .....	172
Support Office for Aerogeophysical Research (SOAR) GS-098-O: Dr. Donald Blankenship .....	174
<b>Overview of the Antarctic Glaciology Program .....</b>	<b>179</b>
History and Evolution of the Siple Coast Ice Stream System as Recorded by Former Shear-margin Scars II-163-O: Dr. Charles Raymond & Dr. Ted Scambos .....	180
West Antarctic Ice Sheet Surface Melting: Recognition, Controls, and Significance II-168-O: Dr. Richard Alley .....	182
High-Precision Borehole Temperature Measurements at Siple Dome, Antarctica, for Paleoclimate Reconstruction and Ice-Dynamics Studies II-171-O: Dr. Edwin Waddington & Dr. Gary Clow .....	184
Basal Conditions in Ice Stream C and Related Borehole Studies of Antarctic Ice Stream Mechanics IO-157-O: Dr. Barclay Kamb .....	186

Firn Air Sampling IO-162-O: Dr. Michael Bender .....	188
Ice Dynamics, the Flow Law, and Vertical Strain at Siple Dome IO-164-O: Dr. William Harrison .....	190
West Antarctic Glaciology-V IO-173-O: Dr. Robert Bindshadler .....	192
Retreat History of the West Antarctic Ice Sheet, Marie Byrd Land IO-175-O: Dr. John Stone .....	194
Iceberg Drift in the Near-Shelf Environment: Ross Ice Shelf, Antarctica IO-190-O: Dr. Douglas MacAyeal .....	196
Collecting Micrometeorites from the South Pole Water Well IO-192-O: Dr. Susan Taylor .....	198
AMS Radiocarbon Chronology of Glacier Fluctuations in the South Shetland Islands During the Last Glacial/Interglacial Hemicycle: Implications for the Role of Antarctica in Global Climate Change IO-196-L: Dr. Brenda Hall.....	200
Deglacial Chronology of the Northern Scott Coast from Relative Sea-Level Curves IO-196-M: Dr. Brenda Hall.....	202
United States Component of the International Trans-Antarctic Expedition (U.S. ITASE) IU-133-0: Dr. Robert Jacobel IU-153-A: Dr. Paul Mayewski IU-153-B: Dr. Paul Mayewski IU-155-0: Dr. Mary Albert IU-158-0: Dr. Roger Bales IU-178-0: Dr. Gordon Hamilton IU-185-0: Dr. Debra Meese IU-193-0: Drs. Eric Steig, James White, and Christopher Shuman IU-311-0: Dr. Steven Arcone .....	204
<b>Overview of the Antarctic Oceans &amp; Climate Systems Program .....</b>	<b>217</b>
Longwave Radiation Processes on the Antarctic Plateau OO-201-O: Dr. Stephen Warren .....	218
A Study of Atmospheric Oxygen Variability in Relation to Annual to Decadal Variations in Terrestrial and Marine Ecosystems OO-204-O: Dr. Ralph Keeling .....	220

Shelf and Bottom Water Formation Near East Antarctic Polynyas and Glaciers OO-225-O: Dr. Richard G. Fairbanks .....	222
Measurements of the Size, Shape, Scattering Phase Function, and Extinction Coefficient of Ice Crystals at South Pole Station OO-226-O: Dr. Paul Lawson .....	224
Chlorine- and Bromine-Containing Trace Gases in the Antarctic OO-254-O: Dr. R. A. Rasmussen .....	226
South Pole Monitoring for Climatic Change - U.S. Department of Commerce, NOAA, Climate Monitoring and Diagnostic Laboratory OO-257-O: Dr. Dave Hofmann .....	228
Drake Passage XBT/XCTD Program OO-260-O: Dr. Ray Peterson .....	230
Katabatic Winds in Eastern Antarctica and Their Interaction with Sea Ice OO-263-O: Dr. Gerd Wendler .....	232
Collection of Atmospheric Air for the NOAA/CMDL Worldwide Flask Sampling Network OO-264-O: Dr. Dave Hofmann .....	234
An Investigation of Sulfur Chemistry in the Antarctic Troposphere (ISCAT) OO-270-O: Dr. Douglas Davis .....	236
University of Miami/Department of Energy-Environmental Measurements Laboratory Remote Atmospheric Measurements Program (RAMP) OO-275-O: Dr. Colin G. Sanderson .....	238
POC Production and Export in the Indian Sector of the Southern Ocean OO-278-O: Dr. Cynthia Pilskaln .....	240
Antarctic Automatic Weather Stations OO-283-M: Dr. Charles Stearns .....	242
Antarctic Automatic Weather Stations OO-283-P: Dr. Charles Stearns .....	244
Antarctic Automatic Weather Stations OO-283-S: Dr. Charles Stearns .....	246

Measurement of Combustion Effluent Carbonaceous Aerosols in the McMurdo Dry Valleys OO-314-O: Dr. Tony Hansen .....	248
Shipboard Acoustic Doppler Current Profiling on R/V Nathaniel B. Palmer and R/V <i>Laurence M. Gould</i> OO-315-O: Dr. Teresa Chereski .....	250
Field Experiments and Modeling of the Breakup of Antarctic Sea Ice OO-316-O: Dr. John Dempsey .....	252
Record of Atmospheric Photochemistry in Firn at South Pole OO-324-O: Dr. Joseph McConnell .....	254
<b>Appendix A</b>	
Alphabetical List of Deploying Research Team Members .....	A-1
<b>Appendix B</b>	
Alphabetical List of Principal Investigators' Names and Associated Science Event Numbers (SENs) .....	A-14
<b>Appendix C</b>	
Alphabetical List of Principal Investigators' Home Institutions / Affiliations .....	A-17
<b>Appendix D</b>	
List of Research Projects by Location .....	A-21
<b>Index of Science Project Write-Ups</b>	
In ascending numerical order of the Science Event Number (SEN) .....	I-1

# **United States Antarctic Program Science Planning Summary 2000-2001 Field Season Overviews**

## **McMurdo Station Overview**

### **McMurdo Station Opening & Closing Dates and Population**

McMurdo Station, the largest of the United States Antarctic stations, is the main operational center for the continental United States Antarctic Program.

During the 2000 austral-winter season, 202 science, Aviation Technical Services (ATS), and Raytheon Polar Services Company (RPSC) contractor personnel remained at McMurdo Station to maintain station operations and to conduct winter-over research.

The winter operations tempo changed at WINFLY (Winter Fly In), which began on 21 August 2000 with a series of four flights from Christchurch, New Zealand, to McMurdo Station. During the time period from WINFLY to the Mainbody austral-summer season station opening on 3 October 2000, three research projects began operations. Preparation of the station's facilities to accommodate the planned summer program will begin at the actual Mainbody station opening. Early estimates indicate that McMurdo's population could peak at 1100 during the 2000-2001 austral-summer season. However, the weekly population average is expected to be approximately 1000.

McMurdo Station will close out the 2000-2001 austral-summer season activities on 24 February 2001. After this closing, approximately 265 people will remain at McMurdo Station during the 2001 austral-winter months to maintain station operations, perform construction tasking, and conduct winter-over research.

### **McMurdo-Based Air Operations**

McMurdo-based aircraft (helicopter, Twin Otter fixed-wing aircraft, and LC-130 fixed-wing aircraft) will continue to support USAP researchers and program logistical functions. Again this season, Petroleum Helicopters Inc. (PHI) will provide helicopter support. All four helicopters (three AS-350B2 "A-STAR" and one Bell 212) will operate from McMurdo Station this season. They will support researchers in the Royal Society Range, the McMurdo Dry Valleys, and on Mt. Erebus. Additionally, helicopters will periodically support four research projects operating in the vicinity of the Darwin Glacier.

LC-130 Hercules fixed-wing aircraft will provide resupply and research support to South Pole Station. They will also support research activities at Siple Dome, Darwin Glacier, Byrd Surface Camp, Ice Stream C, and Vostok Station. Research activities will also be supported by two contract Twin Otter fixed-wing aircraft throughout the USAP area of operations. The introduction of a turbine powered DC-3 aircraft for test and evaluation purposes may also take place this year.

### **McMurdo Station Research Facilities**

The following information describes major McMurdo Station facilities where research projects are conducted.

#### **Crary Science and Engineering Center**

The Albert P. Crary Science and Engineering Center (CSEC), consists of five "pods" in three "phases," comprising 46,500 square feet of working area.

Phase I houses a two-story "Core Pod" and the "Biology Pod." The second floor of the Core Pod contains a telescience room, general-use computer area, small conference room, multipurpose seminar and lecture space, library, and lounge. The Wednesday-night Crary Laboratory Seminar Series is held in the multipurpose space. The first floor of the Core Pod contains laboratory management offices, special equipment rooms, stockrooms, and a receiving and staging area. The Biology Pod contains two analytical chemistry laboratories, eight general-use laboratories, two microscope rooms, one radioisotope laboratory, four walk-in freezers, four walk-in environmental rooms, chemical storage rooms, a field-party staging area, and ten offices. One office is dedicated for use by the NSF Science Representative and another office is dedicated for the support contractor's Science Technician and Environmental Technician.

Phase II houses an "Atmospheric Sciences Pod" and an "Earth Sciences Pod." The Atmospheric Sciences Pod contains a multipurpose area, two general laboratories, an electronics laboratory, a computer workshop, a photo lab, a receiving and recording area, roof hatches designed to accommodate instrumentation (such as lidar and global positioning system (GPS) receiver antennae), and six offices. One office in the Atmospheric Sciences Pod is dedicated to the further development of the Antarctic Meteorological Research Center (AMRC). This office houses a computer system with a Man Computer Interface Data Acquisition System (McIDAS) and meteorological processing software. One of the general laboratories houses a lidar system, which is designed to measure particles in polar stratospheric clouds and atmospheric ozone. The Earth Sciences Pod contains a sorting and storage room, two rock-processing laboratories, a general-use laboratory, a common work area, freezer space for processing and storing ice and snow specimens, and six offices. One of the offices houses the Mt. Erebus Volcano Observatory (MEVO). Room 205

houses the computer control room of a synthetic-aperture-radar (SAR) and the McMurdo Ground Station (MGS), which was installed outside McMurdo Station during the 1994-95 season.

Phase III houses a seawater aquarium. The aquarium contains a holding tank room with several diverse aquaria, three laboratories (two with plumbed seawater), and an electronics workshop.

#### **Sediment-Core Storage Facility & Ice-Core Transit Facility**

A refrigerated sediment-core storage facility is located next to Phase I of the CSEC. This facility is used to store sediment cores at 4 degrees C prior to shipping the sediment cores to home institutions. An ice-core transit facility, which is adjacent to the sediment-core storage facility, is used to store ice cores at -25 degrees C prior to shipment to home institutions.

#### **Old Aquarium**

The McMurdo Old Aquarium is located on the shoreline off the Intake Jetty and below the Helicopter Pad. The facility contains tanks of different sizes to maintain marine organisms ranging from small invertebrates to the large Antarctic cod. The Old Aquarium's close proximity to the Seawater Intake located at the end of the Intake Jetty ensures that the temperature of the seawater delivered to the various tanks is nearly that of ambient seawater. This assists in maintenance of psychrophilic (cold-loving) organisms for study.

#### **Arrival Heights Laboratory**

The Arrival Heights Laboratory is located approximately three miles from McMurdo Station. This laboratory provides a good location for experiments which are sensitive to the electromagnetic and industrial interference conditions found at McMurdo. The laboratory houses several year-round experiments that measure the interaction of the solar wind with the Earth's magnetosphere and ionosphere. Also located at the Arrival Heights Laboratory are UV spectroradiometers that measure how ozone depletion variations change the amount of short wavelength ultraviolet radiation reaching the Earth's surface in Antarctica.

#### **CosRay Laboratory**

The CosRay Laboratory is located approximately one mile from McMurdo Station. This laboratory has been used for measuring the anisotropic flux of cosmic rays that continuously bombards the Earth. Neutron monitors located in this laboratory have been in operation since 1960. These measurements are important because slight changes in geographic location and configuration of the sensors will affect the baseline measurement of the cosmic ray flux.

## **Major Field Camps for McMurdo-Based Researchers**

The following information describes the USAP-supported Antarctic field camps which will be used by McMurdo-based researchers for various research projects.

### **Siple Dome Camp**

The Siple Dome Field Camp--located at 81° 39' S, 149° 04' W--will support the following five research projects this season: IO-168-0 (Dr. Alley), GO-180-0 (Dr. Anandakrishnan), IO-173-0 (Dr. Bindschadler), GF-121-0 (Dr. Luyendyk), and IL-171-0 (Dr. Waddington). In addition, the support contractor's field construction crews will continue to dismantle the infrastructure associated with the PICO drilling project, which was completed last season. This year's major project will be the removal of the ice-core storage trench.

Once again, the Siple Dome Camp will be used as a staging point for research groups utilizing Twin Otter aircraft to access other field locations in West Antarctica. Four resident support contractor staff members will maintain this camp.

### **Byrd Surface Camp**

The Byrd Surface Camp--located at 80° 05' S, 119° 32' W--will be used as a staging area for the U.S. International Trans-Antarctic Scientific Expedition (ITASE) traverse. The following are ITASE projects: IU-133-O: Dr. Jacobel, IU-153-A: Dr. Mayewski, IU-153-B: Dr. Mayewski, IU-155-O: Dr. Albert, IU-158-O: Dr. Bales, IU-178-O: Dr. Hamilton, IU-185-O: Dr. Meese, IU-193-O: Drs. Steig, White, and Shuman, and IU-311-O: Dr. Arcone.

The support contractor's personnel will open and staff the camp while the traverse equipment is de-winterized and prepared for the traverse. The camp will close after the traverse departs and reopen when the traverse team returns. Two members of the support contractor's staff (i.e., a mechanic and a mountaineer) will accompany the traverse team.

### **Ice C Camp**

The Ice C Camp--located at 82° 22' S, 136° 24' W on Icestream C--will support projects IO-157-0 (Dr. Kamb) and IO-163-0 (Dr. Raymond). Five members of the support contractor's staff will support the research based at this camp.

### **East Camp**

The East Camp will be co-located with the Russian camp at Vostok Station, which is located at 78° 28' S, 106° 48' E. (Note: This camp's name is different to avoid confusion with the Russian camp during radio communications.)

This camp will support project GS-098-O: Dr. Blankenship (the Support Office for Aerogeophysical Research), which will conduct a

survey of the subglacial lake in the vicinity of Vostok Station. Six members of the support contractor's staff will support 24-hour flight operations from this camp.

#### **Darwin Glacier Camp**

The Darwin Glacier Camp--located at 79° 49' S, 156° 35' E--will support the following three research projects: GO-058-0 (Dr. Harvey), GO-094-0 (Dr. Isbell), and GO-116-0 (Dr. Stump). The researchers will be working at outlying locations.

This camp will serve as a staging point for equipment and fuel for the helicopters and fixed-wing aircraft that will be supporting these projects. Two members of the support contractor's staff will maintain the camp and provide local flight following for the helicopters.

## **South Pole Station Overview**

### **South Pole Station Opening & Closing Dates and Population**

Amundsen-Scott South Pole Station will open for normal 2000-2001 austral-summer activities on 30 October 2000. An operational opening on 23 October 2000 will precede this normal station opening. During the operational opening, the incoming crew and the outbound winter-over crew will perform turnover activities, including completion of the skiway and preparation of the station for summer operations.

The upper population limit for the 2000-2001 austral summer at South Pole has been established at 220 people. This number reflects the increased construction load at the station, as construction of the new South Pole Station enters its fourth season. With this increase in population, it is more important than ever to focus on safety, interpersonal cooperation, and conservation of water and electrical power.

The austral-summer season is scheduled to end by 15 February 2001. Approximately 50 people will remain on station for the 2001 austral-winter season (from February 2001 until November 2001) to maintain station operations, conduct winter-over research, and continue construction work on the new station.

### **South Pole Research Sectors/Facilities**

The following information describes major South Pole facilities and sectors where research projects are conducted.

#### **Science Building & Skylab Facility**

The Science Building is located within the South Pole geodesic dome. This building contains the meteorology office and recording equipment for several experiments. The SkyLab Facility is adjacent to the dome and accessible through an under-snow arch. The SkyLab Facility is a four-floor

tower housing aeronomy research instrumentation and other equipment.

#### **Quiet Sector**

The Quiet Sector is a region located grid-southeast of the dome. This sector is maintained with minimal interference from experiments, equipment, and activities which generate noise and vibration.

#### **Clean Air Sector**

The Clean Air Sector is a region located grid-northeast of the dome. This sector is maintained to be free from anthropogenic sources of air contamination such as vehicular and pedestrian traffic, or equipment that generates emissions. The Clean Air Sector is generally upwind of all South Pole surface and flight operations. The Atmospheric Research Observatory (ARO) is located within the Clean Air Sector and houses climatology and aeronomy projects.

#### **Dark Sector**

The Dark Sector is a region located grid-northwest of the dome. This sector is maintained with minimal interference from extraneous sources of light and other electromagnetic radiation. Microwave, infrared, and high-energy neutrino telescopes are located within the Dark Sector, as is the Martin A. Pomerantz Observatory (MAPO), which serves as headquarters for many Dark Sector projects, and the Astronomical Submillimeter Telescope/Remote Observatory (AST/RO).

## **Palmer Station Overview**

### **Palmer Station Opening & Closing Dates and Population**

Palmer Station will open for the 2000-2001 austral-summer season on 21 September 2000 with the arrival of the R/V *Laurence M. Gould* (cruise LMG00-08). Turnover of many of the 2000 austral-winter station-support staff (26 staff members) to the 2000-2001 austral-summer station-support staff (22 staff members) will occur at this time and continue over the following four weeks.

The transition from the 2000-2001 austral-summer station-support staff to the 2001 austral-winter station-support staff (average of 25 staff members) will be staggered over several R/V *Laurence M. Gould* cruises from mid-February 2001 to late April 2001.

### **Palmer Station Research Facilities and Local Research Areas**

The following information describes Palmer Station facilities and local areas where research projects are conducted.

**BioLab & Aquarium**

The main BioLab building contains offices, a library, workstations, and ten general and specialized laboratories. The attached aquarium contains both indoor and outdoor areas with running seawater and a variety of tanks, laboratory benches, and controlled environmental laboratories.

**VLF/Clean Air Building**

This small building contains computers, instruments, and air-sampling equipment. The building was designed to be isolated from electromagnetic noise generated by the rest of the station.

**T-5 Building**

This small building contains computers, instruments, and a work area for projects that are supported by the station science technician.

**Local Waters and Islands**

The near-shore marine environment varies from intertidal to several hundred meters in depth with a mixture of rocky and sandy bottoms. Near the station, there are numerous small rocky islands from 0 to 100+ meters in elevation--many with local plant and wildlife populations. Sea ice and brash ice are common in late winter and early summer; but for much of the year, local waters and islands can be accessed from the station by Zodiac inflatable boats.

## ***R/V Laurence M. Gould Overview***

The following information describes the *R/V Laurence M. Gould's* research and logistics operations plan for the 2000-2001 season. The ship's schedule may change throughout the year as various requirements evolve. The current schedule for the *R/V Laurence M. Gould* can be found on the World Wide Web (address: <http://www.polar.org/usapserv/calendars/lmsched.htm>).

The *R/V Laurence M. Gould* begins its fourth year of service to the United States Antarctic Program (USAP) in January 2001. This vessel is on charter to Raytheon Polar Services (the support contractor for the National Science Foundation/Office of Polar Programs) from Edison Chouest Offshore in Louisiana.

The *R/V Laurence M. Gould* will support 12 cruises in the 2000-2001 season. This vessel supports both full-fledged research cruises and supply runs to Palmer Station and Antarctic Peninsula Field Camps throughout the year. Biology, chemistry, physical oceanography, and marine geology research projects are all part of this season's operational plan in Antarctica. Ports-of-call will include Punta Arenas, Chile; Palmer Station, Antarctica; Copacabana Field Camp on King George Island; Seymour Island; Cape

Shirreff Field Station on Livingston Island; and Deception Island.

The R/V *Laurence M. Gould* is a 239-foot ice-classed research vessel, which has a maximum berthing for 28 science personnel, including a minimum of four support contractor staff. In addition, two berthing vans are available for Palmer Station science and support personnel berthing during both southbound and northbound transits.

The following are synopses of the 2000-2001 R/V *Laurence M. Gould* cruises:

#### **LMG00-8 (Logistics Cruise)**

This cruise, which follows an R/V *Laurence M. Gould* maintenance period, will depart from Punta Arenas, Chile, on 15 September 2000. This 13-day cruise is a Palmer Station staff turnover and cargo resupply. The R/V *Laurence M. Gould* will return to Punta Arenas, Chile, on 28 September 2000.

#### **LMG00-8A (Logistics & Research Cruise)**

For this cruise, which is the second of two back-to-back resupply and staff turnovers for Palmer Station, the R/V *Laurence M. Gould* will depart Punta Arenas, Chile, on 01 October 2000 for 12 days. While this cruise is primarily a logistics cruise, the following Antarctic Biology and Medicine Program project will conduct research on the southbound transit to Palmer Station:

- Project BO-282-O (PI: Dr. Dietzman) will work on board to collect invertebrate specimens for studies on human solid tumor cytotoxicity (e.g., anti-cancer drugs) near King George Island. This study is jointly funded with the National Cancer Institute (within National Institute of Health) and NSF, and consists of a revisiting of sites that were accessed during the R/V *Polar Duke* cruise 94-10. The primary tools used will be an 18-ft. otter trawl and a rock dredge to collect benthic biota samples. The specimens will be frozen or preserved and shipped back to the U.S. for further research. A bathymetry profile will be recorded simultaneously to trawls. If insufficient samples are collected during this cruise, then this project will sail on cruise LMG00-9 as well.

The R/V *Laurence M. Gould* will return to Punta Arenas, Chile, on 13 October 2000.

#### **LMG00-9 (Research & Logistics Cruise)**

The R/V *Laurence M. Gould* will depart Punta Arenas, Chile, on 17 October 2000 for a 22-day cruise. The vessel will stop briefly on its southbound transit to open the Copacabana Field Camp (Copa) on King George Island in the northern Bransfield Strait. The Copa Field Camp is the base of operations for Antarctic Biology and Medicine Program project BO-040-O (Dr. Trivelpiece), which is a study of the effect of environmental variability on penguins inhabiting the island. Following the Copa put-in, the ship will

make a one-day logistics port call at Palmer Station before continuing on to the Palmer LTER (Long-term Ecological Research on the Antarctic Marine Ecosystem) study area, which crosses the Antarctic shelf. The vessel will arrive in the work area for the following Antarctic Biology and Medicine Program projects on 24 October 2000:

- Project BO-303-O (PI: Dr. C. Smith) will continue research on a multi-year study to evaluate the seafloor accumulation, fate, and benthic community impact of bloom material. Specifically, the area of interest is along a transect of three stations crossing the western Antarctic Peninsula (WAP) shelf in the Palmer LTER study area.
- Project BO-313-O (PI: Dr. DeMaster) will continue a multi-cruise time study collecting core samples from the continental shelf near the Palmer LTER study area. The samples will be analyzed for naturally occurring radioactive tracers. The radiochemical data will then be used to assess how rapidly bottom-dwelling animals mix sediments on the seafloor and how fast the sediments accumulate. The researchers are also attempting to establish a time series of radiochemical data, enabling comparison of the sediment mixing intensity during the austral spring, summer, and late fall.

The vessel may also return to the study site for the Antarctic Biology and Medicine Program project BO-282-O (PI: Dr. Dietzman, Cruise LMG00-8A) if needed. The R/V *Laurence M. Gould* will make a brief stop at Palmer Station on 04 November 2000 before departing for Punta Arenas, Chile. It will arrive at Punta Arenas on 08 November 2000.

#### **LMG00-10 (Research Cruise)**

The R/V *Laurence M. Gould* will depart Punta Arenas, Chile, on 12 November 2000 and travel to Deception Island via the Cape Shirreff Field Camp (Cape Shirreff season opening) and Palmer Station for this 22-day research cruise. The vessel will arrive at Cape Shirreff on 16 November and at Palmer Station on 18 November. The remainder of November will be spent in and around Deception Island in support of the final research cruise of the following Antarctic Biology & Medicine Program project:

- Project BO-050-O (PI: Dr. K. Smith) will be onboard for the last in a series of five trips to Port Foster, Deception Island. The primary purpose is to examine the abundance and distribution of benthic and pelagic species as they relate to hydrographic and sea-ice coverage variables. A land-based monitoring station, including a camera, which takes periodic photos of the caldera throughout the year, will be removed. Other instruments used will be a gravity corer, profiling water sampler, CTD, oxygen titration system, and One-Meter and 10-Meter MOCNESS. A shore station will be accessed via a Zodiac inflatable boat and then will be occupied to allow for accurate weighing of samples and reagents.

The R/V *Laurence M. Gould* will return to the pier in Punta Arenas, Chile, on 04 December 2000.

**LMG00-11 (Logistics Cruise)**

The R/V *Laurence M. Gould* will depart Punta Arenas, Chile, on 08 December 2000 for this 16-day cruise bound for Seymour Island, Antarctica, which is located on the east of side of the Antarctic Peninsula. While there, the vessel will be working in support of the following Antarctic Geology and Geophysics Program project:

- Project GO-065-O (PI: Dr. Aronson) researchers and support contractor personnel will be conducting reconnaissance for a paleontology project that is scheduled to begin work on Seymour Island in December of 2001.

Following a short stop at Palmer Station on 19 December 2000, the R/V *Laurence M. Gould* will return to Punta Arenas, Chile, on 24 December 2000.

**LMG01-01 (Research Cruise)**

The R/V *Laurence M. Gould* will set sail for this 30-day cruise from Punta Arenas, Chile, on 30 December 2000 and will arrive at Palmer Station on 03 January 2001. The vessel will then depart the following day to spend 20 days in support of the following Antarctic Biology & Medicine Program LTER projects for this austral-summer cruise:

- Project BP-013-O (PI: Dr. Fraser) will focus on seabird communities, emphasizing the sources and quantity of food consumed within the foraging range of the seabirds.
- Project BP-016-O (PI: Dr. Vernet) will focus on rates of primary production, phytoplankton community structure and light absorption properties, and their relationship to physical forcing.
- Project BP-021-O (PI: Dr. Martinson) will compile, model, and manage data from the LTER field season and research cruises.
- Project BP-028-O (PI: Drs. Quetin & Ross) will focus on the effects of interannual variation in the extent of pack ice and food resources on the macrozooplankton.
- Project BP-032-O (PI: Dr. Ray Smith, LTER Project Manager) will focus on processes controlling the space/time variability of phytoplankton biomass and production.
- Project BP-046-O (PI: Dr. Karl) will focus on the microbiology and carbon-flux component.

The R/V *Laurence M. Gould* will return to Punta Arenas, Chile, on 29 January 2001.

**LMG01-01A (NSF Operations)**

The time period from 02 February through 16 February 2001 will be reserved for non-research related operations.

**LMG01-02 (Research Cruise)**

The R/V *Laurence M. Gould* will depart from Punta Arenas, Chile, on 20 February 2001 for this 22-day cruise. The first stop will be at Palmer Station on 24 February 2001. The ship will then depart the following morning in support of the following Antarctic Biology and Medicine Program projects:

- Project BO-303-O (PI: Dr. C. Smith) will continue research on a multi-year study to evaluate the seafloor accumulation and the fate and benthic community impact of bloom material. Specifically, the area of interest is along a transect of three stations crossing the western Antarctic Peninsula (WAP) shelf in the Palmer LTER study area.
- Project BO-313-O (PI: Dr. DeMaster) will continue a multi-cruise time study collecting core samples from the continental shelf near the Palmer LTER. The samples will be analyzed for naturally occurring radioactive tracers. The radiochemical data will then be used to assess how rapidly bottom-dwelling animals mix sediments on the seafloor and how fast the sediments accumulate. The researchers are also attempting to establish a time series of radiochemical data, enabling comparison of the sediment mixing intensity during the austral spring, summer, and late fall.

The vessel will make an overnight stop at Palmer Station on 09 March 2001 before beginning the northbound return transit to Punta Arenas, Chile. The R/V *Laurence M. Gould* will arrive pier side in Punta Arenas on 14 March 2001.

**LMG01-03 (Research & Logistics Cruise)**

The R/V *Laurence M. Gould* will depart Punta Arenas, Chile, on 18 March 2001 for a 27-day cruise, which is the first in a series of cruises supporting the Antarctic Ocean & Climate Systems Program and the Antarctic Biology & Medicine Program project Southern Ocean portion of the Global Ocean Ecosystems Dynamics project (GLOBEC). King George Island, located on the northeast end of the Antarctic Peninsula, will be the first stop the vessel will make during its southbound trip. After a brief stop to drop off a two-person team of glaciologists (project IO-196-L) at the island, the R/V *Laurence M. Gould* will continue on to Palmer Station for one day and then depart the next day in support of the GLOBEC project. This GLOBEC cruise will support the following multi-disciplinary research components:

- Project OG-231-O (PI: Drs. Beardsley & Limeburner) will study circulation and water property evolution using moored, drifter, and float measurements of current and temperature.
- Project OG-238-O (PI: Dr. Padman) will study mesoscale circulation, tides, and mixing using shipboard Acoustic Doppler Current Profiler (ADCP), CTD, and Lowered ADCP for tidal modeling and analysis.
- Project BG-239-O (PI: Drs. Hildebrand, Moore, and McDonald) will study whale population using acoustic mooring and whale

observations to determine population distributions.  
The vessel will return to Punta Arenas, Chile, on 14 April 2001.

#### **LMG01-04 (Research & Logistics Cruise)**

The R/V *Laurence M. Gould* will depart Punta Arenas, Chile, on 21 April 2001 for 46 days. A return to King George and Livingston Islands will be first on the schedule to transport the Project IO-196-L researchers from King George Island to Livingston Island, where they will continue their research. Immediately upon leaving Livingston Island, the vessel will continue on to Palmer Station for a short visit and then continue on to the GLOBEC work area. This GLOBEC cruise is one of several multi-disciplinary research cruises planned for the next two years and is made up of the following components:

- Project BG-234-O (PI: Dr. Fraser) will study seabird ecology using seabird observations and diet samples.
- Project BG-236-O (PI: Dr. Hallam) will study krill distribution, physiology, and predation; copepod prey abundance (water-column component) using net tows, Acoustic Doppler Current Profiler (ADCP), and fish-finding sonar to enhance the krill swarm model.
- Project BG-237-O (PI: Dr. Harvey) will study krill age and dietary history using net tows.
- Project BG-245-O (PI: Dr. Torres) will study krill physiology and fish ecology using net tows, experiments, scuba diving surveys, acoustics.
- Project BG-246-O (PI: Dr. Vernet) will study water-column phytoplankton primary productivity using CTD water samples.
- Project BG-248-O (PI: Dr. Zhou) will study krill distribution, physiology, and predation; copepod prey abundance (water-column component) using net tows, Acoustic Doppler Current Profiler (ADCP), and fish-finding sonar to enhance the krill swarm model.

The R/V *Laurence M. Gould* will return to Punta Arenas, Chile, on 06 June 2001 after returning to Livingston Island to pick up the researchers who were transported there earlier in the cruise.

#### **LMG01-05 (Research Cruise)**

The R/V *Laurence M. Gould* will depart Punta Arenas, Chile, on 10 June 2001 for this 35-day cruise. The vessel will arrive at Palmer Station on 16 June 2001 and then travel to the Livingston Island, Dallman Bay area to continue research support for the following Antarctic Biology and Medicine Program projects:

- Project BO-036-O (PI: Dr. Detrich) will study the physiology and protein structures of Antarctic fishes that are compatible with life at body temperatures of -2 to +2 degrees Celsius. This will be accomplished through the use of Otter Trawl tows, long-line fishing, and anchored fish pots.
- BO-037-O (PI: Dr. Sidell) will study Antarctic fishes to determine

adaptations, at the molecular level, given their chronically low body temperatures of -2 to +2 degrees Celsius. Data will be collected using net tows and Otter Trawls to capture specimens of Antarctic Rock Cod, several ice fishes, Dragonfish, as well as other "fish species of opportunity."

The R/V *Laurence M. Gould* will return to Punta Arenas, Chile, on 15 July 2001.

#### **LMG01-06 (Research Cruise)**

The R/V *Laurence M. Gould* will depart from Punta Arenas, Chile, on 21 July 2001 for this 42-day GLOBEC cruise. The researchers will be using the services of the R/V *Nathaniel B. Palmer* as well as those provided by the R/V *Laurence M. Gould*. This GLOBEC cruise is part of a multi-disciplinary research project made up of the following components:

- Project BG-234-O (PI: Dr. Fraser) will study seabird ecology using seabird observations and diet samples.
- Project BG-235-O (PI: Drs. Fritsen and Griggs) will study sea-ice microbial communities by examining their distribution and in-situ primary production.
- Project BG-237-O (PI: Dr. Harvey) will study krill age and dietary history using net tows.
- Project OG-241-O (PI: Drs. R. Smith, Martinson, and Perovich) will study sea-ice optics.
- Project BG-244-O (PI: Drs. Ross and Quetin) will study krill and zooplankton and how it relates as a function to sea ice using net tows and scuba.
- Project BG-246-O (PI: Dr. Vernet) will study water-column phytoplankton primary productivity using CTD water samples.

The R/V *Laurence M. Gould* will return to Punta Arenas, Chile, on 01 September 2001.

## **R/V *Nathaniel B. Palmer* Overview**

The following information describes the R/V *Nathaniel B. Palmer's* research and logistics operations plan for the 2000-2001 season. The ship's schedule may change throughout the year as various requirements evolve. The current schedule for the R/V *Nathaniel B. Palmer* can be found on the World-Wide Web (address: <http://www.polar.org/usapserv/calendars/nbpsched.htm>).

During the 2000-2001 season, the R/V *Nathaniel B. Palmer* will support 10 cruises. Researchers on the vessel will conduct biological, chemical, physical oceanographic, and marine geophysics studies in the Amundsen, Weddell, Bellingshausen, and Ross Seas. Ports-of-call will include Punta

Arenas, Chile; Palmer Station, Antarctica; Hobart, Tasmania; Cape Town, South Africa; and Port Fourchon, Louisiana.

The R/V *Nathaniel B. Palmer* is managed for the NSF by Raytheon Polar Services on a long-term charter from Edison Chouest Offshore of Galliano, Louisiana. This research vessel, built in 1992, is beginning its ninth research season. The R/V *Nathaniel B. Palmer* is ice-classed (ABS-A2) and capable of breaking three feet of level ice at three knots. The vessel can accommodate 39 scientists including seven support contractor staff and normally sails with an operating crew of between 20 and 24. There are over 4000 square feet of exterior main deck working areas and over 5500 square feet of laboratory space on this vessel.

The following are synopses of the 2000-2001 R/V *Nathaniel B. Palmer* cruises:

**NBP00-6B (Acoustic Trials & Antarctic Research Vessel Oversight Committee Meeting (ARVOC))**

The R/V *Nathaniel B. Palmer* will depart Port Fourchon, Louisiana, on 01 September 2000 and travel to New Orleans, Louisiana. Enroute, the vessel will undergo acoustic trials required for the renewal of the United States Antarctic Program's research vessel/ice breaker (RVIB) charter on the R/V *Nathaniel B. Palmer*. These trials will be sponsored entirely by Edison Chouest Offshore (ECO) to assess the acoustic properties of the vessel to assure that the ship will be capable of meeting the acoustic criteria specified in the RVIB Request For Proposals. All costs and subcontracting for this cruise will be arranged and sponsored by ECO. The survey involves the placing of hydrophones in various locations on the hull of the vessel and measuring transmission of sound at these locations. In addition, a measurement of ambient noise within the ship will be done as well as a measurement of vessel vibration.

Following the acoustic trials, the vessel will then spend four days in New Orleans, Louisiana, for the Antarctic Research Vessel Oversight Committee (ARVOC) meeting prior to returning to Port Fourchon, Louisiana, on 10 September 2000.

**NBP00-6C (Seismic Sea Trials)**

The R/V *Nathaniel B. Palmer* will leave Port Fourchon, Louisiana, on 25 September 2000 for a nine-day seismic equipment sea trial, as well as the first leg of the return transit to Punta Arenas, Chile. This leg of the return journey ends in Panama City, Panama, following the testing of all USAP seismic equipment onboard the R/V *Nathaniel B. Palmer*. This includes the Benthos (formerly Datasonics) sidescan sonar towfish; BOLT and GI seismic air guns; Syntrol air gun controller; Oyo-DAS and Lookout Geophysical seismic recording systems; Benthos and Innovative Transducers Incorporated seismic streamer cables; and the Seabeam 2112 multibeam swath sonar.

The R/V *Nathaniel B. Palmer* will arrive at Panama City on 04 October 2000.

**NBP00-6D (Transit Cruise)**

The R/V *Nathaniel B. Palmer* will depart Panama City on 05 October 2000 for the 18-day second leg of the return transit to Punta Arenas, Chile. The vessel will arrive on 23 October 2000 to prepare for Dr. James Austin's Marine Geology and Geophysics cruise.

**NBP00-7A (Research Cruise)**

The R/V *Nathaniel B. Palmer* will leave Punta Arenas, Chile, on 27 October 2000 for 22 days of sailing in support of an Antarctic Geology and Geophysics Program project. The entire cruise will be spent in the Bransfield Straits in support of the following project:

- Project GO-306-O (PI: Dr. Austin) will continue work which began on cruise NBP00-2 in April 2000. The cruise objective is to examine the deep crustal structure in the Bransfield Strait. The researchers, with the assistance of the support contractor's technicians, will employ Ocean Bottom Seismographs (OBS) to receive refracted sound waves generated by the vessel's new seismic air-gun array. The array, comprised of six BOLT air guns with a total air volume of 3000 cubic inches and an air pressure of 2000 PSI, provides the largest sound source ever deployed on the vessel. The increased power will allow deeper penetration of the sound source into the earth's crust and, hopefully, imaging of the crust-mantle boundary. Dr. Austin proposed nine lines for this survey; but only five were accomplished during cruise NBP00-2. The remaining four lines are planned for this cruise. In addition to the OBS work described above, multibeam bathymetric records and gravity data will be collected.

This R/V *Nathaniel B. Palmer* cruise will end in Punta Arenas, Chile, on 18 November 2000.

**NBP00-7B (Research Cruise)**

The R/V *Nathaniel B. Palmer* will set sail from Punta Arenas, Chile, on 19 November 2000 for a 27-day transit to Hobart, Tasmania. Enroute, the vessel will support research operations for the following Antarctic Geology and Geophysics Program project:

- Project GO-071-O (PI: Dr. Cande) will conduct plate tectonics research in the southern Pacific Ocean using multibeam sonar, gravity, magnetics, and sub-bottom profile sonar instrumentation. In addition, meteorological, thermosalinograph, Acoustic Doppler Current Profiler, and navigation data will be acquired.

The R/V *Nathaniel B. Palmer* will arrive at Hobart, Tasmania, on 16 December 2000.

**NBP00-8 (Research Cruise)**

The R/V *Nathaniel B. Palmer* will depart Hobart, Tasmania, on 20 December 2000 for a 36-day cruise supporting the following Antarctic Ocean & Climate Systems Program project.

- Project OO-225-O (PI: Dr. Fairbanks) will occupy a series of stations in the Mertz Glacier Polynya (offshore of Adelie Land, near Dumont D'Urville Station). This is a collaborative project between the United States Antarctic Program and scientists in the Australian Antarctic Division who visited the area during the austral winter of 1999. The general goals are to characterize the bathymetry and physical oceanography (temperature, salinity, circulation) as determining factors in Antarctic deep-water formation in this perennial polynya maintained by katabatic (offshore) winds. The CTD, SeaBeam, TeraScan, oxygen titrations, and One-Meter MOCNESS systems will be used. (Note: As of 15 August 2000, no decision had been reached regarding whether Australian scientists will deploy on this cruise.)

The R/V *Nathaniel B. Palmer* will return to Hobart, Tasmania, on 25 January 2001.

**NBP01-01 (Research Cruise)**

The R/V *Nathaniel B. Palmer* will set sail from Hobart, Tasmania, on 29 January 2001 for a 59-day cruise supporting the following Antarctic Geology and Geophysics and Ocean and Climate System Program projects:

- Project GO-073-O (PI: Dr. Leventer) will collect seismic data in an effort to reconstruct the climatic and oceanographic history of the East Antarctic Margin. High-resolution seismic mapping and coring sites will be accomplished at Svenner Channel, Iceberg Alley, Nielson Basin, and Amery Depression. Extra time will be spent in the Prydz Channel where mapping of moraines and selected core sites will be accomplished.
- Project OO-278-O (PI: Dr. Pilskaln) will perform sediment trap recovery in Prydz Bay, along with collection of sediment cores, CTD/transmissometer profiles, and small particulate matter in water samples taken at selected sites along the cruise track.

The vessel will arrive at Capetown, South Africa, on 29 March 2001.

**NBP01-02 (Research Cruise)**

The R/V *Nathaniel B. Palmer* will leave Capetown, South Africa, on 03 April 2001 for a 16-day cruise in support of the following Antarctic Geology and Geophysics Program project:

- GO-071-O (PI: Dr. Cande) will conduct plate tectonics research in the southern Pacific Ocean using multibeam sonar, gravity, magnetics, and sub-bottom profile sonar instrumentation. In addition, meteorological, thermosalinograph, Acoustic Doppler Current Profiler, and navigation data will be acquired.

The R/V *Nathaniel B. Palmer* will arrive at Punta Arenas, Chile, on 19 April 2001.

#### **NBP01-03 (Research Cruise)**

The R/V *Nathaniel B. Palmer* will depart Punta Arenas, Chile, on 23 April 2001 in support of the ongoing GLOBEC project. During this 44-day cruise, the vessel will be working alongside its sister ship--the R/V *Laurence M. Gould*. This GLOBEC cruise is a multi-disciplinary research project made up of the following components:

- Project OG-231-O (PI: Drs. Beardsley & Limeburner) will study circulation and water property evolution using moored, drifter, and float measurements of current and temperature.
- Project OG-233-O (PI: Dr. Fanning) will study water-column nutrient analysis using CTD samples.
- Project BG-235-O (PI: Drs. Fritsen & Griggs) will study sea-ice microbial communities by examining their distribution and in-situ primary production.
- Project OG-238-O (PI: Dr. Padman) will study mesoscale circulation, tides, and mixing using shipboard Acoustic Doppler Current Profiler (ADCP), CTD, and Lowered ADCP for tidal modeling and analysis.
- Project BG-239-O (PI: Drs. Hildebrand, Moore, and McDonald) will study whale population using acoustic mooring and whale observations to determine population distributions.
- Project BG-243-O (PI: Dr. Ribic) will study seabird distribution and abundance using strip-transect survey.
- Project OG-240-O (PI: Drs. Hofmann, Klinck, and Locarnini) will study hydrographic modeling, both biological and physical, using shipboard CTD profiles, ADCP circulation data, bio-optical and krill models.
- Project OG-242-O (PI: Dr. Powell) will study small-scale mixing and krill behavior using microstructure profiling/krill swarm models.
- Project BG-246-O (PI: Dr. Vernet) will study water-column phytoplankton primary productivity using CTD water samples.
- Project BG-247-O (PI: Drs. Ashjian, Davis, Gallager, and Wiebe) will study zooplankton distribution, abundance in the water column and sea-ice/water-column boundary using ROVs, BIOMAPER towed sensor array, and net tows.

The R/V *Nathaniel B. Palmer* will return to Punta Arenas, Chile, on 6 June 2001.

#### **Open Period**

The R/V *Nathaniel B. Palmer* will be docked in Punta Arenas, Chile, for the time period from 7 June 2001 through 20 July 2001. No science or logistics activities are scheduled for this time.

#### **NBP01-04 (Research Cruise)**

On 21 July 2001, the R/V *Nathaniel B. Palmer* will depart Punta Arenas, Chile, in support of the last of the year 2000 GLOBEC cruises. This 42-day cruise is another cooperative effort between the R/V *Nathaniel B. Palmer* and the R/V *Laurence M. Gould* in the Antarctic Peninsula. This GLOBEC cruise is a multi-disciplinary research project made up of the following components:

- Project OG-231-O (PI: Drs. Beardsley and Limeburner) will study circulation and water property evolution using moored, drifter, and float measurements of current and temperature.
- Project OG-233-O (PI: Dr. Fanning) will study water-column nutrient analysis using CTD samples.
- Project BG-235-O (PI: Drs. Fritsen and Griggs) will study sea-ice microbial communities by examining their distribution and in-situ primary production.
- Project BG-236-O (PI: Dr. Hallam) will study krill distribution, physiology, and predation; copepod prey abundance (water-column component) using net tows, experiments, predator diets net tows, ADCP krill distribution, experiments/krill swarm model.
- Project OG-238-O (PI: Dr. Padman) will study mesoscale circulation, tides, and mixing using shipboard Acoustic Doppler Current Profiler (ADCP), CTD, and Lowered ADCP for tidal modeling and analysis.
- Project BG-239-O (PI: Drs. Hildebrand, Moore, and McDonald) will study whale population using acoustic mooring and whale observations to determine population distributions.
- Project OG-240-O (PI: Drs. Hofmann, Klinck, and Locarnini) will study hydrographic modeling, both biological and physical, using shipboard CTD profiles, ADCP circulation data, bio-optical and krill models.
- Project OG-242-O (PI: Dr. Powell) will study small-scale mixing and krill behavior using microstructure profiling/krill swarm models.
- Project BG-243-O (PI: Dr. Ribic) will study seabird distribution and abundance using strip-transect survey.
- Project BG-245-O (PI: Dr. Torres) will study krill physiology and fish ecology using net tows, experiments, scuba diving surveys, and acoustics.
- Project BG-246-O (PI: Dr. Vernet) will study water-column phytoplankton primary productivity using CTD water samples.
- Project BG-247-O (PI: Drs. Ashjian, Davis, Gallagher, and Wiebe) will study zooplankton distribution, abundance in the water column, and sea-ice/water-column boundary using ROVs, BIOMAPER towed sensor array, and net tows.
- Project BG-248-O (PI: Dr. Zhou) will study krill distribution, physiology, and predation; copepod prey abundance (water-column

component) using net tows, experiments, predator diets net tows, ADCP krill distribution, experiments/krill swarm model. The R/V *Nathaniel B. Palmer* will return to the port at Punta Arenas, Chile, on 1 September 2001.

## **Southern Ocean Global Ocean Ecosystems Dynamics (SO GLOBEC) Research Objectives**

The goal of the U.S. Global Ocean Ecosystems Dynamics (U.S. GLOBEC) program is understanding and ultimately predicting how populations of marine animal species respond to natural and anthropogenic changes in climate. Research in the Southern Ocean indicates strong coupling between climatic processes and ecosystem dynamics via the annual formation and destruction of sea ice. As participants in the Southern Ocean GLOBEC program (SO GLOBEC), we will investigate the dynamic relationship between physical processes and ecosystem responses through identification of critical parameters that affect the distribution, abundance, and population dynamics of target species. Overall, we hope to elucidate shelf-circulation processes and their effect on sea-ice formation and antarctic krill (*Euphausia superba*) distribution and to examine the factors that govern krill survivorship and availability to higher trophic levels-including penguins, seals, and whales. To accomplish this we will use moored-instrument investigations; broad physical, biological, and chemical oceanographic surveys; process-oriented investigations; and modeling studies focused on austral-winter processes in the western Antarctic Peninsula region.

We have chosen Marguerite Bay in the central western Antarctic Peninsula continental shelf, which is characterized by unusually high krill production. We hypothesize that these high production levels result from a unique combination of physical and biological factors that enhance krill growth, reproduction, recruitment, and survivorship throughout the year.

Water masses on the continental shelf off Marguerite Bay consist of inflowing Upper Circumpolar Deep Water, which is relatively warm, salty, oxygen-poor, and nutrient-rich. In winter, atmospheric processes cool and freshen this water and recharge it with oxygen to produce Antarctic Surface Water. This austral-winter environment also provides particularly favorable conditions for larval and adult krill survival, including the following:

- a shelf circulation that keeps the krill population in a favorable environment for extended periods,
- a persistent winter ice cover that provides dependable food and protection for larval krill to grow and survive over the winter, and

- on-shelf intrusions of Upper Circumpolar Deep Water, supplying heat, salt, and nutrients that affect ice properties and enhance biological production.

Making use of U.S. Antarctic Program's two research ships--the icebreaking research ship *Nathaniel B. Palmer* and the ice-strengthened research ship *Laurence M. Gould*--we will begin our 2-year study in mid-March 2001 (the late austral fall). Working in the Antarctic Peninsula region until mid-August 2001, we will conduct five cruises aboard the two ships in and around Marguerite Bay. The results of the integrated SO GLOBEC program will improve the predictability of living marine resources, especially with respect to local and global climatic shifts.

The following are descriptions of each GLOBEC project's research objectives:

**Southern Ocean GLOBEC: Circulation and Water Property Evolution**  
*Robert Beardsley and Richard Limeburner, Woods Hole Oceanographic Institution*

As part of the Southern Ocean GLOBEC program, we will develop and deploy on the continental shelf off Marguerite Bay a series of moorings, which will include current meters, salinity and temperature sensors, zooplankton concentration, upward-looking acoustic sounders to track ice motion, and acoustic doppler current profilers. Our proposed mooring design will quantify and characterize the inflowing and outflowing water masses and provide the physical component for the integrated modeling effort. Instrumented drifters will supplement the mooring data. Our observations produced will quantify the spatial and temporal variability of the presumed clockwise flow of water masses through the bay and define the tidal and transient flows driven by storms and southward meanders of the Antarctic Circumpolar Current.

**Southern Ocean GLOBEC: Mesoscale Circulation, Tides, and Mixing**  
*Lawrence Padman, Earth and Space Research*

Our project has the following three major components:

- to collect, analyze, and archive Acoustic Doppler Current Profiler (ADCP) and Conductivity-Temperature-Depth (CTD) data to characterize mesoscale circulation features and the regional hydrography;
- to develop an accurate model of tidal currents in Marguerite Bay; and
- to provide a data set of small-scale processes (such as shear instabilities, tidal stirring, mesoscale eddies, and double diffusion) that are required for the effective parameterization of the vertical diffusivities of heat, salt, and nutrients.

The results of our project will provide a unified data, which will link water-column and sea-ice processes with the biology of krill and its predators.

### **Southern Ocean GLOBEC: Water-Column Microstructure**

*Thomas Powell, University of California, Berkeley*

Our objective is to make a quantitative assessment of the small scale temperature and salinity structure of the oceanic surface layer to study the effect of stratification and turbulence on the biochemical and biological processes under the winter sea ice. These modification processes work through mixing associated with shear instabilities of the internal wave field, double diffusion of salt and heat, and mixing driven by surface stress and convection. These processes will be quantified with two microstructure profilers, capable of resolving the small but crucial vertical variations that drive these processes.

### **Southern Ocean GLOBEC: Hydrography and Biological and Physical Modeling**

*Eileen Hofmann, John Klinck, and Ricardo Locarnini, Old Dominion University*

We have two objectives: to characterize the regional hydrography and to develop a hierarchy of models to organize and integrate physical and biological observations. We will define the water masses in the Marguerite Bay region with repeated regional surveys for temperature, salinity, nutrients, and oxygen and will supplement these with data from a moored current-meter and temperature array and from acoustic surveys of the upper ocean current structure. Modeling will provide a mechanism to link water-column and sea-ice processes with the biology of krill and its predators. To synthesize physical and biological models over the continental shelf, we will use three types of models to order the various observations-time-dependent biological models, depth-time models of physical and biological characteristics, and three-dimensional and time-dependent models.

### **Southern Ocean GLOBEC: Sea-Ice Physics**

*Douglas Martinson, Lamont-Doherty Earth Observatory; Raymond Smith, University of California, Santa Barbara; and Donald Perovich, U.S. Army's Cold Regions Research and Engineering Laboratory*

The optical properties of snow and sea ice evolve through the winter and vary greatly both spectrally and spatially. These properties, important elements of the physical environment, strongly influence the distribution of and the resources available to antarctic krill. The intensity and distribution of incident radiant energy within the snow, ice, and water column, and the linked physical, optical, chemical, and biological processes that modulate its distribution are known but poorly quantified. These properties also influence snow and ice algae, water-column productivity, and visibility for both predator and prey as well as being essential in satellite observations as proxy indicators of geophysical sea-ice parameters. To create improved quantitative models with which to follow the temporal and spatial evolution of this snow and ice marine ecosystem, we will deploy an array of instrumented ice beacons, augmented by

periodic ship-based and satellite observations, along with theoretical studies.

**Southern Ocean GLOBEC: Dissolved Nutrients and Oxygen Measurements**

*Kent Fanning, University of South Florida*

Our project focuses on providing high-quality measurements of water-column silica, phosphate, nitrite and nitrate concentrations, as well as dissolved oxygen. These measurements will be used to be examined in conjunction with biological and physical components.

**Southern Ocean GLOBEC: Primary Production in the Water Column**

*Maria Vernet, Scripps Institution of Oceanography, University of California, San Diego*

Focusing on water-column primary production, we will use direct experimental estimates, modeling results from a fast-repetition-rate fluorometer, and modeling of primary production from optical as well as biophysical models. This research will be coordinated with components focused on sea-ice production and sea-ice habitats.

**Southern Ocean GLOBEC: Sea-Ice Microbial Communities**

*Christian Fritsen, Desert Research Institute; University of Nevada*

Focusing on the distribution and activities of sea-ice microbial communities, we will use an integrated combination of sampling (vertical profiles, horizontal surveys, and under-ice surveys) and observational protocols. Experiments will be designed to estimate microbial activity within the sea ice and at the ice-seawater interface. We will coordinate our research with components studying the water-column productivity and the sea-ice habitat.

**Southern Ocean GLOBEC: Water-Column Krill Distribution and Abundance in Winter**

*Meng Zhou, University of Minnesota*

We will use acoustic techniques to acquire data on the distribution of juvenile and adult krill and mesozooplankton prey. We will also conduct studies of krill shrinkage and mortality rates and krill aggregation behavior. The results will be analyzed in coordination with components involved in physical and biological models.

**Southern Ocean GLOBEC: Zooplankton Distribution and Abundance**

*Peter Wiebe, Carin Ashjian, Cabell Davis, and Scott Gallager, Woods Hole Oceanographic Institution*

This project will focus on juvenile and adult krill and mesozooplankton prey distribution and abundance using a sophisticated instrument package, BIOMAPPER II, which is equipped with an acoustic backscatter sonar system, a video plankton recorder, and an environmental

sensor system. Additionally, a remotely-operative vehicle will be used to map the distribution and behavior of krill under ice.

**Southern Ocean GLOBEC: Winter Ecology of Larval Krill**

*Robin Ross and Langdon Quetin, University of California, Santa Barbara*

Focusing on the under-ice distribution and abundance of larval and juvenile krill, we will assess the physiological condition of krill associated with sea ice that provides food of differing quality and quantity. This research will be coordinated with krill components that focus on adults in the water column in an effort to understand the overall age-specific dynamics of krill in winter.

**Southern Ocean GLOBEC: Krill Physiology, Distribution, Predation, and Fish Ecology**

*Jose Torres, University of South Florida and Thomas Hallam, University of Tennessee*

This project will focus on krill physiology, using measures of respiration, excretion, and proximate analysis. Feeding experiments will be conducted using various measurement techniques. Under-ice surveys and sample collection will provide information on krill abundance and distribution. Additionally, the distribution and abundance of fishes and squid, which are krill predators, will be investigated using acoustic and net tow methods.

**Southern Ocean GLOBEC: Biochemical Determination of Age and Dietary History in the Krill**

*H. Rodger Harvey, Center for Environmental Sciences, University of Maryland*

To determine the population-age structure of krill in field populations over seasonal and interannual time scales, we will apply new biochemical approaches using lipids specific to different food resources in parallel to establish markers for dietary history. This research will be coordinated with components studying krill feeding and growth.

**Southern Ocean GLOBEC: Seabird Distribution and Abundance in Winter**

*Christine Ribic, University of Wisconsin and William Fraser, Montana State University*

Our project focuses on large-scale distribution, abundance, and habitats of seabirds, as well as on seabird diet composition and small-scale foraging behavior. To accomplish this, we will use strip-transect surveys and will examine large-scale data with spatial analysis software and models. Additionally, satellite transmitters will be used to document foraging behavior in conjunction with diet studies.

**Southern Ocean GLOBEC: Foraging Ecology of Crabeater Seals**

*Daniel Costa and Daniel Crocker, University of California, Santa Cruz and Jennifer Burns, University of Alaska, Anchorage*

Using a combination of satellite-linked tracking, specialized diver recorders, and stable isotopic tracers, we will focus on the distribution and foraging behavior of adult female crabeater seals. We will coordinate with components focused on prey (krill) distribution and the physical environment. The results will be analyzed using an optimality model.

**Southern Ocean GLOBEC: Mysticete Whale Acoustic Census in the GLOBEC West Antarctic Project Area**

*John Hildebrand, Scripps Institution of Oceanography, University of California, San Diego*

We will determine minimum population estimates, distribution, and seasonality for mysticete whales, especially blue whales, by using passive acoustic recorders deployed on the seafloor for one to two years. The deployment of a large aperture autonomous hydrophone array in the Antarctic will incorporate the use of passive acoustics as a tool to detect and census mysticete whales.

**Southern Ocean GLOBEC: Modeling the Effects of Eddies and Mean Flows on Southern Ocean Biology**

*Glen Flierl, Massachusetts Institute of Technology*

Our objective is to understand the interactions of biological and physical dynamics by modeling the spatial distribution of krill, which form dense aggregations or patches on the small scale. The spatial distribution of these patches apparently depends on the advance and retreat of sea ice, the three-dimensional movement of water masses from small-scale turbulence to the dynamics of the Antarctic Circumpolar Current, and the pressure of the food supply and predation. Earlier studies indicate that physical processes dominate on the larger scale, while biological processes dominate on the smaller scale, but the relative importance of the two as a function of scale has not been investigated systemically. To accurately represent patchiness in a circum-antarctic model, we will study a detailed model that can resolve the scale of krill patches and help us to analyze and understand the field observations. These results will allow us to improve the parameters of krill distributions in meso-scale and basin-scale models of the Southern Ocean.

## Technical Events

Every field season, the United States Antarctic Program sponsors a variety of technical events that are not scientific research projects in their own right, but support one or more science projects with field support, data collection and archiving, or technical services. The technical events for the 2000-2001 research season are as follows:

**TO-150-M**  
**Ice Coring and Drilling Services (ICDS)**  
**Core Drilling on U.S. ITASE**

Charles R. Bentley  
Geophysical and Polar Research Center  
University of Wisconsin  
1215 W. Dayton St.  
Madison, WI 53706  
Phone: (608) 262-1922  
Fax: (608) 262-0693  
bentley@geology.wisc.edu

ICDS will be providing two coring drills to the U.S. ITASE program (project IU-153-A) this season. One is the Eclipse drill purchased from Icefield Instruments, Inc. in Whitehorse; the other is a standard 4" electromechanical drill. The 4" drill will be used to core to 200 m at a site, about 150 km northeast of Byrd Station, that is projected to be the location of the WAISCORES "Western Divide" deep core drilling some years hence. The Eclipse drill will be used to collect 50-m cores at about 100-km intervals along a 1000-km triangular traverse from there northward and then back to Byrd Station. All the cores are being collected to sample the spatial and temporal variability of a large suite of environmental and glaciological parameters. ICDS will provide one driller for the program. Nominal dates for the entire traverse are 15 November 2000 to 7 January 2001.

**TO-150-S**  
**Ice Coring and Drilling Services (ICDS)**  
**Core Drilling on FIRN Air Sampling**

Charles R. Bentley  
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University of Wisconsin  
1215 W. Dayton St.  
Madison, WI 53706  
Phone: (608) 262-1922

Fax: (608) 262-0693  
bentley@geology.wisc.edu

Two drillers from the ICDS will use a 4" drill to drill 3 holes near South Pole Station to depths slightly below the firn-ice boundary. The purpose is to permit members of the Firn Air Sampling project (IO-162-O: Dr. Bender) to collect air from a series of depths in the firn down to the firn-ice boundary. They will examine the atmospheric histories of oxygen and some trace species. Depending on arrangements not finalized at this time, some or all of the cores may be saved and returned to the United States for analysis. The hole depths will be 120-150 m, depending in part on the needs of the core users. ICDS will provide two drillers, one each for two 12-hour shifts that will allow the drilling and sampling to proceed around the clock. The program is scheduled to be completed in 19 days at the Pole in January 2001.

**TO-296-O**  
**Automatic Geophysical Observatory (AGO) Servicing Program**

Joe Kujawski  
Raytheon Polar Services Company (RPSC)  
61 Inverness Dr East, Suite 300  
Englewood, CO 80112  
Phone: (303) 790-8606  
FAX: (303) 792-9006  
Kujawsjo@polar.org  
<http://space.augsburg.edu/ago/>

There are six Automatic Geophysical Observatory (AGO) stations distributed over the Antarctic Plateau. Each station is a general research station that can support a wide variety of experiments. Each station is intended to run for 12 months without human intervention and will supply electrical power (up to 50 watts in the winter and 180 watts in the summer) and heat to the experiments. The current experiments include the Polar Experiment Network for Geophysical Upper-Atmosphere Investigations (PENGUIn), which are a suite of six different experiments all of which are examining the same phenomenon, and a Seismometer.

The support contractor's AGO service team's objective is to visit each site and perform the servicing, refueling, and upgrading of the sites as is necessary. The service team will prepare the station to run for the next year and will ensure that all of the existing experiments are functional. At some of the sites, the service team will install upgrades to existing experiments.

AGO team engineers will retrieve the AGO data and send it to Augsburg College, where it will be processed and distributed to each investigator.

**TO-308-O**  
**NASA McMurdo Ground Station**

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Honeywell Technology Solutions  
Wallops Flight Facility  
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The McMurdo Ground Station (MGS) downloads data, tracks, and provides uplink commands to a variety of scientific and mapping satellites. Ground Station personnel record data on tapes, which are shipped to Alaska Synthetic Aperture Radar (SAR) facility and other locations. Real-time data support to a variety of projects is provided via a dedicated 128 Kbit circuit. If needed, MGS can also uplink data through the McMurdo TDRSS (i.e., Telemetry & Data Relay Satellite System) Relay System (MTRS) ground station located on Black Island to White Sands, New Mexico.

Several project members will work at McMurdo Station to provide routine maintenance of the ground station and to download and transmit data.

**TO-396-O**  
**Installation, Operation, and maintenance of a CTBT Class**  
**Infrasound Array in Windless Bight, Antarctica**

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The proposed Infrasonic System envisioned for the Comprehensive Nuclear-Test-Ban Treaty (CTBT) site at Windless Bight, Antarctica (WBA) will be similar to that which was deployed by the University of Alaska in Windless Bight, from 1976 to 1985. An array of microphones will be used to collect time series data on the atmospheric pressure fluctuations in a

passband from 4 Hz to 0.02 Hz. The basic scientific techniques to be used for the CTBT infrasonic sites will be the same as those previously employed by this project at Windless Bight. The major changes that are expected for the new systems are as follows: (1) the sensors will be updated; (2) the data will be digitized and preprocessed to CTBT specifications at the location of each sensor; (3) the telemetry will be digital; (4) the data from each sensor will be amalgamated, processed, and recorded to CTBT specifications at McMurdo; and (5) then data will be telemetered to University of Alaska and the CTBTO in Vienna, Austria, in near real time from the NSF satellite earth station at Black Island.

The project team will deploy one (ski-mounted) hybrid solar/diesel genset power system in WBA and eight infrasound sensor-digitizers and RF telemetry transceivers in vaults in two overlapping triangles centered on the power system. The triangle's sides will be 1 km. After installation, it is expected that two visits to WBA will be required each year for maintenance and calibration. The data will be automatically processed and forwarded.

In January 2001, a field team will install the core sensor vaults; lay power cable to each sensor site from the power supply; install the core sensors, TM links, and Hub system; and begin transmitting data to Alaska. In February, the team will deploy the pre-built power supply at WBA. During this final period, the team will continue to install any remaining infrasonic sites. Each sensor and the Hub, as required by the CTBT/PTS treaty, will be in a secure tamper indicating facility.

The data may also be available for scientific purposes (from CTBT archives to CTBT signers), and this project expects to perform research into the natural infrasound background similar to that which was previously performed with the project's Windless Bight array from 1976 to 1985.

**TO-513-O**  
**National Science Foundation Polar Programs**  
**Ultraviolet Spectroradiometer Network**

Charles Booth  
Biospherical Instruments, Inc.  
5340 Riley St.  
San Diego, CA 92110  
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Booth@biospherical.com  
<http://www.biospherical.com>

The National Science Foundation (NSF) Ultraviolet (UV) Monitoring Network was first established in 1987 by the NSF's Office of Polar Programs in response to the serious ozone depletion reported in

Antarctica. Biospherical Instruments installed this network and has operated it since. This network is the first automated, high-resolution UV scanning spectroradiometer network installed in the world. It has been successfully operated in the harshest environments of Antarctica and the Arctic and is currently providing data to researchers studying the effects of ozone depletion on terrestrial and marine biological systems. In addition, the network is used to develop and verify models of atmospheric light transmission and the impact of ozone depletion.

The annual Biospherical Instruments site visits to McMurdo and South Pole Stations will take place from mid-January 2001 to early February 2001, while the Palmer Station site visit will take place from late March 2001 to early April 2001. The team members plan to test, maintain, conduct an engineering upgrade, and calibrate the high-resolution UV spectroradiometers located at the Arrival Heights Facility in McMurdo, at the Atmospheric Research Observatory in South Pole, and at the T-5 building in Palmer Station. The team members also plan to train the support contractor's science technicians to operate and repair the instruments.

## **Media Visitors to U.S. Antarctic Research Stations**

Each year, the National Science Foundation (NSF) selects a very limited number of journalists to visit the U.S. Antarctic Program's research stations to report on the scientific work being conducted in Antarctica. The media visits to the research sites--which could not take place without NSF's assistance because of the lack of commercial transport to and within the continent--serve to inform U.S. taxpayers about the publicly supported program.

Public affairs officers from NSF's Office of Legislative and Public Affairs (OLPA) assist reporters during their stay in Antarctica. Many reporters maintain their interest in the U.S. Antarctic Program for years after they visit the southernmost continent.

An Antarctic "group media tour" of previous years has been replaced by individual visits, for which there are many more requests than can be met. Reporters apply with a concise letter that proposes a reporting plan, based on ideas often developed in conjunction with OLPA's public affairs officers. Reporters may join a research cruise, for example, or spend an extended time at a field camp. They may focus on research in a particular discipline, pursue a broader interest in the science program as a whole, or concentrate on a unique project taking place in a particular season. For most reporters, the individual scientists and life at the remote stations are a compelling part of the scientific story to be told.

The program is open only to media professionals; and representatives from a variety of media, including print, radio, television, film, and online journalism, may be selected in a given year. These reporters reach diverse audiences that include everyone from children to semi-technical readers to the general public. U.S. media receive preference in selection as do proposals that reflect some background knowledge of the U.S. Antarctic Program.

Reporters interested in covering the science program are usually rated more highly than those who wish to focus on operations or on Antarctica in general. Freelance writers must provide evidence in the form of a letter on the target market's letterhead that their work will be published or aired as a result of the trip. Space is particularly limited each year for television and film outlets.

Reporters' requests are competitively evaluated in June of each year by a committee drawn from OLPA and the Office of Polar Programs, and final selections are made from highly rated proposals for travel during the upcoming Antarctic summer (usually between November and February).

For more information on NSF's Antarctic media visits, contact:

Peter West  
Public Affairs Officer  
Office of Legislative and Public Affairs  
National Science Foundation  
4201 Wilson Blvd., Rm. 1245  
Arlington, VA 22230  
tel.: 703-292-8070  
e-mail: pwest@nsf.gov

The news media selected to visit Antarctica during the 2000-2001 research season include reporters and photographers from the following:

- *Education Week* newspaper
- *The Los Angeles Times*
- *The Milwaukee Journal-Sentinel*
- *National Geographic* magazine
- National Public radio

## **Antarctic Artists & Writers Program**

The Antarctic Artists & Writers Program, National Science Foundation, provides an opportunity for the humanities (e.g., painting, photography, writing, history, and other liberal arts) to be part of the U.S. Antarctic Program. Artists and writers work at U.S. stations and camps, often with science groups but sometimes on their own, to create works that portray the region or activities there.

The program helps to record America's antarctic heritage and responds to White House direction that the U.S. Antarctic Program "support the range of U.S. antarctic interests." Application procedure, selection criteria, and a list of past participants are at <http://www.nsf.gov/od/opp/aawr.htm>.

Selection compares to the way NSF selects science projects: a peer-review panel meets at NSF annually to evaluate the applications, and its advice heavily influences NSF's decisions. Those selected receive field support (including air travel from the United States), but no direct award of NSF funds. The program is mainly for U.S. citizens; applicants from other Antarctic Treaty nations can be considered if their works will reach a significant U.S. audience.

The following are participants during the 2000-2001 season:

### **Underwater photography, McMurdo Sound (WO-317-O)**

Norbert Wu  
1065 Sinex Avenue  
Pacific Grove, California 93950  
(831) 375-4448  
<http://www.norbertwu.com>

Objective: This season will conclude Mr. Wu's project, begun during the 1997-1998 and 1999-2000 seasons, to document the underwater natural history of the McMurdo Sound region and to disseminate the work by means of print, the web, and a high-definition-television program for public TV. The team is headed by Norbert Wu, a widely published underwater photographer who in 1999 won a Pew Marine Conservation Fellows Award ([www.neaq.org/pfp](http://www.neaq.org/pfp)), the world's largest and most prestigious award for preservation of the sea, partly for his antarctic work.

Field season: A four-person team will work out of McMurdo Station in October 2000. Three team members will be on site in January 2001. Diving and related work will take place.

**A Guide to the Birds of Chile and the Adjacent Antarctic (WO-009-O)**

Sophie Webb  
Point Reyes Bird Observatory  
4990 Shoreline Highway  
Stinson Beach, California 94970  
415-868-9565  
swebb@prbo.org

Objective: Ms. Webb and coauthor Steve N.G. Howell are illustrating and writing a book, *A Guide to the Birds of Chile and the Adjacent Antarctic*, accepted for publication by Cornell University Press. Ms. Webb will collect field notes and sketches for the book.

Field season: Ms. Webb will participate in a cruise (To Be Announced) of the R/V *Laurence M. Gould*. Mr. Howell will not deploy.

**Expressionist paintings (WO-008-O)**

Robert Andrew Parker  
P.O. Box 114  
West Cornwall, Connecticut 06796  
860-672-0152  
jmellecker@snet.net

Objective: Mr. Parker, whose paintings since the 1950s have entered numerous public and private collections, will experience the light, shadow, weather, and terrain of Antarctica to provide a personal and intimate view accomplished by traditional materials of paper, brush, paint, and his own artist's eye. In addition to painting, he will keep an illustrated journal of his time there, with drawings and watercolors of current events and projects. Likely venues are *The New Yorker*, galleries, and museums.

Field season: Mr. Parker will work out of McMurdo Station from mid-December through January.

**Paintings and modern scientific images of the Antarctic (WO-087-O)**

James Morrison  
Craigview House Usan Montrose  
Angus, Scotland DD10 9SD  
01674 672639  
d.j.morrison@tesco.net

Ian Dalziel  
Institute for Geophysics  
The University of Texas at Austin

4412 Spicewood Springs Road, Building 600  
Austin, Texas 78759-8500  
512-471-6156  
utig@utig.ig.utexas.edu

Objective: Mr. Morrison, a landscape painter who among his travels has made four expeditions to the Arctic, and Dr. Dalziel, a geophysicist who has led numerous research projects in the U.S. Antarctic Program, will collect perspectives and information for an exhibition of Mr. Morrison's paintings combined with modern scientific images of the Antarctic. The exhibition will be shown at universities in the United States and in Scotland. The scientific images will help viewers place the paintings in their time and space context, and the paintings will breathe life into digital scientific images, leading to fuller understanding and appreciation of the Antarctic and of Earth as a whole.

Field season: The team of two will work out of McMurdo for about one month in November.

## **Teachers Experiencing Antarctica (TEA)**

Seven teachers will join seven research projects to continue Teachers Experiencing Antarctica, an NSF program that selects teachers to work with investigators who volunteer to accept them on their teams. (NSF funds a similar program for the Arctic.) TEA is part of NSF's strategy to integrate research and education in order to infuse education with the joy of discovery and an awareness of its connections to exploration.

The TEA goal is to immerse teachers in research as part of their professional development, to infuse polar research into the classroom in engaging and innovative ways that underscore the societal relevance of science and the scientific process, and to maintain a Polar Learning Community of teachers, students, school districts, and researchers.

NSF funds the extra cost of supporting each teacher, including the following:

- a substitute at the teacher's school while the teacher is away
- travel by the teacher to the investigator's institution before the Antarctic trip
- travel by the teacher to Antarctica (and related expenses)
- travel by the investigator to the teacher's school district for joint presentations before and/or after field work

The Foundation's Division of Elementary, Secondary, and Informal Education funds the teacher-related expenses. Office of Polar Programs support consists of funding extra PI expenses, increasing the investigator's field party size by one person, and providing U.S. Antarctic Program operational, communications, and management support.

This season's seven TEA teachers and their research hosts (plus one teacher-PI pair who completed their deployment last season) are as follows:

- Richard M. Jones, who teaches physics and has taught biology, earth science, and physical oceanography at Billings Senior High School in Billings, Montana, will join Steve Warren and Von Walden at South Pole.
- Kolene M. Krysl, who teaches science and reading at Central Middle School in Omaha, Nebraska, will join Don Siniff and Michael Cameron at McMurdo.
- Kevin Lavigne, who teaches chemistry, biology, and other science subjects at Hanover High School in Hanover, New Hampshire, will join Ross Virginia at the McMurdo Dry Valleys LTER site.
- Karina Leppik, who teaches physics and astronomy at Choate Rosemary Hall in Wallingford, Connecticut, will join John Carlstrom and Chris Martin in the Center for Astrophysical Research in Antarctica project at South Pole.
- Larry Reynolds, who teaches earth science, math, and oceanography at Liberty School in Blue Hill, Maine, joined Tom and Davida Kellogg aboard R/V *Nathaniel B. Palmer* cruise 00-01 in February-March 2000.
- Wendy Sue Slijk, who teaches earth, space, and environmental science at La Cost Canyon High School in Carlsbad, California, will join Amy Leventer and other investigators aboard R/V *Nathaniel B. Palmer* cruise 01-01 to Prydz Bay.
- William Swanson, who teaches on an interdisciplinary team at Montwood High School in El Paso, Texas, will join Ray Smith at the Palmer Station LTER site.
- Rolf Tremblay, who teaches earth and space science, interactive science, and math at Goodman Middle School in Gig Harbor, Washington, will join Gary Clow and Ed Waddington at Siple Dome.

TEA depends on the generosity of U.S. Antarctic Program investigators volunteering to accept a teacher on their teams. NSF greatly appreciates this collaboration and support, and it has received positive comments from investigators who have hosted a teacher in prior seasons.

Investigators: If you are willing to host a teacher in the 2001-2002 season, contact Guy G. Guthridge (gguthrid@nsf.gov, 703-292-7414), Manager, Antarctic Information, in NSF's Office of Polar Programs. The eight teachers for that season have been selected. They began their training at a week-long workshop in August 2000.

For the 2002-2003 season, investigators may nominate teachers, and teachers may nominate themselves, by using the application at <http://tea.rice.edu/>. Or contact Wayne W. Sukow (wsukow@nsf.gov), Head, Education and Research Section, in NSF's Education and Human Resources directorate. The deadline is 15 May 2001. NSF selects TEA teachers in a competitive process that requires each teacher to apply in response to NSF criteria.

## **USAP Environmental, Health, and Safety Initiatives**

The participation, cooperation, and patience of all USAP participants are required for the successful implementation of the Environmental, Health, and Safety (EHS) initiatives of the USAP. These initiatives were established in 1987 by a Safety Review Panel appointed by the Director of the National Science Foundation (NSF). The goals of these initiatives are to clean up the debris from past antarctic activities, improve USAP participant health and safety, and minimize the environmental impact of current activities.

The United States has enacted environmental protection regulations (45 CFR 670-672) which are applicable to all USAP participants. It is imperative that all materials and wastes be managed in a manner consistent with guidelines and procedures developed by the USAP support contractor-Raytheon Polar Services Company (RPSC). One of the major elements of compliance with these regulations is the establishment of an aggressive waste management program. The cooperation of every person working in the USAP is essential for the waste management program to work effectively and for the USAP to attain compliance. Proper identification and segregation of wastes at the point-of-generation are the keys to a successful program.

The recycling programs at McMurdo and South Pole Stations include segregating glass, aluminum cans, scrap metal, wood, cardboard, paper, wire, copper, brass, and some hazardous wastes. The recycling programs at Palmer Station and on board the USAP research vessels are similar in scope; however, the segregation processes are less stringent because the recycled materials are sent to locations that do not require extensive segregation.

For the 1999-2000 season, approximately 3.75 million pounds (1,875 tons) of recyclables, waste, and equipment were removed from U.S. stations and field camps. Historically, the USAP has recycled approximately 60-70% of all waste generated. The remaining waste is incinerated, treated, or landfilled at United States facilities in accordance with U.S. environmental regulations. The preferred waste management strategy is pollution prevention. Participation in this waste minimization effort has reduced waste by approximately 9% annually since 1994. Whenever possible, USAP participants should select reusable rather than disposable products, and substitute nonhazardous materials for hazardous materials. The backpacking philosophy of "pack it in, pack it out" should be adopted whenever possible. For example, boxes and packing material may be saved and reused. RPSC will provide guidance to all participants

through routine orientations ("waste briefings") and specialized instruction for those participants generating hazardous or radioactive wastes.

A clear understanding of the waste management program and the various categories of waste is essential. It is imperative that hazardous waste be managed appropriately, including proper packing, labeling, and characterization. (Note: Materials such as batteries, aerosol cans, fuels, oils, and glycols are managed as hazardous wastes.) Improperly labeled containers can result in delays in the field, costly chemical analysis to identify the waste, and potential noncompliance. All participants are required to follow the guidance that will be provided by RPSC waste management specialists.

If USAP participants will be using chemicals, they should plan on sending only what is needed to Antarctica to avoid leaving behind unused chemicals. Placing any waste other than water from sinks and showers or human waste into a waste-water system is not acceptable unless it is specifically approved by the NSF.

Another important facet of the EHS initiatives is the NSF's environmental impact assessment program. Under this program, if an activity may have at least a minor or transitory environmental impact, then appropriate documentation highlighting the alternatives and the potential impacts of each must be completed. The intent of this program is to ensure that environmental considerations are taken into account in the planning stage of an activity to prevent avoidable environmental impacts. RPSC has been directed to conduct audits of research activities to determine compliance with these environmental impact assessment requirements. If audited, researchers can discuss with RPSC auditors any difficulties or challenges that they may experience in understanding and meeting the requirements. Part of the auditing process is to find more efficient ways to meld environmental protection into the conduct of scientific research in Antarctica. Further information on this program may be obtained from the NSF/OPP Environmental Officer or the RPSC Environmental Manager.

By taking the time to be aware of and comply with the waste management protocol and the environmental review program for each station, field camp, and research vessel, USAP participants can ensure that their work in Antarctica has minimal impacts.

Each year, waste management specialists provide detailed instructional information and technical assistance to ease the burden of waste management and to ensure that all participants are in compliance with the regulations. USAP participants are encouraged to take the time to become familiar with this guidance and ask for assistance or advice. It is the duty of all USAP participants to comply with these new regulations and to establish the United States as an exemplary visitor to Antarctica.

With respect to health and safety, the USAP is a program in transition. We will continue past practices that have been proven effective, but implement changes where necessary to provide the NSF and USAP

participants with world-class safety performance. To that end, RPSC promotes an environment for the USAP that integrates health and safety requirements and issues into every activity at every site. You are ultimately responsible for your behaviors and contributions to the Program. This includes compliance with USAP health and safety procedures.

USAP participants will have increased responsibilities for health and safety, as will RPSC supervisors. By taking the time to become aware of the health and safety requirements of the USAP, all participants can ensure not only their safe return from Antarctica, but the safe return of others.

### United States Antarctic Program Science Event Numbering System

Example:  
OO-283-M

$$X_{[1]}X_{[2]}-000-X_{[3]}$$

$X_{[1]}$   $X_{[2]}$  and  $X_{[3]}$  are alpha

000 are numeric

$X_{[1]}$  indicates the Antarctic Program under which the project is funded.

- A Antarctic Aeronomy & Astrophysics Program**
- B Antarctic Biology & Medicine Program**
- E Antarctic Environmental Monitoring Program**
- G Antarctic Geology & Geophysics Program**
- I Antarctic Glaciology Program**
- O Antarctic Ocean & Climate Systems Program**
- T Technical project**
- W Writers & Artists Program**

$X_{[2]}$  indicates if this is a meta project. That is, is this particular project linked to a larger effort? If so, this indicates that research collaboration is in the same location and during the same general time period.

- A Antarctic Muon and Neutrino Detector Array (AMANDA) project**
- B Long-Duration Ballooning (LDB) project**
- C Center for Astrophysical Research in Antarctica (CARA)**
- F Ford Ranges project**
- G Global Ocean Ecosystems Dynamics (GLOBEC)**
- I Siple Dome Ice Coring project**
- M McMurdo Long-Term Environmental Research (LTER) project**
- O NOT PART OF A META PROJECT**
- P Palmer Long-Term Environmental Research (LTER) project**
- S Support Office for Aerogeophysical Research (SOAR) project**
- U U.S. International Trans-Antarctic Scientific Expedition (ITASE)**

**000** are sequential numbers from 001 - 999. This number does not track one-to-one with the NSF grant number. In many cases, the three-digit number adheres to tradition (i.e., the 3 digits are the same as the previous numbering system). The three numbers are now assigned based upon availability.

$X_{[3]}$  is a location designator. If the project has subcomponents and/or research at different locations during the same research season, then a location designator is assigned to the science-event number.

NOTE: An "O" indicates that there are no subcomponents.

<b><i>R/V Laurence M. Gould</i></b>	<b>L</b>
<b>McMurdo Station</b>	<b>M</b>
<b><i>R/V Nathaniel B. Palmer</i></b>	<b>N</b>
<b>Palmer Station</b>	<b>P</b>
<b>South Pole Station</b>	<b>S</b>

If the projects have subcomponents, but the subcomponent does not refer to a location, then  $X_{[3]}$  is a letter--starting with A, then B, then C, and so on in consecutive order.

## Overview of the Antarctic Aeronomy and Astrophysics Program

The polar regions have been called Earth's window to outer space. Originally, this term applied to the study of auroras and phenomena related to the interaction of solar plasmas and fields. In this context, the polar upper atmosphere is a screen on which the results of such interactions can be viewed and through which evidence of other processes can pass. Today, this concept has been extended to the study of other phenomena. With the discovery of polar stratospheric ozone depletion, a window previously thought "closed" (the ultraviolet window) is now known to "open" in certain seasons. In astronomy and astrophysics, favorable atmospheric conditions and the unique location of the South Pole enable scientists to probe the structure of the Sun and the universe with unprecedented precision.

The Antarctic Aeronomy and Astrophysics Program supports studies of the following three regions:

- The stratosphere and the mesosphere: Current research focuses on stratospheric chemistry and aerosols, particularly in the context of the ozone hole.
- The thermosphere, the ionosphere, and the magnetosphere: These regions derive many characteristics from the interplay of ionized plasmas and energetically-charged particles with geomagnetic and geoelectric fields. The upper atmosphere, particularly the ionosphere, is the ultimate sink of solar wind energy transported into the magnetosphere. Also, particle precipitation, which partially results from resonant wave-particle interactions, and Joule heating from currents driven by electric fields dissipate the energy in the ionosphere.
- Astronomy and astrophysical studies: Projects consider regions outside the magnetosphere, including sun and cosmic rays. Astrophysical studies are primarily conducted at Amundsen-Scott South Pole Station or on long-duration balloon flights launched from McMurdo Station.

Research projects sponsored by this program require or benefit from the unique conditions of the Antarctic, contribute to the understanding of Antarctica's role in global environmental change, promote interdisciplinary study of geosphere-biosphere interactions in the middle and upper atmosphere, and improve understanding of the coupling of Earth's polar atmosphere with the magnetosphere and of the ways in which solar activity affects both.

# **AMANDA- Antarctic Muon and Neutrino Detector Array AA-130-O**

**Dr. Robert Morse, Principal Investigator**

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## **Research Objectives**

Neutrinos are elementary particles. With no electrical charge, and believed to have very little or no mass, they 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 in the ice near the South Pole, between 1 and 2 kilometers deep, to create a Cherenkov detector out of the natural ice. This system will detect high-energy neutrinos that have passed through Earth. Their 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.

## Field Research Plan

### Logistics

Dates in Antarctica: late October 2000 to mid-February 2001 AND throughout the 2001 austral winter

Research Location(s): Martin A. Pomerantz Observatory (MAPO) in the Dark Sector and in the back of the Science Building under the dome

### Team Members

Giles Barouch	Steven Barwick	David Besson
Michael Boyce	Jan Conrad	Paolo Desiati
Jean-Paul Dewult	Tyce DeYoung	Thomas Feser
Markus Gaug	Azreil Goldschmidt	Kael Hansen
Marc Hellwig	Per Olof Hulth	John Jacobsen
Albrecht Karle	Bruce Koci	Lutz Koepke
Marek Kowalski	Ilya Kravchenko	Jodi Lamoureux
Matthias Leuthold	James Madsen	Pavel Marciniewski
Charles McParland	Yulia Minaeva	Robert Morse
Bob Paulos	Katherine Rawlins	Steffen Richter
Thomas Scheider	Torsten Schmidt	David Schmitz
Darryn Schneider	Andrea Silvestri	Peter Steffen
Ignacio Taboada	Lars Thollander	Muriel Vanderdonckt
Ralf Wischniewski	Kurt Woschnagg	Dmitri Chirkin
Gerald Przybylski	David Ross	Thorsten Stezelberger
Kaila Sulanke	David Steel	

### Field-Season Operations

During this season, there will be no drilling of holes in the ice nor string deployments for the AMANDA project. Originally, there were 20 strings in the ice. Last season, six new string were deployed. Each string is hard-wire cabled to computers in the Martin A. Pomerantz Observatory (MAPO) facility. These computers analyze gigabytes of data to sort out true neutrino events.

This season, the project team members will work at the South Pole from late October 2000 to mid-February 2001 to calibrate (via computers) and analyze the new data from the six new strings (i.e., the data from the 2000 austral winter and from the 2000-2001 austral summer), which comprise the AMANDA-2 detector. They will also install two new computers in the MAPO building to increase computing ability.

Support contractor personnel will survey the surface area of this project's string deployments to fine tune the location of the holes where the strings go into the ice.

Two project team members plan to winter-over at South Pole Station to collect data throughout the 2001 austral-winter season and to send this data to the home institution.

**NSF/OPP Program Manager**  
Dr. John Lynch

**RPS Point-of-Contact**  
Mr. Eivind Jensen

## Long Duration Balloon Program

### AB-145-O

**Mr. Steven Peterzen, Project Manager**

National Scientific Balloon Facility (NSBF)

FM 3224

Palestine, TX 77565

**Phone:** (903) 723-8058

**E-Mail:** [steven@master.nsbf.nasa.gov](mailto:steven@master.nsbf.nasa.gov)

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**Web:** [master.nsbf.nasa.gov](http://master.nsbf.nasa.gov)

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## Research Objectives

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, the LDB program will support two stratospheric flights from its facility at Williams Field:

- **TopHat:** Instruments used in this project (AB-147-O) will help researchers estimate the mass of the Universe to at least the 10-percent level by measuring the variations in the Cosmic Microwave Background Radiation. The instruments will also provide a high precision map of the sky in the far-infrared for galactic studies.
- **Advanced Thin Ionization Calorimeter (ATIC):** This project (AB-149-O) involves a series of balloon flights (each 10-14 days) to investigate the composition and energy spectra of galactic cosmic rays (GCR) at the highest energies accessible from balloon platforms.

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## Field Research Plan

### Logistics

Dates in Antarctica:

mid-October 2000 to mid-January 2001

Research Location(s):

Long-Duration Balloon (LDB) Site at Williams Field, McMurdo; Payload recovery site to be determined

### Team Members

Steven Peterzen

Robin Whiteside

Randal Henderson

Marty Crabil

David Sullivan

Derek Dolbey

Mark Cobble

Victor Davison

Frank Candelaria

Dwight Bawcom

Mark Metzger

Scott Hadley

Gary Marchant

Bill Stracner

Erich Klein

Francie Peterzen

Robert Mullenax

Gerald Gregg

Thomas W. Thomas

## **Field-Season Operations**

The National Scientific Balloon Facility team members will begin arriving in Antarctica in mid- October 2000 to prepare the launch site, balloons, and payloads for the 2000-2001 field season. The team plans to launch, track, and recover two stratospheric helium balloons with payloads of scientific instruments supporting the following science projects:

- Project AB-147-O: Dr. Stephan Meyer's TopHat study of the Cosmic Microwave Background
- Project AB-149-O: Dr. John Wefel's ATIC study of galactic cosmic rays

Once launched, the 28.4-million-cubic-foot balloons will ascend at a rate of approximately 275 meters per minute (900 feet per minute) to circumnavigate Antarctica at a float altitude of approximately 125,000 feet. The balloon launches will take place at the Long-Duration Balloon Facility at Williams Field near McMurdo Station. The balloons will be launched approximately three days apart within the launch window of 10 December 2000 to 10 January 2001, with the exact launch time determined by weather and atmospheric conditions. The balloons will reach float altitude and circumnavigate the continent between 77 degrees south latitude and 80 degrees south latitude for up to twenty-four days.

NSBF personnel will monitor the balloons via remote telemetry as they circle the continent. If the balloons come within range, the researchers plan to conduct one or more underflights of the balloons to download data from instruments during the flights. These underflights will be conducted with helicopters or Twin Otter fixed-wing aircraft. When the balloons return to the McMurdo area and are over the Ross Ice Shelf or the Polar Plateau, team members will terminate the flights by radio commands sent from a helicopter or Twin Otter to the gondola. If the balloons are out of range of these two aircraft, the researchers will use an LC-130 aircraft to terminate the balloon flights.

When the gondolas receive the termination signal, they will detach from the balloons and parachute to the ground. Team members will travel via helicopter or Twin Otter from McMurdo Station to the drop sites for the recovery operation. If the payloads land out of range of these two aircraft, team members will use an LC-130 aircraft for recovery operations. Team members will break down the gondolas at the landing site, remove data disks and instrumentation, and return these components to McMurdo Station. Due to weight considerations, the gondolas themselves will not be recovered.

The LDB project will also launch up to five small "Pathfinder" balloons, which carry a 25-pound GPS transponder payload suspended on parachute cord. These small balloons will be sent up to determine stratospheric conditions prior to launching the large balloons.

If time and resources are available, LDB team members will attempt to recover the Boomerang Telescope, which was launched during the 1999-2000 field season. Team members will travel via Twin Otter aircraft to the Boomerang landing site near Midpoint Charlie in East Antarctica, where they will remove the telescope from the gondola and cut the gondola into pieces small enough to fit inside the aircraft. Both the gondola and the telescope will then be returned to McMurdo Station for eventual return to the United States.

**NSF/OPP Program Manager**  
Dr. John Lynch

**RPS Point-of-Contact**  
Mr. Curt LaBombard

## **TopHat LDB 2000-2001 Antarctic Campaign**

### **AB-147-O**

#### **Dr. Stephan Meyer, Principal Investigator**

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**Web:** [topweb.gsfc.nasa.gov](http://topweb.gsfc.nasa.gov)

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### **Research Objectives**

We have developed a program of complementary, balloon-borne experiments to measure the cosmic microwave background radiation (CMBR) anisotropy on angular scales from 0.33 to 180 degrees between 2.3 and 23 cm (70 and 660 GHz, or 0.4 and 4.4 mm). Such measurements have become increasingly important for providing information on the initial conditions from which the large-scale structure of the Universe has evolved. The recent detections on large angular scales by COBE and our FIRS experiment have completed the discovery phase for CMBR anisotropy studies. We now enter a detailed measurement phase, which promises quantitative answers to some of the fundamental questions concerning structure evolution in our Universe.

To take advantage of new opportunities for long-duration circumpolar ballooning (LDB), we have developed a novel instrument concept—TopHat. Designed to provide reliable, quantitative measurements of the CMBR anisotropy, TopHat is optimized to reject both systematic and foreground spurious signals. We achieve this by placing the telescope on top of the balloon, creating an observing environment unequaled in any sub-orbital CMBR experiment performed to date. By mounting the telescope on top of the balloon, the entire sky above the instrument will be free from supporting structures that could scatter radiation into the sidelobes of the optics—a critical source of systematic uncertainty for anisotropy measurements at the  $10^{-6}$  level of sensitivity.

Two versions of TopHat are being constructed—the Pointer and the Spinner. The TopHat Pointer is similar to a Medium-Scale Anisotropy Measurement (MSAM) instrument, both in the Cassegrain style of the telescope and its ability to perform pointed integrations. The beam size makes this instrument sensitive to angular scales as fine as 0.33 degrees. The TopHat Pointer will be able to observe the same region of sky as MSAM2, with similar sensitivity except at shorter wavelengths. This will provide unprecedented spectral coverage of a significant portion of the sky. Not only does this yield an excellent check of systematic errors that can plague any experiment of this sensitivity, it also will enable us to understand the nature of the far-infrared foreground spectrum in high-galactic latitudes as never before.

## **Field Research Plan**

### **Logistics**

Dates in Antarctica: late October 2000 to mid-January 2001  
Research Locations: Long-Duration Balloon (LDB) Site at Williams Field, McMurdo; Payload recovery site to be determined

### **Team Members**

James Aguirre	Jeff Bezaire	Alex Bier
Edward Cheng	Sean Cordone	David Cottingham
Thomas Crawford	Steven Edwards	Dale Fixsen
Peter Kenney	Stephan Meyer	Eun Oh
Kenneth Rehmann	Rene Kristensen	Elmer Sharp
Robert Silverberg	Grant Wilson	

### **Field Season Operations**

Team members from project AB-147-O will begin to arrive at McMurdo Station at the end of October 2000. They will immediately begin work preparing instrumentation for the TopHat experiment which will measure the anisotropy of the Cosmic Background Radiation (CMBR) over a 48 degree diameter cap centered on the South Celestial Pole. Working in the Balloon Barn at Williams Field, team members will prepare the experimental package and assemble the solar panels necessary to power the instruments. They will then begin to integrate the solar panels and the experimental package with the gondola. Sometime after 15 December 2000, as weather and atmospheric conditions allow, the team members will collaborate with members of the Long-Duration Ballooning program (project AB-145-O) to launch the TopHat payload.

Once launched, the 28.4-million-cubic-foot balloon will ascend at a rate of approximately 275 meters per minute (900 feet per minute) to circumnavigate Antarctica at a float altitude of approximately 125,000 feet. The launch will take place at the Long-Duration Balloon Facility at Williams Field near McMurdo Station. The balloon will reach float altitude and circumnavigate the continent between 77 degrees south latitude and 80 degrees south latitude for up to twenty-four days.

If during its flight, the balloon comes within range of helicopters or Twin Otter fixed-wing aircraft based at McMurdo Station, team members from this project and from project AB-145-O may travel via these aircraft to conduct underflights of the balloon to download data via telemetry. Once the balloon flight is complete and the balloon has returned to the McMurdo area, team members will transmit a radio signal to terminate the flight. The gondola will detach from the balloon and parachute to the surface on the Ross Ice Shelf or the Polar Plateau. Team members will travel to the drop site via helicopter or Twin Otter aircraft to recover the data disks and instruments. If the gondola lands out of range of these aircraft, the researchers will use an LC-130 aircraft for the recovery.

The data disks will be returned to the University of Chicago for analysis.

**NSF/OPP Program Manager**  
Dr. John Lynch

**RPS Point-of-Contact**  
Mr. Curt LaBombard

## **Advanced Thin Ionization Calorimeter (ATIC) Scientific Balloon Payload**

**AB-149-O**

**Dr. John Wefel, Principal Investigator**

Louisiana State University

Department of Physics and Astronomy

Room 272, Nicholson Hall

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**Fax:** (225) 388-1222

**Web:** NA

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### **Research Objectives**

The ATIC Balloon Experiment is designed to use NASA's Long Duration Ballooning (LDB) program for a series of balloon flights from Antarctica (each 10-14 days) to investigate the composition and energy spectra of galactic cosmic rays (GCR) at the highest energies accessible from balloon platforms—the region up to  $\sim 10^{14}$  eV. In this high-energy region, we anticipate observing effects from the acceleration process, if, as is widely believed, supernovae remnants are the “cosmic accelerators” for the GCR. Previous, pioneering experiments have revealed differences in the spectra of hydrogen, helium, and the heavier nuclei, leading to an energy dependent composition. In addition, the “all-particle” GCR spectrum and composition, as measured by ground-based air-shower arrays, exhibits changes in the energy regime approaching the well-known spectral “knee” at  $10^{15}$ - $10^{16}$  eV. ATIC's goal is to apply new experimental techniques to the study of these very high-energy particles to verify previous reports and to search for the behavior expected from the supernovae-remnant acceleration process.

The ATIC experiment, weighing 1,360 kilograms and consuming 400 watts of power, consists of three major detector systems (from the top):

- (a) a Si-matrix pixelated detector (over 4,000 pads) to measure the particle charge;
- (b) a three-layer, crossed scintillator strip hodoscope, interspersed within a carbon target, to measure the trajectory of the particle;
- (c) a fully active Bismuth Germanate scintillation calorimeter,  $\sim 20$  radiation lengths in depth, to measure the energy of the hadronic cascade initiated by particle interactions in the carbon target.

The individual detectors are read-out with Application Specific Integrated Circuit devices. The ATIC experiment is fully built, was calibrated in September 1999 at the SPS facility at CERN, and is now scheduled for a balloon flight from McMurdo Station, Antarctica, in December 2000.

## Field Research Plan

### Logistics

Dates in Antarctica: late October 2000 to mid-January 2001  
Research Locations: Long-Duration Balloon (LDB) Site at Williams Field, McMurdo; Payload recovery site to be determined

### Team Members

James Adams	Gary Case	Mark Christl
Opher Ganel	Randy Gould	Doug Granger
T. Gregory Guzik	Joachim Isbert	Evgueni Kouznetsov
Tom Lemczyk	Leslie Mock	Donny Olano
Brad Price	Bill Rodman	Michael Stewart
Doug Smith	Alexey Toptygin	John Wefel
Mark Wefel	YeonJu Han	

### Field Season Operations

Researchers from project AB-149-O plan to investigate the composition and energy spectra of galactic cosmic rays (GCR) at the highest energies accessible from balloon platforms, the region up to approximately  $10^{14}$  electron volts. Immediately after their arrival at McMurdo Station in late October 2000, the team members will begin working in the Balloon Barn at Williams Field to prepare their 1360-kg Advanced Thin Ionization Calorimeter (ATIC) experimental package for launch. Sometime after 15 December 2000, as weather and atmospheric conditions allow, researchers will collaborate with members of the Long-Duration Ballooning program (project AB-145-O) to launch the ATIC payload.

Once launched, the 28.4-million-cubic-foot balloon will ascend at a rate of approximately 275 meters per minute (900 feet per minute) to circumnavigate Antarctica at a float altitude of approximately 125,000 feet. The launch will take place at the Long-Duration Balloon Facility at Williams Field near McMurdo Station. The balloon will reach float altitude and circumnavigate the continent between 77 degrees south latitude and 80 degrees south latitude for up to twenty-four days.

If during its flight, the balloon comes within range of helicopters or Twin Otter fixed-wing aircraft based at McMurdo Station, team members from this project and from project AB-145-O may travel via one of these aircraft to conduct at least one underflight of the balloon to check the payload's status and download data via telemetry. Once the balloon flight is complete and the balloon has returned to the McMurdo area, team members will transmit a radio signal to terminate the flight. The gondola will detach from the balloon and parachute to the surface on the Ross Ice Shelf or the Polar Plateau. Team members will travel to the drop site via helicopter or Twin Otter aircraft to recover the data disks and instruments. If the gondola lands out of range of these aircraft, the researchers will use an LC-130 aircraft for the recovery.

The data disks will be returned to Louisiana State University for analysis.

**NSF/OPP Program Manager**  
Dr. John Lynch

**RPS Point-of-Contact**  
Mr. Curt LaBombard

## **Center for Astrophysical Research in Antarctica (CARA)**

**AC-370,371,372,373,374,375,376,378-O**

**Dr. John Carlstrom, Project Director**

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### **Research Objectives**

Astronomers probe the infrared spectrum at submillimeter scales in search of data that could suggest answers to some of the seminal questions about the formation of the Universe, such as:

- How do stars form from interstellar gas?
- How did the planets form?
- What was the nature of primeval galaxies?
- How were matter and energy distributed in the early Universe?

Antarctica is an ideal spot for such research: The cold temperatures and lack of water vapor in the atmosphere above the polar plateau make the infrared spectrum of sky in that region consistently clearer and darker than anywhere else on Earth. These conditions enable scientists to collect measurements that would be extremely difficult or impossible from other sites.

To capitalize on these advantages, the University of Chicago and several collaborating institutions in 1991 established the Center for Astrophysical Research in Antarctica (CARA), one of 17 Science and Technology Centers funded by the National Science Foundation. CARA's scientific mission is to investigate the conditions for astronomy at the South Pole and other sites on the polar plateau and to establish an observatory at the South Pole. Currently, CARA supports research using three major telescope facilities:

- The Astronomical Submillimeter Telescope/Remote Observatory (AST/RO) project uses a 1.7-meter (m) diameter telescope to survey interstellar gas in the galactic plane, the galactic center, and the Magellanic Clouds.
- The South Pole Infrared Explorer (SPIREX) project uses a 0.6-m diameter telescope to observe distant galaxies, cool stars, and heavily obscured star-forming regions.

- The Cosmic Background Radiation Anisotropy (COBRA) project helps researchers test current theories of the origin of the Universe.

In addition to projects using these three telescopes, CARA's Advanced Telescopes Project collects data on the quality of polar plateau sites for astronomical observations and configures plans for future telescopes and facilities. The following projects are currently part of CARA:

### **CARA-wide Operations and Activities (AC-370-O)**

#### **Antarctic Submillimeter Telescope and Remote Observatory (AST/RO) (AC-371-O)**

This austral summer, we will install a new array receiver called PoleSTAR that will permit high frequency (809 GHz) spectral line observations in four spatial channels simultaneously. We will use PoleSTAR to map emissions from excited carbon atoms and carbon-monoxide molecules in interstellar clouds. To characterize the properties of the polar atmosphere at far-infrared and submillimeter wavelengths, we also will install a broadband Fourier Transform Spectrometer in the AST/RO building.

#### **Automated Astrophysical Site Testing Observatory (AASTO) (AC-372-O)**

Our objective is to categorize those conditions on the Antarctic plateau, from the ultraviolet to the sub-millimeter, that are relevant to a future large telescope. This season we will be deploying sky monitors for the mid-infrared and sub-millimeter, and we will be continuing our measurements of the atmospheric turbulence and the sky emission in the near-infrared.

#### **Degree Angular Scale Interferometer (DASI) (AC-373-O)**

DASI is a 13-element interferometer designed to measure anisotropies in the Cosmic Microwave Background (CMB) and determine its angular power spectrum. The unique imaging capabilities of DASI (especially its future millimeter and submillimeter capabilities to be provided by ACBAR) and its angular coverage ( $140 < l < 910$ ) complement the Viper telescope, as well as the MAP satellite and other CMB experiments.

#### **South Pole Infrared Explorer (SPIREX) (AC-374-O)**

This austral summer we will dismantle and remove the SPIREX telescope (60 centimeters in diameter) that was built to exploit the unique observing conditions at the South Pole and to develop and demonstrate the technology needed to operate IR telescopes during the Antarctic winter.

#### **Viper Telescope (AC-375-O)**

Viper, a 2-meter class telescope, extends our observations to structures in the cosmic microwave background (CMB) having smaller angular scales. Our primary goal is to determine the power spectrum of the CMB anisotropy over the range of angular scales where cosmological models most differ in their predictions. This austral summer we will refurbish the telescope to allow for new cables

and hoses for the ACBAR, Corona, and SPARO instruments. We also will raise the elevation of the telescope by just under one foot and install a new cable wrap, a new azimuth rind, and new control wiring.

**Submillimeter Polarimeter for Antarctic Remote Observing (SPARO) (AC-376-O)**

SPARO, which was deployed to the South Pole in 1999, operates on the Viper 2-meter telescope. It is a 9-pixel, 450-micron, polarimetric imager that requires only infrequent cryogen refills, making maintenance easier during the winter-over. The South Pole offers superb conditions for SPARO observations, extending submillimeter polarimetry (measurement of the polarization of thermal emission from magnetically aligned dust grains) to regions of low-column density that cannot be studied from other sites. SPARO is similar to polarimeters in the University of Chicago array designed for other telescopes, but those instruments (for example, at the Caltech Submillimeter Observatory and the Owens Valley Radio Observatory) provide much better angular resolution. SPARO's geographic advantage, however, results in a much-enhanced submillimeter sensitivity to extended emission.

**Arcminute Cosmology Bolometer Array Receiver (ACBAR) Instrument (AC-378-O)**

We plan to install the ACBAR receiver on the Viper telescope and get it ready for winter observations. ACBAR, a 16-element, 300 mK, bolometer array, will be used to map the cosmic microwave background radiation with high-angular resolution, characterize the evolution of the structure formation by searching for clusters of galaxies, and study nearby clusters with targeted observations. Preliminary observations and calibration will be done in the 2000-2001 summer season; the majority of the science data will be gathered during the 2001 winter.

The following list contains the CARA projects' Principal Investigator contact information:

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**AC-371-O: Astronomical Submillimeter Telescope/Remote Observatory (AST/RO)**

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**AC-372-O: Automated Astrophysical Site Testing Observatory (AASSTO)**

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**AC-373-O: Degree Angular Scale Interferometer (DASI)**

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**AC-374-O: South Pole Infrared Explorer (SPIREX)**

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**AC-375-O: Viper - Cosmic Microwave Background Radiation Telescope**

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**AC-376-O: Submillimeter Polarimeter for Antarctic Remote Observations (SPARO) Instrument**

Dr. Giles Novac  
Northwestern University  
Department of Physics and Astronomy  
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**CARA: AC-370,371,372,373,374,375,376,378-O**  
**South Pole Based**

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**AC-378-O: Arcminute Cosmology Bolometer Array Receiver  
(ACBAR) Instrument**

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## Field Research Plan

### Logistics

Dates in Antarctica: The CARA project components will have various durations of deployment from early November 2000 to mid-February 2001, and four project members will remain at the South Pole throughout the 2001 austral-winter months

Research Locations: Dark Sector at South Pole

### Team Members

#### AC-370-O

Robert Pernic	Joseph Rottman	Caesar (Jesse) Wirth
Robert Spatz	Robert Loewenstein	Randy Landsberg
Rhodri Evans	Bill Volna	Charles Kaminski
TBD (Student/Teacher)		

#### AC-371-O

Chris Martin (winter-over)	Jeff Capara	Karl Jacobs
Chris Walker	Chris Groppi	Oliver Siebertz
Tony Stark	Greg Wright	Urs Graf
Jacob Kooi	Richard Chamberlin	Karina Leppik
TBD (2)		

#### AC-372-O

Michael Ashley	Michael Burton	Paolo Calisse
Jon Everett	Andre Phillips	John Storey

**AC-373-O**

John Carlstrom	Nils Halverson	John Kovac
Eric Leach	Benjamin Redell	TBD

**AC-374-O**

No deploying team members

**AC-375-O**

Jeff Peterson	Chris Cantalupo	Edgor Griffith
Mark Thoma	Matt Newcomb	TBD

**AC-376-O**

Giles Novac	David Chuss
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**AC-378-O**

John Ruhl	Bill Holzapfel	Mike Daub
Chaolin Kuo	John Goldstein	Marcus Runyan
Martin Leaker	Kim Coble	Eric Torbet

**Field-Season Operations**

**AC-370-O: Center for Astrophysical Research in Antarctica (CARA): Polar Operations**

The team members plan to work from the Martin A. Pomerantz Observatory (MAPO) to coordinate the activities of all the CARA projects and provide administrative support, technical assistance, and labor as needed. This team will also coordinate the educational outreach program.

**AC-371-O: Astronomical Submillimeter Telescope/Remote Observatory (AST/RO)**

The project team members plan to service all existing receivers, refrigerators, and coldheads on the AST/RO telescope, which maps the 492 and 809 gigahertz lines of neutral carbon and the 460 gigahertz line of carbon monoxide. The team members plan to install a new array receiver called PoleSTAR in the AST/RO annex, which will permit high frequency (809 GHz) spectral line observations in four spatial channels simultaneously. This receiver will be used to efficiently map emission from excited carbon atoms and carbon monoxide molecules in interstellar clouds. Use of PoleSTAR will require the team members to install a new four-channel array AOS, a new control computer, additional data storage, and new control and data acquisition software.

For characterization of the properties of the polar atmosphere at far-infrared and submillimeter wavelengths, the team members also plan to install a broadband Fourier Transform Spectrometer in the AST/RO building.

**AC-372-O: Automated Astrophysical Site Testing Observatory (AASTO)**

The project team members plan to refuel and perform annual maintenance on the AASTO. This automated geophysical observatory (AGO) is configured to perform astrophysical and atmospheric observations across a broad-wavelength spectrum (i.e., visible to submillimeter).

The team members plan to deploy sky monitors adjacent to the AASTO building for the mid-infrared and sub-millimeter and to continue to measure the atmospheric turbulence and the sky emission in the near-infrared from the same location.

The thermo-electric generator (TEG), which burns propane to produce heat and electricity in order to power the instruments and keep them at appropriate temperature, was removed from the AASTO building last season and rebuilt at the University of Chicago. The team members plan to return the TEG to the AASTO building and put it back into service during this season.

**AC-373-O: Degree Angular Scale Interferometer (DASI)**

The DASI telescope was assembled and installed last year on top of the SPIREX tower adjacent to the Martin A. Pomerantz Observatory (MAPO). This season, support contractor personnel plan to complete the construction phase by installing the ground shield around the telescope. (*Note:* The ground shield shields the instrument from extraneous background radiation coming from the ground.) Data acquisition began in February 2000, and data were acquired throughout the entire 2000 austral-winter season. The quality of data is expected to be enhanced with the installation of the ground shield.

The team members plan to fine tune, adjust, and calibrate the DASI telescope and perform maintenance on the telescope (i.e., service the DASI cooling system for the detectors).

**AC-374-O: Infrared Projects**

Last season, the SPIREX telescope was removed from the SPIREX tower and dismantled on site. This season, several of the CARA team members and support contractor personnel will package the telescope for shipment back to the home institution.

**AC-375-O: Viper Telescope**

The project team members plan to maintain and upgrade the Cosmic Microwave Background Radiation (CMBR) telescope—Viper—in preparation for the 2001 austral-winter season.

Last season, the team members upgraded the software on SPARO and the mount for ACBAR was tested. (*Note:* SPARO and ACBAR are sub-experiments on the Viper telescope.) This season, the team members—with assistance from the support contractor personnel—plan to refurbish the Viper telescope to allow for new cables and hoses for the ACBAR and SPARO instruments and to raise the elevation of the telescope by just under one foot. They will also install a new cable wrap, a new azimuth ring, and new control wiring.

Support contractor personnel will provide a heated weatherport for this work to be done.

**AC-376-O: Submillimeter Polarimeter for Antarctic Remote Observations (SPARO) Instrument**

The project team members plan to install the SPARO instrument on the Viper telescope, which is located on a tower adjacent to the MAPO building opposite the SPIREX tower.

The team members plan to operate the SPARO instrument and gather data during the austral-summer months. They also plan to calibrate the instrument in preparation for operation during the 2001 austral-winter months. (*Note: The majority of data will be gathered during the austral winter.*)

**AC-378-O: Arcminute Cosmology Bolometer Array Receiver (ACBAR) Instrument**

The project team members plan to install the ACBAR receiver on the Viper telescope, which is located on a tower adjacent to the MAPO building opposite the SPIREX tower, and prepare the receiver for austral-winter observations. ACBAR will be used to map the cosmic microwave background radiation with high-angular resolution, characterize the evolution of the structure formation by searching for clusters of galaxies using the Sunyaev-Zeldovich effect, and study the nearby clusters with targeted observations.

Preliminary observations and calibrations are planned for the austral-summer season. The majority of the science data will be gathered during the austral winter.

## **Continuation of Magnetometer Data Acquisition at McMurdo and South Pole Stations**

### **AO-101-O**

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### **Research Objectives**

Magnetometers installed at McMurdo and Amundsen-Scott South Pole Stations, Antarctica, continue to measure the magnitude and direction of variations in Earth's magnetic field, in the frequency range of 0 hertz to about 0.1 hertz and with a resolution of about one nanoTesla. These data are being analyzed in association with similar data acquired at the six automatic geophysical observatories (AGOs) that are a part of the Polar Experiment for Geophysical Upper Atmosphere Investigations (PENGUIn) program (project AO-112-0). They are also analyzed in association with data obtained from magnetometers operated by Bell Laboratories in the continental United States. Using the Antarctic systems, we gather unique data related to the coupling of the interplanetary medium into the dayside magnetosphere, including the magnetospheric cusp region. We are also able to use the data to probe the causes and propagation of low-frequency hydromagnetic waves throughout the magnetosphere. Because of unique climatic conditions at the South Pole, we are able to correlate optical measurements (project AO-104-O) with particle-precipitation measurements and with hydromagnetic wave phenomena recorded by the magnetometer.



## **High Latitude Magnetic Pulsations**

### **AO-102-O**

**Dr. Mark Engebretson, Principal Investigator**

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### **Research Objectives**

Our objective is to measure fluctuations in Earth's magnetic field on time scales between 0.1 second and 1,000 seconds. These "micropulsations" result from the interaction between the solar wind and Earth's magnetosphere. By studying these variations over periods of time comparable to a complete solar cycle and at a variety of locations, we hope to learn more about how variations in the solar wind effect both the Earth and man-made systems. Magnetic variations can significantly affect such systems as power grids and pipelines. Predicting such disruptions is important and is becoming possible, because satellite systems now monitor the solar wind as well as view solar activity. Although a primary objective of our work is to obtain a better understanding of the world, predicting space weather is also an important aspect. To accomplish our goals, we will use magnetometers that are distributed at high latitude in both the Antarctic and Arctic.



## **Antarctic Auroral Imaging**

### **AO-104-O**

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### **Research Objectives**

Scientists are only beginning to perform quantitative studies on the dynamic behavior of the magnetosphere. In the past, detail-oriented explorations by space satellites have enabled scientists to map the average distribution of magnetospheric, energetic-particle plasma. But the dynamics of auroral phenomena – when particles from the magnetosphere precipitate into the atmosphere, producing fluorescence – have been hard to quantify through optical means. Amundsen-Scott South Pole Station is uniquely situated to observe auroras because the darkness of polar winter permits continuous optical monitoring; in most other sites, the sky becomes too bright near local mid-day.

An aurora can actually be regarded as a two-dimensional projection of the three-dimensional magnetosphere because particles tend to travel along the magnetic field line. By observing the dynamics and the morphology of an aurora, scientists get a reliable glimpse into the dynamics of the three-dimensional magnetospheric region associated directly with it. This method relies on knowledge relating the type of aurora to specific energies of precipitation and to specific regions of the magnetosphere.

In this study, an intensified optical, all-sky imager, operating in two parallel wavelength channels – 4,278 and 6,300 Ångstroms – will be used to record digital and video images of auroras. These wavelength bands allow us to discriminate between more- and less-energetic electron auroras and other precipitation. South Pole Station observations of the polar-cap and cleft regions entail measuring auroral-precipitation patterns and then interpreting the results in terms of two data sets: the coordinated observations of (magnetic) radio-wave absorption images, and (high-frequency) coherent-scatter radar measurements.

This work should provide insight into the sources and energizing mechanisms of auroral particles in the magnetosphere, as well as other forms of energy inputs into the high-latitude atmosphere.

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## **Field Research Plan**

### **Logistics**

Dates in Antarctica: early February 2001  
Research Location(s): Aurora Lab in the Skylab Building

### **Team Member**

John Doolittle

### **Field-Season Operations**

This project operates a special-purpose all-sky imager (located in the Aurora Lab), which records digital and video images of the Antarctic aurora during the winter darkness. The researcher will work in the Aurora Lab for 3 days in early February 2001 to check out and calibrate the imager.

During the 2000-2001 austral-summer season, the support contractor's science technician will perform regular maintenance activities on the all-sky imager. During the 2001 austral-winter season, the science technician will operate the imager, change the data tapes and disks, conduct periodic calibrations, and transmit sample data to the home institution via the Internet.

**Global Thunderstorm Activity  
and its Effects on the  
Radiation Belts and the Lower Ionosphere  
AO-106-P**

**Dr. Umran Inan, Principal Investigator**

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## **Research Objectives**

Tracking dynamic storms is a challenge, but lightning associated with thunderstorms can provide scientists an indirect way of monitoring global weather. This project employs very-low-frequency (VLF) radio receivers at Palmer Station, Antarctica, operated in collaboration with the British and Brazilian Antarctic Programs, both of which operate similar receivers. All are contributors to the Global Change Initiative.

The VLF receivers measure changes in the amplitude and phase of signals received from several distant VLF transmitters. These changes follow lightning strokes because radio (whistler) waves from the lightning can cause very energetic electrons from the Van Allen radiation belts to precipitate into the upper atmosphere. This particle precipitation then increases ionization in the ionosphere, through which the propagating VLF radio waves must travel. Because the orientations to the VLF transmitters are known, it is possible to triangulate the lightning sources that caused the changes, and thus to track remotely the path of the thunderstorms.

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## **Field Research Plan**

### **Logistics**

Dates in Antarctica: late April 2001 to late May 2001  
Research Location(s): Clean Air/VLF Hut at Palmer Station

### **Team Member**

Charles Cox

### **Field-Season Operations**

The team member plans to travel on the R/V *Laurence M. Gould* (cruise LMG01-4) to Palmer Station in late April 2001 to continue the VLF radiometer upgrade begun last season.

The VLF radiometer will continue to operate in the Clean Air/VLF Hut at Palmer Station. Throughout the year, the support contractor's science technician will archive the data and return it regularly to the home institution. The science technician will also maintain and calibrate the equipment when necessary. The data will be used for lightning direction finding and lightning waveform analysis, and by scientists engaged in magnetospheric and ionospheric research. The data will also be correlated with data collected by the Automatic Geophysical Observatory network in Antarctica.

**Global Thunderstorm Activity  
and its Effects on the  
Radiation Belts and the Lower Ionosphere  
AO-106-S**

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## **Research Objectives**

Atmospheric scientists orient their studies around different strata, or regions, and the boundaries and interactions between these regions are of particular interest. How are the upper atmospheric regions coupled electrodynamically? What can we learn by measuring the energy that is being transported between the magnetosphere and the ionosphere? These are but two of the questions the U.S. Antarctic Program's automatic geophysical observatory program is designed to explore.

Plasmas occur in the magnetosphere and the ionosphere, and they can be transported and accelerated by a variety of different wave-particle interactions. One important dynamic in this system is particle precipitation that is driven by extra-low-frequency/very-low-frequency (ELF/VLF) waves. Thus, measuring ELF/VLF waves from multiple sites provides a powerful tool for remote observations of magnetosphere processes.

This project maintains a system at Amundsen-Scott South Pole Station to measure magnetospheric ELF/VLF phenomena, and to correlate the data with measurements made by the automatic geophysical observatory system.

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## **Field Research Plan**

### **Logistics**

Research Location(s): CUSP Lab in Skylab Building

### **Team Members**

No deploying project members

### **Field-Season Operations**

The support contractor's science technician will work year-round to change data tapes, conduct routine instrument checks, and perform monthly calibrations on the ELV/VLF recording equipment in the CUSP Lab.

Last season, a new digital recording system was designed and installed to potentially replace the reel-to-reel analog AMPEX system. Both the digital system and reel-to-reel system will operate in parallel this season. If the digital system is successful, the reel-to-reel system will be returned to the home institution, as the digital system provides higher quality data and requires less operator support.

## **Study of Polar Stratospheric Clouds by Lidar**

### **AO-107-O**

**Dr. Alberto Adriani, Principal Investigator**

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### **Research Objectives**

The appearance each spring of the stratospheric ozone hole above Antarctica is driven by chlorine compounds interacting on the surfaces of polar stratospheric clouds (PSCs) that formed during the previous polar winter. This is one explanation for why ozone depletion is much more severe in polar regions than elsewhere.

This project uses light detection and range finding (lidar) to study the polar stratospheric clouds, stratospheric aerosol, and the thermal behavior and dynamics of the atmosphere above McMurdo Station. Continuous lidar observations provide insight on PSC formation, evolution, and other peculiar characteristics. These data will provide a complement to the information gained from balloon-borne instruments in project AO-131-O, and thus collaborative activities will be coordinated with the University of Wyoming.

## **Field Research Plan**

### **Logistics**

Dates in Antarctica: late August 2000 to early October 2000  
Research Location(s): Crary Science and Engineering Center (CSEC)

### **Team Members**

Francesco Cairo  
Alessandro Conidi

### **Field-Season Operations**

Two team members plan to travel to McMurdo Station in late August 2000 to operate the lidar located in Phase II of the CSEC, as part of an on-going study of polar stratospheric clouds and stratospheric thermal behavior and dynamics. The team members will coordinate lidar observations with ozonesonde and atmospheric aerosol balloon launches by project AO-131-O (Dr. Deshler). One team member will leave McMurdo Station on the last flight of WINFLY 2000, while the other will continue to work in the CSEC until the mainbody station opening in early October 2000.

The support contractor's winter-over science technician will operate this project's lidar at regular, pre-arranged times during the 2001 austral-winter season. The McMurdo weather office will support this project by taking winter meteorological soundings. These soundings will provide calibration parameters for the lidar up to 20-25 kilometers altitude.

## **South Pole Air Shower Experiment - 2 (SPASE-2) AO-109-O**

**Dr. Thomas Gaisser, Principal Investigator**

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### **Research Objectives**

Cosmic rays consist of protons and other atomic nuclei accelerated to high energy in distant astrophysical sources, such as supernova remnants. As cosmic rays from space arrive at the Earth, they interact in the upper atmosphere. The South Pole Air Shower Experiment-2 (SPASE-2) is a sparsely filled array of 120 scintillation detectors spread over 15,000 square meters at South Pole. This array detects charged particles (primarily electrons) that are produced by interactions of incident cosmic rays of very high energy.

A nine-station subarray called VULCAN has been constructed to detect Cherenkov radiation produced high above the ground in the same showers. The SPASE array is located less than half a kilometer from the top of AMANDA and is designed to complement AMANDA's neutrino detecting capacity.

SPASE-2 has two goals:

1. To investigate the high-energy primary cosmic radiation by determining the relative contribution of different groups of nuclei at energies above approximately 100 tera-electron volts. This can be done by analyzing coincidences between SPASE and AMANDA. Such coincident events are produced by high energy cosmic-ray showers with trajectories that pass through SPASE (on the surface) and AMANDA (buried 1.5 to 2 kilometers beneath it). AMANDA detects the high energy, penetrating muons in those same showers for which SPASE detects the low energy electrons arriving at the surface. The ratio of muons to electrons depends on the mass of the original primary cosmic ray nucleus. VULCAN adds two other ratios that also depend on primary mass in readings from the showers it detects.
2. To use the coincident events as a tagged beam. This permits investigation and calibration of certain aspects of the AMANDA response. This project cooperates with the University of Leeds in the United Kingdom.

## **Field Research Plan**

### **Logistics**

Dates in Antarctica: early November 2000 to late December 2000  
AND mid-January 2001 to mid-February 2001  
Research Location(s): Dark Sector and Science Building under the Dome

### **Team Members**

Glenn Spiczak Xinhua Bai  
Gerald Poirier Greg Forte

### **Field-Season Operations**

The project team members will work at the South Pole during two separate deployments: from early November 2000 to late December 2000 and from mid-January 2001 to mid-February 2001. They will work in the computer room of the Science Building under the dome to calibrate and optimize the SPASE-2 array, which is located on the surface of the ice in the Dark Sector. The team members will be bringing their own computers and electronics equipment to upgrade the data acquisition system.

Support contractor personnel will conduct surveys to determine the relative positions of the SPASE-2 and AMANDA (project AA-130-O) components. They will then input this survey data into a system to upgrade the database of detector locations (i.e., the relative distance and orientation between the AMANDA and SPASE-2 detectors).

The support contractor's science technician will support the SPASE-2 project year-round by conducting routine data transfers and back up, changing data tapes, and conducting routine instrument checks.

## **Austral High-Latitude Mesospheric and Thermospheric Dynamics and Thermodynamics**

**AO-110-O**

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### **Research Objectives**

South Pole is a unique and interesting spot from which to observe the dynamical motion of the atmosphere. The fact that it is on the axis of Earth's rotation places strong restriction on types of wave motion that can occur there, as compared to lower latitude sites. The resulting simplifications may help in understanding the behavior of the global atmosphere.

For example, how do scientists measure the wind speed of the atmosphere? One direct method is by determining the Doppler shift of naturally occurring emissions in the upper atmosphere as they flow along at predictable heights. Hydroxyl radicals, for example, are confined to a fairly narrow band near 90 kilometers altitude.

This study uses a high-resolution Fabry-Perot interferometer (located at Amundsen-Scott South Pole Station, Antarctica) to make simultaneous azimuthal observations of the individual line spectra of several upper atmospheric trace species, most importantly the hydroxyl radical and atomic oxygen. The observed Doppler shift of the emission lines provides a direct measure of the line-of-sight wind speed, while the wind field structure is derived from these multi-azimuth measurements. The simultaneously observed line widths provide a direct measurement of kinetic temperature.

## **Field Research Plan**

### **Logistics**

Dates in Antarctica: late January 2001 to early February 2001  
Research Location(s): Aurora Lab in Skylab Building

### **Team Members**

Gonzalo Hernandez                      Roger Smith                      TBD

### **Field-Season Operations**

The project team members plan to work in the Aurora Lab for two weeks—during late January 2001 to early February 2001—to perform routine service on the Fabry-Perot Interferometer (FPI) and ancillary equipment. They also plan to provide on-site training to the support contractor’s winter-over science technician for the operation of the FPI.

Observation of the doppler shift and width of natural emission lines will be made year-round with the high-resolution spectrometer on the 4<sup>th</sup> floor of the Skylab building. The support contractor’s science technician will operate this high-resolution spectrometer year-round—the FPI in self-calibration mode during the austral summer and in 24-hour data-acquisition mode during the austral winter. The science technician will also periodically send data to the home institution via the Internet.

## **Riometry in Antarctica and Conjugate Regions**

### **AO-111-O**

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### **Research Objectives**

The University of Maryland continues to conduct research into upper atmospheric processes, using photometry to take auroral luminosity measurements and riometry to take high-frequency, cosmic noise absorption measurements. A primary focus of our analytical activities over the next several years will include coordinated ground- and satellite-based studies and Sun-Earth comparisons.

The latest work also involves extensive collaboration with other investigators using complementary data sets. Continuation of science activities into the 2000-2001 time frame will enable us to participate in, and contribute to, several major science initiatives, including the GEM, CEDAR, ISTP/GGS, and National Space Weather programs, as we enter the next solar maximum period.

Riometers measure the relative opacity of the ionosphere. This work employs a new imaging riometer system called IRIS (imaging riometer for ionospheric studies). The first two IRISs were installed at Amundsen-Scott South Pole Station and Sondre Stromfjord, Greenland.

A third IRIS has been installed at Iqiluit, Northwest Territories, Canada – the magnetic conjugate to South Pole. Broadbeam riometers also operate in several frequencies at South Pole, McMurdo, and Iqiluit; auroral photometers operate at South Pole and McMurdo. This array of instruments constitutes a unique network for the simultaneous study of auroral effects in both magnetic hemispheres.

The focus of all of this work is to enhance understanding of the relevant physical processes and forces that drive the observed phenomena. This includes both internal forces, such as magnetospheric/ionospheric instabilities, and external forces, such as solar wind/IMF variations. From such knowledge may emerge an enhanced capability to forecast. Many atmospheric events can have negative technological or societal impacts, and accurate forecasting could ameliorate these impacts.

## **Field Research Plan**

### **Logistics**

Dates at South Pole: mid-January 2001 to late January 2001  
Research Locations: McMurdo Station—Arrival Heights  
South Pole Station—CUSP Lab in Skylab

### **Team Members**

Alan Weatherwax TBD

### **Field-Season Operations**

The researchers plan to use imaging and broadband riometers and optical photometers to study the processes of energy transfer from the solar wind to Earth's magnetosphere and ionosphere at high geomagnetic latitudes. The emphasis will be on understanding the ionospheric signatures of dayside auroral phenomena associated with the particle entry into the cusp and boundary layers, as well as the nightside substorm effects associated with the magnetotail and plasma sheet.

The project team members plan to work primarily in the CUSP Lab at the South Pole Station for one week in mid-January 2001 and in the Arrival Heights facility at McMurdo Station for approximately one week during mid-to-late January 2001. They will install updated data collection hardware and software on the two data-acquisition system computers. They will also perform general maintenance on the riometer/photometer systems.

While in Antarctica, the team members will train the support contractor's science technicians at McMurdo Station and South Pole Station to electronically troubleshoot the instruments and computers and to perform data collection. The science technicians will provide year-round instrument maintenance and data transmittal to the home institution.

**NSF/OPP Program Manager**  
Dr. John Lynch

**RPS Point-of-Contact**  
Mr. Eivind Jensen (South Pole)  
Mr. Jesse Alcorta (McMurdo)

## **Polar Experiment Network for Geophysical Upper-Atmospheric Investigations (PENGUIn)**

**AO-112-O**

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### **Research Objectives**

The data obtained from automatic geophysical observatories (AGOs) help researchers understand the Sun's influence on the structure and dynamics of the Earth's upper atmosphere. The ultimate objective of this research into how the solar wind couples with the Earth's magnetosphere, ionosphere, and thermosphere is to be able to predict solar-terrestrial interactions that can interfere with long-distance phone lines, power grids, and satellite communications.

A consortium of U.S. and Japanese scientists will use a network of six AGOs, established on the east Antarctic polar plateau and equipped with suites of instruments to measure magnetic, auroral, and radiowave phenomena. The AGOs are totally autonomous, operate year round, and require only annual, austral-summer service visits.

When combined with measurements made at selected manned stations, these arrays facilitate studies on the energetics and dynamics of the high-latitude magnetosphere on both large and small scales. The research will be carried out in combination with in situ observations of the geospace environment by spacecraft, in close cooperation with other nations working in Antarctica, and in cooperation with conjugate studies performed in the Northern Hemisphere.

## **Field Research Plan**

### **Logistics**

Research Location(s):           AGO sites 1 - 6

### **Team Members**

No deploying team members

### **Field-Season Operations**

No team members from project AO-112-O will deploy to Antarctica this season. All field-season operations will be conducted by the support contractor's AGO engineering team (project TO-296-O).

Between mid-October 2000 and late December 2000, the AGO engineering team members plan to travel to all six automatic geophysical observatories (AGOs 1-6) to service, refuel, and repair the observatories and upgrade the science systems. The team members will deploy to each AGO in two groups. First, the groom team will travel to an AGO site via Twin Otter aircraft. Immediately after arriving, team members will groom the ski-way to prepare it for additional aircraft. Groom team members will also service the AGO as much as possible at this time. The engineering team will arrive one day later, via Twin Otter, to begin upgrades of the science systems.

Once the necessary upgrades are complete, an LC-130 aircraft will arrive carrying replacement propane cylinders to power the AGO. The AGO team members will quickly connect the propane into the power system and remove the used propane cylinders while the LC-130 is on the ground. Then, all team members will return to McMurdo Station via the LC-130. All field equipment, cargo, and empty propane cylinders from the previous season will be returned to McMurdo at this time. At some high altitude AGO sites, retrograde of empty propane cylinders may not be possible. Also, because of reduced aircraft loads at some sites, two LC-130 flights may be necessary to resupply these AGOs with propane.

This season, the engineers plan to perform several science upgrades to the AGOs. At AGOs 1-5, the Stanford VLF Broadband Experiment will be upgraded. At AGOs 1-6, team members will upgrade the Dartmouth LF-MF-HF Experiment, the All-Sky Camera, and the Tohoku Search Coil Magnetometer. Team members will also complete the power supply and data storage upgrade to AGO 4 begun last season.

AGO team engineers will retrieve the PENGUIn AGO data and send it to Augsburg College in Minnesota, where it will be processed and distributed to PENGUIn investigators.

**NSF/OPP Program Manager**  
Dr. John Lynch

**RPS Point-of-Contact**  
Mr. Curt LaBombard

## **All-Sky Imager**

### **AO-117-O**

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## **Research Objectives**

The South Pole is a unique platform for auroral observation during the austral winter season. We can observe auroras continuously through the 24 hour day, allowing us to collect data on (1) the dayside polar cusp/cleft aurora connected to the direct entry of the solar wind, (2) the afternoon aurora closely associated with night side magnetospheric storm/substorm activities, and (3) the polar cap aurora dependent on the polarity of the interplanetary magnetic field. Research has shown that these auroras come from the precipitation of low-energy particles entering the magnetosphere in the solar wind. The South Pole, as a point on the axis of the earth's rotation, also provides us with a unique platform to observe the airglow and study the multi-wavelength (different altitude) characteristics of acoustic gravity waves in the polar region.

Since 1965, data have been acquired at the South Pole using a film-based, all-sky-camera system. Using advanced technology, we can now obtain digital images and process large amounts of information automatically. Another advantage of the digital CCD all-sky-imager (ASI) is that it can be monitored and controlled by a National Institute of Polar Research (NIPR) computer in Japan, via the satellite internet. The ASI is equipped with interference filters for auroral emissions of 427.8nm, I 557.7nm, and I 630.0nm. A 730nm hydroxide filter is also available, though a panchromatic image can be obtained without the filter.

International collaborations such as this one will contribute to a fuller understanding of the magnetosphere and ionosphere, including upper/middle atmosphere physics. High frequency radars at Halley Bay, Sanae, and Syowa Station give us the vector velocity of ionospheric plasma over the South Pole. Together, these studies should provide further insight into the physics of the magnetosphere, the convection of plasma in the polar cap, and the effects of both on the solar wind. Specifically, we expect to gain insight into dayside auroral structure, nightside substorm effects, and polar-cap arcs.

## **Field Research Plan**

### **Logistics**

Dates in Antarctica: early November 2000 to mid-November 2000  
Research Location(s): Aurora Lab in Skylab Building

### **Team Members**

Masaki Okada Takeshita Shu

### **Field-Season Operations**

The project team members will work in the Aurora Lab to maintain the all-sky imager (ASI) instruments (i.e., optical camera, workstation, and data recorder) and to check and calibrate the absolute intensity of the optical device. The support contractor's operations personnel will unmount the ASI so the researchers can do their work and will then remount it.

The ASI is remotely operated through a satellite link by researchers at the National Institute of Polar Research (NIPR) in Japan during the polar night. During the 2001 austral-winter months, the support contractor's on-site science technician will assist in running the instrument by turning on and off power as required, changing data tapes, periodically checking the condition of the glass radome, turning on and off a moon blocker, and performing repairs as necessary.

## **Solar and Heliospheric Studies with Antarctic Cosmic Ray Observations**

### **AO-120-O**

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### **Research Objectives**

Cosmic rays – penetrating atomic nuclei from outer space that move at nearly the speed of light – continuously bombard the Earth. Neutron monitors deployed in Antarctica provide a vital, three-dimensional perspective on this shower and how it varies along all three axes. Accumulated neutron-monitor records (begun in 1960 at McMurdo Station and in 1964 at South Pole Station) provide a long-term historical record that supports efforts to understand the nature and causes of cosmic-ray and solar-terrestrial variations occurring over the 11-year sunspot cycle, the 22-year Hale cycle, and even longer time scales.

This project continues a series of year-round observations at McMurdo and Amundsen-Scott South Pole Stations, recording cosmic rays with energies in excess of 1 billion electron volts. These data will advance our understanding of a number of fundamental plasma processes occurring on the Sun and in interplanetary space. At the other extreme, we will study high time-resolution (10-second) cosmic-ray data to determine the three-dimensional structure of turbulence in space, and to elucidate the mechanism by which energetic charged particles scatter in this turbulence.

## Field Research Plan

### Logistics

Dates at South Pole: late December 2000 to early January 2001  
Research Location: CosRay Lab in Skylab

Dates at McMurdo: mid-January 2001 to late January 2001  
Research Location: CosRay Facility

### Team Members

Leonard Shulman                      Roger Pyle                      James Roth

### Field-Season Operations

Two project team members will visit the CosRay Lab at South Pole Station during late December 2000 to early January 2001 and the CosRay Facility at McMurdo Station during mid-January 2001 to late January 2001 to perform routine maintenance and calibration of the neutron monitors and to train the support contractor's science technicians in project operations.

At both CosRay Laboratories, the support contractor's science technicians will maintain the neutron monitors throughout the 2001 austral-winter months. The technicians will collect daily data, perform system checks, troubleshoot and repair the system if necessary, and transmit data to the home institution on a weekly basis.

At the South Pole, the support contractor's personnel will groom the snow around the detector platform, which will mitigate snow build-up and drifting and enhance the quality of data collection.

One team member will travel to Adelaide, Australia, around the beginning of March 2001 to meet the icebreaker *Polar Sea* and service the neutron monitor on board this icebreaker during the port call.

**NSF/OPP Program Manager**  
Dr. John Lynch

**RPS Point-of-Contact**  
Mr. Eivind Jensen (South Pole)  
Mr. Jesse Alcorta (McMurdo)

## **Antarctic Miniature Lidar / Automatic Weather Station Lidar AO-126-O**

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### **Research Objectives**

The Antarctic miniature lidar project has two primary science objectives:

- 1) to establish a long-term data record of the temporal and spatial evolution of polar stratospheric clouds; and
- 2) to establish a long-term data record of the near-surface to 30-kilometer atmospheric backscatter and transmission at several locations on the polar plateau.

To achieve these objectives we have been developing and testing a robust, low-power-consumption, atmospheric lidar instrument that can operate autonomously and still achieve sufficient performance to fulfill the science requirements.

Detecting, profiling, and monitoring Type 1a (nitric acid trihydrate) polar stratospheric clouds (PSCs) is important to the understanding of the annual, austral springtime destruction of stratospheric ozone over Antarctica. These clouds play a crucial role in the freeing up of chlorine radicals from the stable reservoir compounds. Understanding the origin (natural vs. anthropogenic) and evolution (spatial as well as temporal) of Type 1a PSCs is essential to complete our understanding of springtime ozone destruction processes and to predict the magnitude of future ozone holes.

The other primary science objective is to continuously monitor the long-term, atmospheric optical thickness from the surface to an altitude of 30 kilometers. This data will be compiled into a database that will provide statistics on atmospheric conditions that can be used by future space altimetry missions, such as ICEsat.

The first fully autonomous lidar was deployed to Automated Geophysical Observatory (AGO) P1 in January of 1999. This instrument operated continuously until the AGO platform failed in July 1999. This instrument will be removed from AGO P1, refurbished at Goddard Space Flight Center, and redeployed to an Automatic Weather Station Site in the 2000-2001 season. Given the limited number of AGO platforms and their fixed locations, it was decided to collocate the lidar instruments with established Automatic Weather Stations (OO-283 M, Stearns). The AWS project has nearly 50 stations at various locations on and around the continent.

## **Field Research Plan**

### **Logistics**

Dates at McMurdo: early January 2001 to mid-January 2001  
Research Locations: Crary Science and Engineering Center (CSEC) and one AWS site—to be determined

Dates at South Pole: mid-January 2001  
Research Location: Atmospheric Research Observatory (ARO)

### **Team Members**

Jonathan Rall                      Sergei Dolgy  
John Cavanaugh                 Gary Duerksen

### **Field-Season Operations**

In early January 2001, the project team members will arrive at McMurdo Station and stage their operations from the CSEC Phase II loading dock. Shortly thereafter, two team members will travel via helicopter on a day trip to an Automatic Weather Station (AWS) site, which is yet to be determined. Once at the AWS site, the team members will work for several hours to install the lidar, a battery box, and a wind generator.

In mid-January 2001, two team members will travel via LC-130 aircraft from McMurdo Station to the South Pole Station, where they will work for approximately one week. Once at the South Pole, the team members will work in the Atmospheric Research Observatory (ARO) to replace or refurbish the existing lidar. They will then move the lidar outside of the ARO into a small enclosure, which will be mounted on poles augered into the snow. They will also install a small 400-watt wind generator on an aluminum pipe at approximately 10 feet above the surface of the snow in close proximity to the lidar enclosure. They will bury a battery box several feet below the surface near to or possibly directly under the lidar. Support contractor personnel will assist with the erection of the new lidar tower and wind generator and will set up guy-wires to stabilize the structure. Supplementary power from the ARO building will be supplied in case of wind generator failure.

**NSF/OPP Program Manager**  
Dr. John Lynch

**RPS Point-of-Contact**  
Mr. Eivind Jensen (South Pole)  
Mr. Jesse Alcorta (McMurdo)

# **Rayleigh and Sodium LIDAR Studies of the Troposphere, Stratosphere, and Mesosphere at the Amundsen-Scott South Pole Station**

## **AO-127-O**

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## **Research Objectives**

The Earth's atmosphere is described by several stratified layers, each with distinctive structure, dynamics and characteristics. The stratosphere begins about 11 kilometers (km) above the surface. The mesosphere runs from about 50 km to its upper boundary, the menopause, where atmospheric temperature reaches its lowest point (about  $-80^{\circ}\text{C}$ ), before beginning to rise with increasing altitude through the outer layer, the thermosphere, which runs from 80 km to outer space.

This research deploys a sodium-resonance lidar at the South Pole to study the atmosphere's vertical structure and dynamics, from the lower stratosphere up to the menopause. As the project enters its third year, scientists will add an iron-resonance lidar, extending their ability to measure the air dynamics and temperature structure even higher, to about 100 kilometers. Another addition, an air-glow imaging camera, will be used to study horizontal structure.

This final complement of instrumentation, used in conjunction with the normal balloon-borne radiosondes flown regularly from South Pole, will provide extensive data on:

- the temperature structure from the surface to 100 kilometers altitude;
- the nature of the polar stratospheric clouds, which are important to ozone chemistry;
- the variability and frequency of occurrence of metallic layers in the mesosphere, which play roles in communications as well as atmospheric chemistry;
- atmospheric gravity waves; and
- many other phenomena, some of which are unique to the South Pole.

## **Field Research Plan**

### **Logistics**

Dates in Antarctica: early November 2000 to mid-February 2001  
Research Location(s): Atmospheric Research Observatory (ARO)

### **Team Members**

Gary Swenson                      Chester Gardner                      Xinzhao Chu  
Alan Lui                              TBD (winter-over)

### **Field-Season Operations**

The project team members will work in the Atmospheric Research Observatory (ARO) at the South Pole to operate the lidar and airglow instruments and to analyze balloon sonde data (collected by the support contractor's meteorologist at the South Pole) in order to characterize the thermal structure of the atmosphere above the South Pole from the surface to 100 kilometers. They will also characterize polar stratospheric clouds above the South Pole, mesospheric temperature structure using the iron lidar system, and gravity waves in the troposphere, lower stratosphere, and mesopause regions.

The team members will install a sodium-resonance lidar in the ARO—in a separate room from where the iron lidar is installed. Support contractor personnel will operate a crane and provide electrical assistance for this installation.

One team member will remain at the South Pole during the 2001 austral-winter season to maintain the lidar equipment and conduct measurements.

**Low Frequency / Middle Frequency /  
High Frequency (LF / MF / HF)  
Auroral Radio Noise Observations**

**AO-128-O**

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## **Research Objectives**

Auroras are light shows (streamers and arches of light) created when electrons accelerated along Earth's magnetic field lines excite atoms in the atmosphere. Many people are familiar with pictures of optical auroras, but it turns out that auroras also generate radio signals that are invisible to the human eye but easily detectable with radio receivers tuned to frequencies between 0.05 and 5.0 megahertz (MHz).

Scientists understand the phenomenon of auroral hiss that causes broadband noise at frequencies below 1 MHz. But two other radio phenomena attributable to auroras remain unexplained: Narrowband emissions near 2.8 and 4.2 MHz, and broadband noise bursts in the frequency range of 1.4 to 4.0 MHz.

Although these radio emissions constitute a small fraction of the total energy of the aurora, studying them may provide important clues to the more energetic processes. This possibility would mirror the practice of using radio emissions from the Sun to infer processes taking place in the solar corona.

Taking advantage of radio-quiet Antarctic conditions, this project uses low-frequency/middle-frequency/high-frequency receivers in hopes of developing insights about these emissions from Antarctic auroral zone and polar cap sites. The receivers have been installed at Amundsen-Scott South Pole Station, in five U.S. automatic geophysical observatories, and in two British automatic geophysical observatories.

## **Field Research Plan**

### **Logistics**

Research Location(s): CUSP Laboratory in Skylab Building

### **Team Members**

No deploying project personnel

### **Field-Season Operations**

The support contractor's science technician at the South Pole will perform year-round routine maintenance of this project's low-frequency/middle-frequency/high-frequency receiver, which is located in the CUSP Laboratory. The technician will also provide year-round periodic data transfer to the home institution via FTP, and routine maintenance of the receiving system—including occasional time setting.

# **Spectroscopic and Interferometric Studies of Airglow and Auroral Processes in the Antarctic Upper Atmosphere over the South Pole Station**

**AO-129-O**

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## **Research Objectives**

At Amundsen-Scott South Pole Station we maintain an infrared spectrophotometer, an eight-channel photon-counting photometer, and an infrared Michelson interferometer to study the dynamics and chemistry of the upper atmosphere. By measuring the variations in the brightness and temperature of airglow band emissions, researchers can detect planetary, gravity, and tidal waves. Studying the horizontal wave structures by looking in several directions while making these measurements at several wavelengths, which come from different heights in the atmosphere, provides information on the vertical extent of the wave activity. Additionally, viewing the different altitude auroral emissions with the spectrophotometer provides insight into the nature of the sources of the auroral precipitating electrons and how these different sources vary as a function of time.

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## **Field Research Plan**

### **Logistics**

Dates in Antarctica: late January 2001 to mid-February 2001  
Research Location: Aurora Lab in the Skylab

### **Team Members**

Jonathan Pescue                      G.G. Sivjee                      Justin Bartee

### **Field-Season Operations**

The project team members will work at the South Pole Station from late January 2001 to mid-February 2001 to maintain and service the Michelson interferometer, the spectrometer, the photometer, and the data-acquisition system located in the Aurora Lab in the Skylab Building.

Throughout the 2001 austral-winter season, the support contractor's science technician will operate, maintain, and calibrate this project's equipment, record data, conduct data-quality checks, troubleshoot the system, back-up the data, and transmit the data to the home institution.

## **Measurements of Polar Stratospheric Clouds, Condensation Nuclei, and Ozone During the Austral Winter and Spring**

**AO-131-O**

**Dr. Terry Deshler, Principal Investigator**

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### **Research Objectives**

The understanding of ozone depletion in the Antarctic stratosphere, in a general sense, is quite well understood. However, questions remain concerning both the character of particles in polar stratospheric clouds (PSCs) and the observations which may provide the first indications of ozone recovery. Here we will contribute to our understanding in these areas through the continuation of balloon-borne measurements based at McMurdo Station, Antarctica.

There are still many uncertainties about PSCs; however, it is clear that the heterogeneous chemistry that activates chlorine to destroy ozone occurs on the surface of these particles. We will continue our PSC size distribution measurements during the early and mid-winter periods when PSC activity is the greatest, and during late winter when ozone loss begins. The mid-winter measurements will be taken by science technicians from the civilian support contractor. We will make 15 aerosol flights between June and September to measure the concentrations of condensation nuclei and particles between 0.15 and 10.0  $\mu\text{m}$  radius. These measurements provide estimates of the size of the particles that form in PSCs. From these measurements, the surface areas, and volumes within PSCs are estimated. Estimates of particle size are helpful in calculating denitrification/dehydration rates, surface area in quantifying chlorine activation models, and volume in estimating particle composition. Further estimates of particle composition will derive from inferring the particle index of refraction, a function of composition. To do this, we will continue our collaboration with Guido Di Donfrancesco, of the Instituto di Fisica Dell'Atmosfera, Rome (project AO-107-O) to compare optical scattering calculated from measured aerosol size distributions with the scattering measured either by ground based lidar or in situ by a balloon-borne laser backscattersonde.

In addition to the aerosol measurements, we will continue annual late winter/spring measurements of ozone. The ozone measurements will be taken about every 3 days. These measurements have been approved for inclusion in the

database of the Network for the Detection of Stratospheric Change. At a minimum, this will continue to provide a measurement base for use in detecting the first signs of ozone recovery. Stratospheric chlorine levels are now peaking. The lessening of ozone depletion following this peak is expected to be altitude dependent. Measurements of vertical ozone profiles will be one of the important tools used to observe the first signs of recovery following the decline in stratospheric chlorine.

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## **Field Research Plan**

### **Logistics**

Dates in Antarctica: late August 2000 to early November 2000 AND  
early February 2001 to mid-February 2001  
Research Locations: Ross Ice Shelf, Crary Science and Engineering  
Center (CSEC)

### **Team Members**

Terry Deshler Mark Hervig Lyle Womack  
Carlen Williams Swarndeeep Gill

### **Field-Season Operations**

The researchers plan to measure the development of the Antarctic ozone hole and the characteristics of polar stratospheric clouds (PSCs) by balloon-borne instruments launched from the VXE-6 Building at McMurdo Station. Approximately 20 ozonesondes and 9 aerosol counters will be launched between late August 2000 and early November 2000 to provide concentration profiles of ozone and aerosol from the surface to 30-35 kilometers. In October 2000, the team members will attempt to recover 18 of these instruments, which are expected to be scattered within a 100-nautical-mile-radius of McMurdo Station on the Ross Ice Shelf. The packages are equipped with transmitter beacons, and GPS locations of the sondes are usually available.

Information of PSCs will be supplemented by lidar measurements taken at McMurdo Station between late August and early October 2000 by researchers from project AO-107-O (Dr. Adriani) of the Istituto di Frisica del' Atmosfera at the National Research Council in Frascati, Italy.

One project team member will return to McMurdo Station for two weeks in February 2001 to train the support contractor's technicians in instrument preparation, launching techniques, and data acquisition. Aerosol measurements will also be obtained on nine occasions, at approximately two-week intervals, during the austral-winter segment of this project, planned for June-August 2001. Support contractor personnel in McMurdo will carry out the winter balloon launches and record the telemetry data.

**NSF/OPP Program Manager**  
Dr. John Lynch

**RPS Point-of-Contact**  
Ms. Robbie Score

## **Trace Gas Measurements over the South Pole Using Millimeter-Wave Spectroscopy**

**AO-138-O**

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### **Research Objectives**

Many atmospheric gases radiate millimeter-length radio waves, but each species has its own unique spectrum. These fingerprints not only identify the gas, but also provide information on its temperature and pressure. These properties enable scientists to use the millimeter-wave spectrum of the atmosphere to determine how abundantly and at what altitudes a number of trace species can be found.

This research uses a millimeter spectroscope to monitor the atmosphere above South Pole, Antarctica for ozone, carbon monoxide, nitrous oxide, nitric acid, water vapor, and nitrogen dioxide over the course of a year. Several of these gases have important roles in the formation of the annual Antarctic ozone hole. Others – particularly water vapor and carbon monoxide – can provide information about the vertical transport and other dynamics of the upper stratosphere and the mesosphere.

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## **Field Research Plan**

### **Logistics**

Dates in Antarctica: early November 2000 to mid-November 2000  
Research Location: AST/RO annex in the Dark Sector

### **Team Members**

Michael Ahrens Giovanni Muscari

### **Field-Season Operations**

This project, which conducts trace gas measurements over the South Pole using millimeter-wave spectroscopy, will be completed by November 2000.

The project team members will coordinate the dismantling of this project's millimeter-wave spectrometer, which is located in the AST/RO annex. The support contractor's science technician will assist with the dismantling of the equipment. The dismantled instrument will then be packaged for shipment back to the home institution. The team members will receive assistance from support contractor construction personnel to help build shipping crates and pack the dismantled instrument in the crates.

## **Dynamics of the MLT Region using Ground-Based Radar and TIMED Instruments AO-284-O**

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### **Research Objectives**

We will study the dynamics of the mesosphere and lower thermosphere over Antarctica using measurements from two sources: instruments on NASA's TIMED satellite, and a meteor radar to be installed at South Pole station. Specific science objectives include measuring the space-time decomposition of wave motions, delineating the spatial climatology over Antarctica with emphasis on the structure of the polar vortex, measuring dynamical response to energetic events, and measuring interannual variability. The proposed meteor radar is a VHF system that will be able to measure the spatial structure and temporal evolution of the horizontal wind field over the South Pole. We will also use the existing ground-based radars at Davis Station, Syowa Station, Rothera Station, and Scott Base to determine spatial climatology. Wind and temperature measurements to be made by NASA's TIMED satellite during orbits over the South Pole will provide opportunities for combined ground-based and space-based experiments and validation activities.





## Overview of the Antarctic Biology and Medicine Program

The Antarctic Biology and Medicine program funds research that will improve understanding of the physiology, behavior, adaptations, and processes of antarctic life forms and ecosystems at all organizational levels, ranging from molecular, cellular, and organismal to communities, ecosystems, and global processes. Support is focused on the following areas:

- **Marine ecosystem dynamics:** Understanding the natural variability of marine ecosystems, correlating the structure and function of the marginal ice-zone ecosystem with oceanic and atmospheric processes, the influence of physical and biological factors on the recruitment of krill, and the role of marine phytoplankton in carbon dioxide cycling are among the research topics.
- **Terrestrial and limnetic ecosystems:** Organisms in ice-free areas and in perennially ice-covered lakes show remarkable adaptations to extreme environments. The presence of relatively few species eases study of ecosystem dynamics and interpretation of experiments, although more research is needed on adaptive mechanisms and evolutionary processes.
- **Population biology and physiological ecology:** Research areas include population dynamics of krill and other zooplankton, fish species, marine mammals, and birds, which have been the object of much research and merit further attention in some areas. Long-term observations are improving understanding of manmade or natural changes.
- **Adaptation:** Research topics include low-temperature photosynthesis and respiration, enzymatic adaptations, adaptive strategies such as development of antifreeze compounds and modifications to circulation systems, and the response of organisms to increased UV-B from the ozone hole. The genetic basis for adaptation is an important avenue of research.
- **Human behavior and medical research:** Antarctica's extreme climate can induce social, psychological, and physiological stresses, particularly during the winter isolation. Studies have focused on epidemiology, thermal regulation, immune system function, individual behavior, and group dynamics.

The Southern Ocean GLOBEC program (SO-GLOBEC) will begin in the austral winter of 2001 in the Western Antarctic Peninsula region. The goal of the SO-GLOBEC program is to understand shelf circulation processes and their effect on sea-ice formation and Antarctic krill distribution and to examine the factors that govern krill survivorship and availability to higher trophic levels, including seals, penguins, and whales. The program also supports two Long-Term Ecological Research (LTER) Projects — one in the Palmer Station Area of the Antarctic Peninsula and the other in the McMurdo Dry Valleys. The NSF's LTER Program consists of a network of 24 research sites extending from Alaska to Puerto Rico to Antarctica. The Palmer Station/Antarctic Peninsula LTER program centers on ecological processes that link the extent of annual pack ice to the biological dynamics of different trophic levels within the antarctic marine community. The McMurdo Dry Valleys LTER project is an interdisciplinary study of the aquatic and terrestrial ecosystems in a cold desert region of Antarctica.

## **McMurdo Dry Valleys: A Cold Desert Ecosystem Long-Term Ecological Research (LTER)**

**BM-042-D,F,L,M,P,V,W**

**Dr. W. Berry Lyons, Project Manager**

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### **Research Objectives**

The largest ice-free area in Antarctica can be found in the McMurdo Dry Valleys, located on the western shore of McMurdo Sound. Among the most extreme deserts in the world, the Dry Valleys are the coldest and driest of all LTER sites. Consequently, the biological systems are limited to microbial populations, microinvertebrates, mosses, and lichens. Yet complex trophic interactions and biogeochemical nutrient cycles develop in the lakes, streams, and soils of the Dry Valleys. In the austral summer, solar energy produces glacial meltwater, which supplies the vital water and nutrients that are a primary influence on these ecosystems. Such material transport and climatic influences shape all ecosystems, but nowhere is this more apparent than in the McMurdo Dry Valleys.

In 1993, this region was selected as a study site for the National Science Foundation's Long-Term Ecological Research (LTER) program. During the first 6 years of this project, investigators studied the perennially ice-covered lakes, ephemeral streams, and extensive areas of the soil to assess the role of physical constraints on the structure and function of these ecosystems. Clearly, the production of liquid water in both terrestrial and aquatic portions of this environment is a primary driver in ecosystem dynamics. Thus, the role of present-day climate variation is extremely important. However, one of the most significant discoveries has been that past climatic legacies strongly overprint the present ecological conditions in the McMurdo Dry Valleys.

The McMurdo LTER project focuses on the aquatic and terrestrial ecosystems in the Dry Valley landscape as contexts to study biological processes and to explore material transport and migration. During the second phase of this LTER project, we will extend our research by continuing to investigate the McMurdo Dry Valleys as an "end-member" system, with the aim to better ascertain the role of the past climatic legacies on ecosystem structure and function. We will test a series of eight hypotheses in three major focus areas—hydrology, biological

activity and diversity, and biogeochemical processes—by continuing monitoring projects and long-term experiments. Understanding the structure and function of the McMurdo Dry Valleys ecosystems requires understanding hydrological response to climate both now and in the past. Current patterns of biological activity and diversity reflect both past and present distributions of water, nutrients, organic carbon and biota. Biogeochemical processes responsible for the transport, immobilization, and mineralization of nutrients and other chemicals provide the linkages between the region's biota and the physical environment. The timing, duration, and location of biogeochemical processes in the past and present are controlled by water availability. Efforts will continue to focus on the integration of the biological processes within and among the lakes, streams, and terrestrial ecosystems comprising the McMurdo Dry Valleys landscape. Our interdisciplinary research team will continue to use modeling and other integrative studies to synthesize data derived from our ongoing examination of McMurdo Dry Valleys ecosystems.

During the 2000-2001 field season, the following studies will be conducted in the McMurdo Dry Valleys as part of the LTER project:

- paleoclimatology, paleoecology, and meteorological data collection (Peter T. Doran, University of Illinois at Chicago);
- glacier mass balance, melt, and energy balance; climate monitoring in Taylor, Wright, Victoria, and Beacon valleys; establishment of a snow fence to mimic the effects of increased precipitation in Beacon Valley (Andrew Fountain, Portland State University);
- chemistry of streams, lakes, and glaciers (W. Berry Lyons, Ohio State University);
- flow, sediment transport, and productivity of streams; water quality of Lake Fryxell; water loss from the streams to the atmosphere by sampling water-content changes (Diane McKnight, University of Colorado);
- lake pelagic and benthic productivity, and microbial food webs (John Prisco, Montana State University);
- the influence of environmental conditions on carbon and nitrogen cycling and on soil biota; the effects of environmental change and food supply availability on soil biota; and the effects of climate change on biota (Diana Wall, Colorado State University, and Ross A. Virginia, Dartmouth College).

The following list contains the McMurdo Dry Valleys projects' Principal Investigator contact information:

**BM-042-D: Paleoclimatology, Paleoecology, and Meteorological Data Collection**

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**McMurdo Dry Valleys LTER / BM-042-D,F,L,M,P,V,W  
McMurdo Based**

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**BM-042-F: Glacier Mass Balance, Melt, and Energy Balance**

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**BM-042-L: Chemistry of Streams, Lakes, and Glaciers**

Dr. W. Berry Lyons, Ohio State University  
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**BM-042-M: Flow, Sediment Transport, and Productivity of Streams**

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**BM-042-P: Lake Pelagic and Benthic Productivity and Microbial Food Webs**

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**BM-042-V: Soil Productivity**

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**BM-042-W: Soil Productivity**

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**Field Research Plan**

**Logistics**

Dates in Antarctica: mid-October 2000 to mid-February 2001  
Research Locations: McMurdo Dry Valleys, Cray Science and Engineering Center (CSEC)

**Team Members**

**BM-042-D**

Peter Doran	Richard Costello	Jennifer Lawson
Derek Mueller		

**BM-042-F**

Thomas Nylen	Susan Kaspari	Robin Johnston
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**BM-042-L**

W. Berry Lyons	Gayle Dana	Daryl Moorhead
Kathleen Welch	Adrian Green	Whitney Gann

**BM-042-M**

Diane McKnight	Peter Conovitz	Chris Jaros
Wil Sadler	Kevin Wheeler	

**BM-042-P**

Craig Wolf	Christine Foreman	Chad Marshall
Birgit Sattler	Aaron Hall	

**BM-042-V**

Ross Virginia	John Barrett	Kevin Lavigne (TEA)
Katie Catapano		

**BM-042-W**

Diana Wall  
Dorota Porazinska

Andy Parsons

Steve Blecker

**Field-Season Operations**

The McMurdo Dry Valleys LTER team members (composed of seven subgroups) plan to occupy the camps and labs at Lakes Hoare, Fryxell, and Bonney at various times from mid-October 2000 through early February 2001. The camps will serve as bases of operation for sample collection and experimentation on the glaciers, streams, soils, and lakes of the Dry Valley Ecosystem. Field-team members will travel via helicopter between the camps and McMurdo Station, and from the camps to research sites within the valleys. The team members will also work in the CSEC to conduct chemical and biological analyses. They will prepare samples for return to home institutions at the end of the field season.

**BM-042-D: Paleoclimatology, Paleoecology, and Meteorological Data Collection**

The researchers plan to characterize carbon and nitrogen isotopic signatures and controls in five Dry Valley lakes. They will also maintain long-term automated lake monitoring equipment, carry out hydrologic balance measurements, and continue long-term benthic experiments.

All team members will travel via helicopter between McMurdo Station and Lake Hoare, and among the Dry Valley lake study sites. The team members plan to deploy to the field in two separate groups. Both groups will be based at the Lake Hoare camp, which will be occupied from early November 2000 to mid-February 2001. The first group, from early November 2000 to mid-December 2000, will conduct diving operations in Lake Hoare and in the near-shore region of Lake Bonney. Holes will be melted through the lake surfaces with a glycol-loop hole melter, allowing divers access to collect microbial mat samples and other data. The first group will also establish a number of long-term environmental sensors both in and on the lakes, as well as retrieve, collect data from, and reset sensors already in place. The second group will deploy to Lake Hoare from mid-December 2000 through mid-February 2001. This group will collect microbial mat samples and water samples from the moat regions of several lakes. Data from analyzing these samples will be used to characterize the biogeochemistry in the moats and calibrate moat benthos isotopic signatures. Team members from the second group will also conduct diving operations in the moat region of Lake Fryxell to resample an experiment established two years ago. In addition, they will continue measurement of debris movement on the ice cover of Lake Hoare using GPS.

Team members from both groups will take conductivity, temperature, and depth (CTD) readings to characterize the chemical and physical properties of lake water at the collection sites. Team members will work in the CSEC laboratories to analyze nucleic acids and lake-water samples and prepare samples for return to the home institution.

### **BM-042-F: Glacier Mass Balance, Melt, and Energy Balance**

The project team members plan to travel via helicopter to Lake Hoare in early November 2000, where they will continue monitoring the mass balance of selected glaciers in the Taylor Valley. The team members will examine the development of rough channels on the Taylor Glacier, and they will sample ice from the Canada Glacier to determine the age of sediment layers. Team members will also maintain existing weather stations in the Taylor, Wright, and Victoria Valleys, and they will install a new weather station in Beacon Valley. Existing radar reflectors in the Taylor Valley will be re-established and refurbished to winter over in the field.

Pending the outcome of an environmental assessment, the team members plan to construct and deploy snow fences at two sites in Taylor Valley to mimic the effects of increased precipitation.

The team members will work in the CSEC to analyze some samples and prepare other samples for return to the home institution.

### **BM-042-L: Chemistry of Streams, Lakes, and Glaciers**

The researchers plan to continue monitoring the inorganic chemistry of water collected from glaciers, streams, and lakes of the Dry Valleys, in collaboration with other teams involved with LTER lake and stream sampling programs. The project team members will travel via helicopter to the Dry Valleys in late October 2000, where they will work out of the Lake Hoare, Lake Fryxell, and Lake Bonney camps.

Traveling by helicopter, the team members will collect rock, water, sediment, snow, and ice samples from several lakes, streams, glaciers, and exposed soil areas in Taylor, Beacon, and Arena Valleys. Helium analysis of these samples will be used to provide information on the age of moraines and on the budget and ages of lake water. Team members will work closely with project BM-042-M to characterize the dissolved and suspended mineral loads in the Dry Valley streams. With the assistance of a support contractor mountaineer, the team members also plan to conduct snow pit studies on the Commonwealth and Canada Glaciers.

Team members will analyze lake, stream, and glacier samples in the CSEC, using the Dionex IC instrument. Samples will also be prepared and stored for return to the home institution at the end of the season.

### **BM-042-M: Flow, Sediment Transport, and Productivity of Streams**

The project team members plan to occupy the Lake Hoare, Lake Bonney, and F6 field camps between early November 2000 and early February 2001 as they operate the stream-gauging network in the Taylor and Wright Valleys. They will travel via helicopter from McMurdo Station to the Dry Valley camps, and from the camps to various sampling sites in the valleys.

The team members will maintain the current network of 19 stream gauges, collect water quality samples, and make necessary hydrologic measurements. These measurements will include taking water samples and gathering data with conductivity, temperature, and depth (CTD) instruments and dissolved oxygen meters. The team members also plan to move the Lyons Creek (B4) stream gauge downstream to a safer location in the Lake Bonney Basin. As in the previous

season, the established stream algal transects in Taylor Valley will be sampled and surveyed.

The team members plan to sample Lake Fryxell waters at various times and locations, and in various intervals, especially in the moat. Data from these samples will support current efforts to create a quantitative physical model for Lake Fryxell. The team members will also deploy a Sigma Sampler at several stream sites over the course of the season. This instrument automatically samples conductivity, pH, and integral flow at programmed intervals.

As much as possible, team members will sample for water content changes in the hyporheic zone before, during, and after the flow season. This will involve placing up to four temporary stream gauges to obtain an accurate water balance. Data from this element of the research should help to quantify water loss to the atmosphere from the hyporheic zone of Dry Valley streams.

Soil, sediment, and water samples will be prepared and stored in the CSEC for return to the home institution.

#### **BM-042-P: Lake Pelagic and Benthic Productivity and Microbial Food Webs**

The researchers plan to continue their measurements of the biological, chemical, and physical properties of Dry Valley lakes, with special emphasis on LTER core research areas, and other parameters relevant to modeling the Taylor Valley ecosystem. The project team members will travel via helicopter from McMurdo Station to the Lake Fryxell camp in mid-October 2000 to begin operations. Though Lake Fryxell will be their primary base, the team members will also occupy the Lake Hoare and Lake Bonney camps at various times during the field season. They will make frequent day trips via helicopter between camps and to other study sites in the Dry Valleys, including Lakes Meirs and Joyce.

Team members will use ice augers and other coring devices to penetrate lake ice caps for the collection of water samples, and for the annual retrieval and deployment of sediment traps and Licor Spherical quantum sensors in Lakes Bonney, Hoare, and Fryxell. New, time-series sediment traps will be deployed in Lake Bonney at the beginning of the season—one in the east lobe and one in the west lobe. These traps will be sampled at the end of the season, then the traps will be left in the lakes during the austral-winter season.

The team members also plan to work in the CSEC to analyze lake water samples for dissolved oxygen, carbon dioxide, ammonium, nitrate/nitrite, and other nutrients. Water, sediment, and ice samples will be returned to the home institution for further analyses.

#### **BM-042-V: Soil Productivity**

The team members plan to arrive at McMurdo Station in early January 2001. They will then travel via helicopter on day trips to various sites in the Dry Valleys, including Lake Hoare, Lake Bonney, Mummy Pond, and Site F6 in Taylor Valley, and several sites in Beacon Valley. The team members plan to conduct experiments to determine the influence of natural environmental conditions on carbon and nitrogen cycling and on the abundance and distribution of soil biota. Team members will also attempt to determine the effects of changes in environmental conditions and food supply on soil biota and decomposition. Specifically, they

will investigate how sudden climactic and food supply changes affect soil biodiversity and soil processes.

The team members also plan to collect soil samples and measure in situ soil CO<sub>2</sub> flux with the LICRO 6400 instrument. They will also incubate soils from the Lake Fryxell area in intact soil chambers located in Beacon Valley, and Beacon Valley soils in the Lake Fryxell area. The purpose of this experiment is to assess the influence of climate on nematode survival. During the course of the field season, team members will monitor multi-year experiments placed in Taylor and Beacon Valleys.

Team members from project BM-042-V will work closely with team members from project BM-042-W to schedule field trips and helicopter time, and the two projects will collaborate on meeting research goals.

With the assistance of the support contractor's analytical technician, the team members plan to analyze samples in the CSEC for microbial and inorganic nitrogen and phosphorous, as well as organic carbon and nitrogen. Team members also plan to transport soil samples to the home institution for further analysis.

### **BM-042-W: Soil Productivity**

The team members plan to arrive at McMurdo Station in early January 2001. They will then travel via helicopter on day trips to various sites in the Dry Valleys, including Lake Hoare, Lake Bonney, Mummy Pond, and Site F6 in Taylor Valley, and several sites in Arena and Beacon Valleys. At the research sites, the team members will conduct experiments intended to determine the effects of natural environmental conditions on the abundance and distribution of soil biota. They will also investigate the effects of climate, environmental change, and changes in food supply on soil biota and soil processes, climatic controls on soil biodiversity, and the role of wind as a link between streams, lakes, and soils.

The team members will sample and monitor multi-year experiments deployed last season, including fiberglass chambers placed to increase the soil temperature and soil plots enriched with inorganic sugar solutions or algae from Lake Hoare. Additionally, team members will recover cotton strips inserted into the soil during the 1999-2000 field season to study decomposition rates.

Team members from project BM-042-W will work closely with team members from project BM-042-V to schedule field trips and helicopter time, and the two projects will collaborate on meeting research goals.

Team members will also work in the CSEC and use a high-powered microscope to measure, photograph, and identify nematodes. Soil samples and vials containing soil organisms in water will be shipped back to the home institution for further studies.

## Antifreeze Proteins in Antarctic Fishes: Ecological and Organismal Physiology, Structure-Function, Genetics and Evolution

**BO-005-M**

### Dr. Arthur DeVries, Principal Investigator

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### Research Objectives

The Southern Ocean represents the world's coldest marine environment, with its near-shore waters perennially at the freezing point of seawater and replete with ice crystals. Marine teleost fishes are hypo-osmotic to seawater and therefore would readily freeze in these waters from nucleation by environmental ice. Cold-adapted fishes have more serum electrolytes, but these are insufficient to prevent freezing in Antarctic fishes. A number of polar and subpolar fish have evolved special biological antifreeze proteins, which have allowed the fish to avoid freezing and successfully colonize their frigid habitats. The impact of this evolution of the antifreeze function on organismal success is particularly clear in the Antarctic notothenioids. Combining new research with our ongoing studies, we are investigating the role of antifreeze glycopeptides, antifreeze peptides, and a newly-discovered antifreeze potentiator protein in freezing avoidance of Antarctic fishes. Specifically, we will study:

- the relationship between the severity of environment and the exposure of fish to ice in the water column;
- the uptake of endogenous ice and its fate;
- the structure of antifreeze proteins;
- the molecular mechanism of antifreeze adsorption to ice and inhibition of ice crystal growth.

We will also conduct comprehensive analyses of the antifreeze capacity at both the protein and gene levels across the suborder *Notothenioidei*. Research specific to antifreeze glycopeptides includes identifying the chromosomal locus of the gene family and its protease progenitor gene, calibrating the rate of notothenioid nuclear protein coding sequences to arrive at a more precise time estimate of gene evolution, and investigating the temporal aspects of antifreeze glycopeptides during embryogenesis and early larval stages. This multidisciplinary approach will lead to major advances in our understanding of the molecular biology and evolution of the antifreeze systems and will be applicable to a wide range of disciplines.

## Field Research Plan

### Logistics

Dates in Antarctica: mid-August 2000 to mid-February 2001  
Research Locations: McMurdo Sound sea ice, Ice edge, Bratina and Dailey Islands, Crary Science and Engineering Center (CSEC)

### Team Members

Arthur DeVries	Chris Cheng-DeVries	Kevin Hoefling
Benjamin Hunt	Teri McLain	Nelyn Soto
Kim Praebel		

### Field-Season Operations

The project team members plan to establish 35 fishing stations on the annual sea ice of McMurdo Sound, where they will catch *Dissostichus mawsoni* and other fish with traps or hooks at depths up to 730 meters. In mid-August 2000, heated sea-ice huts will be located near McMurdo Station's salt-water intake jetty. Later fishing stations will be located on the sea ice up to three miles west of McMurdo Station. The support contractor's operations personnel will drill new holes with the Reed Drill as fish captures dwindle at existing holes. Live fish will be transported via tracked vehicle to the aquaria at McMurdo Station, where researchers will study the physiological parameters governing the natural growth of ice crystals and the role of antifreeze glycoproteins (AFGP) in fish tissues.

Between mid-October 2000 and early December 2000, team member plan to make day trips via helicopter to the ice edge and to Bratina and Dailey Islands. There they will deploy fish traps and take conductivity, temperature, and depth (CTD) readings at discreet depths to determine seawater conditions at the collection sites. Team members will also make CTD casts at other sites and at various depths in McMurdo Sound to determine the hydrographic conditions and level of iciness that the different McMurdo Sound fish species encounter.

Project SCUBA divers will retrieve developing dragonfish eggs or hatchlings from the *in situ* cages set up during the 1999-2000 field season. The collected eggs or hatchlings will be used for laboratory studies on the cellular and molecular elements of AFGP expression. SCUBA divers will also search for and collect fertilized eggs of other species at various sites in McMurdo Sound for similar studies. Fertilized eggs will be hatched in the CSEC aquarium to study the expression levels of antifreeze glycoproteins during development. Team molecular biologists will determine levels of glycoprotein expression in developing fish larvae by fluorescent *in situ* hybridization using fluorescent antibodies and riboprobes. The chromosomal locations of genes in the antifreeze glycoprotein family will be visualized using fluorescent DNA and RNA probes. Researchers will determine if these genes co-localize in the same genomic region or have dispersed throughout the genome during expansion of the gene family.

Also in the CSEC, team members will attempt to isolate the gene for pancreatic trypsinogen-like protease (a member gene of which evolved into the first AFGP gene in notothenioid fishes) for the purpose of identifying its precise function. Molecular cytogenetic techniques will be used to localize AFGP and trypsinogen-like protease gene loci in freshly prepared metaphase chromosomes.

In February 2001, fish tissues and fluids will be returned to the home institution for further studies. During the 2001 austral winter, live fish eggs collected during the summer field season will be kept in the Phase III Aquarium. The support contractor's winter-over Laboratory Supervisor will harvest and preserve aliquots of these eggs at regular intervals for later studies of larval development.

**NSF/OPP Program Manager**  
Dr. Polly Penhale

**RPS Point-of-Contact**  
Ms. Robbie Score

# The Use of a Long-Term Data Base and Molecular Genetic Techniques to Examine the Behavioral Ecology and Dynamics of a Weddell Seal (*Leptonychotes weddellii*) Population

**BO-009-O**

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## Research Objectives

The Weddell seal (*Leptonychotes weddellii*) is found in regions of pack ice or fast ice close to the Antarctic continent. These seals are relatively long-lived, and the waters of McMurdo Sound have provided a continuous environment in which to study their survival and aquatic reproductive patterns. A series of long-term population studies, ongoing since the mid-1960s, have generated a rare and valuable set of data.

Recently developed molecular biology techniques, however, permit scientists to examine the DNA of individual seals as well as groups, and to gain insight into their genetic histories, breeding systems, and reproductive fitness. Breeding males behave characteristically. Looking at their behavioral ecology and their mating systems through the lens of their DNA can project backwards in time and correlate their reproductive success and the effective size of their populations.

Using and building on the long-term data set, the study will also examine how hypotheses can be tested and parameters can be estimated in producing models and studies of population demographics. The population dynamics of the Weddell seal will also be explored through the lens of immigration and emigration into and out of the group.

As the southernmost breeding mammal in the world, the Weddell seal exemplifies the ability to adapt to environmental extremes. Understanding the mating strategies these seals employ should contribute to a deeper understanding of the evolution and population dynamics of the Pinnipedia (a suborder of aquatic, carnivorous mammals, including all the seals and walruses), as well as how marine mammals (more generally) compete.

## Field Research Plan

### Logistics

Dates in Antarctica: early October 2000 to mid-February 2001  
Research Locations: McMurdo Sound, Erebus Bay, Big Razorback Island, various sites along the western shore of McMurdo Sound, Cape Washington, White Island, Cray Science and Engineering Center (CSEC)

### Team Members

Michael Cameron	Daniel MacNulty	Pamela Yochem
Thomas Gelatt	Brent Stewart	Cory Counard
Shawn Dahle	Kolene Krysl	Katsufumi Sato
Yoko Mitani		

### Field-Season Operations

The project team members plan to continue the long-term tagging studies of Weddell seals begun in the late 1960s. In early October 2000, the team members will set up a camp of three sea-ice huts on the northwest side of Big Razorback Island, which will serve as their base for the field season. Within the study area, stretching from Cape Evans to Pram Point, all newborn pups will be tagged and tags will be replaced on previously marked adults. Team members will travel via snowmobile and tracked vehicle to conduct a weekly census to count and record the tag number of all seals within the study area. This information is used to examine behavioral ecology and population dynamics of the Ross Island Weddell seal population.

The team members will also travel via helicopter, Twin Otter aircraft, tracked vehicle, and snowmobiles to tag seals and collect information on marked seals outside the study area. This will include areas around Ross Island, parts of the continental coast on the western side of McMurdo Sound, Cape Washington, and White Island. The researchers plan to use this data for an in-depth examination of the factors influencing immigration and emigration of seals into and out of the study area. Satellite-linked radio transmitters will be deployed to investigate the emigration of weaned pups and adults. The transmitters will be attached to seals to monitor their movements on the ice and underwater.

Concurrent with the population ecology studies, the team members will collect blood and tissue samples from specific seals for use in a genetic investigation of the breeding system and behavioral ecology of Weddell seals. The research team will also collect blood, scat, and diet samples for collaborative work with scientists studying Weddell seal blood chemistry, health parameters, blood parasites, and diet. In conjunction with these studies, the researchers will continue their investigations of anesthetic agents used in handling Weddell seals.

Finally, team members plan to collaborate in two video data gathering studies this season. In one, team members from this project will attach small video cameras to the backs of Weddell seals, in collaboration with two Japanese scientists who are interested in diving and other underwater behaviors of free-ranging seals. In the other, a teacher from the Teachers Experiencing Antarctica program will use remotely operated cameras to assist the researchers in examining the spacing patterns of adult females on the ice surface and underwater.

Frozen seal blood and tissue samples will be prepared in the CSEC and returned to the home institution for further studies.

**NSF/OPP Program Manager**  
Dr. Polly Penhale

**RPS Point-of-Contact**  
Ms. Robbie Score

# Studies on the Impact of Sewage-Associated Microorganisms on Indigenous Seal and Bacterial Populations and Drinking Water Quality at McMurdo Station

**BO-024-O**

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## Research Objectives

McMurdo Station, Antarctica, has been releasing macerated, untreated human sewage into the seawater off the coast for years. The seawater affected by the sewage plume sometimes extends to the drinking-water intake at Intake Jetty. Deposit-feeding invertebrates located within the area impacted by the sewage effluents appear not only to assimilate the nutrients associated with the sewage but also to exhibit increased mean body and organ sizes. Previously, researchers found preliminary but inconclusive evidence that the sewage-associated bacterium, *clostridium perfringens*, was colonizing Weddell seals feeding in the affected area. Our hypotheses are that:

- (1) Sewage-associated bacteria and viruses are colonizing Weddell seals.
- (2) Sewage-associated bacteria are exchanging their DNA with indigenous species, potentially altering the procaryotic gene pool of this ecosystem.
- (3) Sewage-associated bacteria and viruses are entering the drinking water system at McMurdo Station.
- (4) The current methods used to monitor the microbiological quality of marine and drinking waters at McMurdo Station are underestimating the risks associated with their respective contact and/or ingestion.

We will address these hypotheses by using molecular techniques (e.g., pulse field gel electrophoresis, PCR); *in situ* microcosms for gene transfer experiments; more sensitive culture-based techniques for determining the extent of sewage contamination in marine waters, sediments, and seal feces and scat; and the most extensive microbiological survey of the drinking-water distribution system to date. A major focus of this work will be to determine if the same *C. perfringens* genotypes present in the sewage are related to those isolated from seal feces and scat, marine waters and sediments, and drinking water samples. This approach has been used in other systems to establish a direct epidemiological link between a



## **The Biogeochemistry of Dimethylsulfide (DMS) and Related Compounds in a Chemically Stratified Antarctic Lake**

**BO-025-O**

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### **Research Objectives**

The Earth's atmospheric cycle involves continuous transport of basic elements, one of which is sulfur. Dimethylsulfide (DMS) is the dominant volatile sulfur compound emitted from the ocean and may represent up to 90 percent of the sea-to-air biogenic sulfur flux. When these volatile sulfur molecules oxidize in the atmosphere, condensation nuclei can be released that, scientists hypothesize, may directly counteract the warming effects of anthropogenically produced CO<sub>2</sub>. Aquatic systems – in particular the waters of the south polar region – thus play a crucial role in one of the planet's basic transactions. Yet both the sources and the sinks of DMS and associated sulfonium compounds have yet to be fully identified and understood.

This research will examine the biogeochemistry of water column and sedimentary DMS/DMSP (dimethylsulfoniopropionate), and the role of associated compounds (e.g., dimethylsulfoxide, dimethylated polysulfides) in Lake Bonney. A relatively simple aquatic system, Lake Bonney provides a highly tractable environment for investigating the microbially mediated cycling of biogenic sulfur because there is no turbulence, there are no grazers, and there is little atmospheric exchange.

Preliminary data suggest that maximum levels of DMS precursors may be found in the deep-chlorophyll layer of the lake, a zone dominated by cryptophyte algae. In addition, DMS concentrations deep in the lake, where there is very little light (i.e., in the aphotic waters), are among the highest recorded in a natural aquatic system. These observations indicate that precursors produced by trophogenic zone phytoplankton sink to the aphotic waters and sediments, where microbes decompose them to DMS and other sulfur compounds. The proposed research will define the sources and sinks of DMS and associated compounds, and establish how they function in the overall ecosystem. We hope to develop a model describing the biogeochemical transformations of organo-sulfur compounds in Lake Bonney.

## Field Research Plan

### Logistics

Dates in Antarctica: mid-October 2000 to mid-January 2001  
Research Locations: Lakes Bonney, Hoare, Fryxell, Vanda, Miers, and Joyce; Bratina Island; McMurdo Sound tide cracks; Crary Science and Engineering Center (CSEC)

### Team Members

John Priscu	Giacomo DiTullio	Peter Lee
John Lisle	Sarah Riseman	TBD

### Field-Season Operations

This multi-investigator field and laboratory project plans to examine the biogeochemistry of the water column, as well as sedimentary dimethylsulfide/dimethylsulfoniopropionate (DMS/DMSP), in several Antarctic Dry Valley lakes. The relative simplicity of these lakes (no turbulence, no grazers, and little atmospheric exchange) provides a highly tractable situation for investigating microbial mediated cycling of biogenic sulfur. This study will help define the biogeochemistry of organic sulfur compounds in nature and produce information that can be used to understand microbial processes in the sea. This information will also be relevant to the Dry Valleys LTER project (BM-042) by defining sources and sinks of DMS and associated compounds and relating them to overall ecosystem function.

The project team members will be based at the Lake Bonney field camp in Taylor Valley from mid-October 2000 through mid-January 2001. They will travel by 6-wheel-drive, all-terrain vehicles to collect samples from Lake Bonney, and via helicopter to sample other Dry Valley lakes, Bratina Island sites, the Labyrinth, and tide cracks in McMurdo Sound. Helicopters will also be used for transit to and from McMurdo Station. The team members will use ice augers and hole melters to create holes through the surface ice and Niskin bottles to collect water samples from different depths in the lakes. Conductivity, temperature, and depth (CTD) data will also be collected during sampling. Sediment box corers will be used to collect lake bottom sediments.

Water samples will be analyzed by gas chromatography at the Lake Bonney field camp. Phytoplankton collected from the Dry Valley lakes will be cultured in an environmental chamber in the CSEC to examine their role in the DMS/DMSP cycle. The research team plans to use the CSEC facilities about three days per week, depending on weather conditions. Rock, soil, sediment, ice, and water samples will be returned to the home institution for further analyses.

This project is jointly funded through the Life in Extreme Environments (LExEn) Program.

**NSF/OPP Program Manager**  
Dr. Polly Penhale

**RPS Point-of-Contact**  
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## Temperature Compensation in Antarctic Pteropods: An Integrative Approach

**BO-030-O**

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### Research Objectives

Life in polar waters requires physiological specialization to overcome thermal limits on reaction processes. The long-standing hypothesis of metabolic cold adaptation, which proposes upregulation of basal and active metabolic rates in polar taxa relative to temperate-zone counterparts, remains contentious and has been taxonomically limited in evaluation to fish and benthic invertebrates. Polar pteropods (*Mollusca: Gastropoda*) represent an abundant and metabolically active taxon with potentially substantial thermal compensation of the physiological processes underlying locomotion.

Our research will examine metabolic cold adaptation in two pteropod taxa, with particular reference to the thermal dependence of locomotor performance. To test hypotheses of cold adaptation, we will compare representative temperate zone and polar species and examine whether the thermal compensation of metabolic, biomechanical, and neural underpinnings is coordinated to locomotor behavior. Our project comprises three parts:

- 1) comparison of basal and metabolic rates of sister pteropod species from polar and temperate zones, together with comparisons of mitochondrial energetics;
- 2) comparison of locomotor biomechanics for the same pteropod taxa, with particular reference to the differential effects of reduced temperature and concomitantly increased viscosity on locomotor performance;
- 3) comparison of the responses of swim-system neurons to variable temperatures, with particular reference to resting potentials, firing thresholds, action potential durations, and ion-channel kinetics.

By evaluating similarities and linkages in metabolic, biomechanical, and neural responses to variable water temperature, we will test the overall hypothesis of temperature compensation in polar pteropods. The results of our investigation will provide fundamental physiological and behavioral information for this taxon, assist in the systematic evaluation of the hypothesis of cold adaptation across organizational levels in pteropods, and, more generally, provide information on the nature of thermal and locomotor constraints for the many invertebrate taxa living and moving within polar waters.

## Field Research Plan

### Logistics

Dates in Antarctica: mid-November 2000 to early February 2001  
Research Locations: Sea ice in front of McMurdo Station, Transition Zone, Cape Evans, Cape Royds, Crary Science and Engineering Center (CSEC)

### Team Members

Robert Dudley	Steve Childress	Josh Rosenthal
Francisco Bezanilla	Brad Seibel	

### Field-Season Operations

The researchers plan to carry out metabolic, biomechanical, and neurobiological studies on pteropods—small gastropod molluscs which are commonly found in the Antarctic zooplankton. Specifically, the researchers plan to evaluate pteropod physiological responses to variations in water temperature. They will also compare polar pteropods with their counterparts in temperate waters by performing identical experiments on closely related species at the Friday Harbor Marine Labs.

Support contractor operations personnel will use the Reed Drill to create 1.3-meter holes in the sea ice at several locations, including Cape Evans, Cape Royds, and directly in front of McMurdo Station. The project team members will travel by foot, tracked vehicle, and helicopter to collect pteropod samples using plankton nets lowered through these holes. All experiments on pteropod physiology will be carried out in the CSEC. Specimens will be stored in the Phase III aquarium of the CSEC.

The team members will also carry out sampling at the sea-ice holes to collect data on pteropod distribution, abundance, and body size.

## Factors Regulating Population Size and Colony Distribution of Adelie Penguins

BO-031-O

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### Research Objectives

Over the past few decades, the Adélie penguin (*Pygoscelis adeliae*) colonies in the Ross Sea region have grown dramatically in size. What demographic mechanisms might account for this change? This collaborative project investigates (in particular) the possible effects of documented changes in the region's climate. We will look at nesting habitat as a function of access to food, and we hope to distinguish the relative importance of the key resources that constrain or encourage the growth of colonies. A number of behavioral and demographic mechanisms may influence a colony's growth, relative to its initial size and distribution. One, for example, is a phenomenon known as philopatry, which is the interrelationship between the balance achieved by immigration/emigration and consequent breeding effort and success.

As the first empirical study to consider the geographic structuring of a seabird population, we expect our results to increase understanding in two key areas: how populations regulate themselves, and the patterns they follow when they disperse. We also hope to elucidate the effects of climate change, mediated through changes in sea-ice cover, on penguin populations. The results should also provide a context in which to interpret conflicting data on penguin population trends from existing programs. In particular, Adélie penguins have been studied as an indicator of such anthropogenic impacts on Antarctic resources as fishery catches and disturbances created by tourism. However, distinguishing anthropogenic-driven changes from natural ones is problematic without a regional perspective on penguin life history.

Our 6 years of research to date (including two by our New Zealand colleagues) include intensive field study of the four colonies within one cluster—Ross Island and Beaufort Island. We quantify reproductive effort and success, food availability (access to food), diet quality, foraging habitat overlap among colonies, and immigration/emigration relative to colony size and environmental conditions (i.e., pack-ice cover). We employ several well-established techniques that have been successfully (but infrequently) used in Antarctic biological research:

- Aerial photography, to evaluate the availability of nesting habitat and determine annual changes in population size;
- Microwave imagery of sea-ice concentration, to assess the availability of feeding habitat;
- Stable isotope analysis, to evaluate food quality;
- Doubly-labeled water, to assess the energetic demands of foraging trips;
- Time-depth recorders, to evaluate foraging behavior;
- Radio telemetry, to assess overlap in colony feeding areas; and
- Chick banding and subsequent surveys of recruits, to assess among-colony emigration.

We have also developed the only fully functional automatic system that, by weighing individually identified parents each time they visit their nest, allows the quantification of food-loads and feeding frequencies as they change over time or vary between colonies.

Landcare Research New Zealand (LCRNZ) conducted two preliminary field seasons, including the testing of new equipment. This project builds on their results, and they will collaborate with us throughout the lifetime of the project. The LCRNZ work is independently funded. Researchers from the University of California-Santa Cruz, the University of Wisconsin, Point Reyes Bird Observatory, and Beigel Technology, collaborate with those from H.T. Harvey and Associates and LCRNZ to accomplish the project's goals.

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## **Field Research Plan**

### **Logistics**

Dates in Antarctica: early December 2000 to late January 2001  
Research Locations: Terra Nova Bay; Capes Crozier, Royds, and Bird; Mt. Bird; Mt. Erebus; Beaufort Island

### **Team Members**

David Ainley	Grant Ballard	Hannah Nevins
Michelle Hester	Lisa Ballance	Sacha Heath
TBD (4)		

### **Field-Season Operations**

The researchers plan to compare the breeding and foraging ecology of Adelie penguins among four differently sized colonies: Capes Royds (4000 breeding pairs), Cape Bird (35,000 pairs), Beaufort Island (35,000 pairs), and Cape Crozier (170,000 pairs).

In early December 2000, the PI and another team member will make a day trip via helicopter to Terra Nova Bay, where they will test the range of the telemetry equipment. Also in early December 2000, two to three-person field teams will deploy to Cape Royds and Cape Crozier via helicopter, where they will camp in tents until the end of the field season in late January 2001. The work at Cape Bird will be conducted by biologists from LandCare Research New Zealand.

Penguins will be observed at all sites using remote radio telemetry to monitor their foraging behavior. As in previous seasons, a "snow fence" will be erected around subcolonies of Adelie penguins at Capes Royds and Crozier. The team members will use nets to capture penguins and place them inside the snow fence. Some birds will have digital tracking devices inserted under their fins and, as they travel in and out of the fence to forage, a telemetry device will record their number and their weight.

A team consisting of the PI and three other researchers will visit all study sites on a regular basis to assist the teams in place and coordinate research activities. This "roving" team will also travel via helicopter to four sites on Mount Bird and Mount Erebus over a three-week period from late December 2000 to mid-January 2001 in order to set up radio telemetry repeaters. At times, researchers will visit three of these repeater sites simultaneously. Using the repeaters, the researchers will attempt to conduct a series of simultaneous censuses (3 to 4) of the penguin colonies under investigation.

In late December 2000 or early January 2001, the PI and another team member will travel via icebreaker to Beaufort Island to attach transmitters to penguins. These researchers will deploy to the island for a few hours via helicopter or small boat from the icebreaker. If possible, they will return to the island in late January 2001 to retrieve the transmitters and collect blood samples. At the CSEC, the team members will assemble and test electronic equipment in early December 2000. In late January 2001, they will study Adelie penguin stomach contents. Chilled penguin blood samples will be returned to the home institution for further studies.

**NSF/OPP Program Manager**  
Dr. Polly Penhale

**RPS Point-of-Contact**  
Ms. Robbie Score

## **Investigations of Abandoned Penguin Colonies in Antarctica**

**BO-034-O**

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### **Research Objectives**

Factors which influence the distribution and long-term success of populations in the marine ecosystem are of current interest to those studying the relationship between climate and population dynamics in Antarctica. The focus of our project is Adelle penguins, specifically the population response by this species to late Holocene climatic change.

The study will integrate data from the ecological, geological, and paleobiological records with satellite-imagery analyses to test two hypotheses: that Adelle penguins have been responding to climate change over decades to centuries in a predictable manner, and that fluctuations in sea-ice extent and marine productivity are the primary parameters from which to measure these responses. Past responses by penguins to climate change, as indicated by the paleoecological record, should parallel those observed today with regional warming over the past 20 to 50 years.

The study will include field and laboratory investigations of abandoned colonies along coastal Antarctica. Excavations of field sites that are located within current Adelle penguin population centers will be conducted in the Ross Sea region and along the Antarctic Peninsula. We will determine the occupation history of each abandoned colony by collecting surface and subsurface bones, feathers, and eggshell fragments for identification and radiocarbon analyses. Sediments sifted from each site will allow us to recover organic remains (such as squid beaks and fish otoliths) that represent the former diet of penguins. These remains can be quantified statistically to assess changes in penguin prey consumption in relation to past episodes of climate change, which are well documented for the late Pleistocene and Holocene in ice-core and marine-sediment records.



## Proteins of Oxygen-Binding and Energy Metabolism in Muscles of Antarctic Fishes: Evolutionary Adjustments to Life at Cold Temperatures

**BO-036-O**

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### Research Objectives

The suborder *Notothenoidei* is the dominant fish group of the Southern Ocean surrounding Antarctica, both in terms of number of species and biomass. For about 14 million years, these highly successful fish evolved under stable thermal conditions that result in body temperatures of about 0° C throughout their life histories. Evolution in this cold environment has led to unusual physiological and biochemical characteristics. In some cases, the characteristics contribute to overcoming constraints of cold temperature on biological processes. In other instances, mutations that probably would have been lethal in warmer, less oxygen-rich environments than the Southern Ocean have been retained in Antarctic fishes.

Our project focuses on identifying mechanisms compatible with normal cellular function at cold temperature and gaining insights into the physiological roles of key intracellular proteins. The three lines of study that we will pursue are: the molecular basis for the failure of the myoglobin-encoding gene to be expressed in certain Antarctic notothenioid fishes, the basis of the substrate specificity of the enzyme fatty acyl-CoA synthetase (which is involved in the catabolism of fatty acids), and the functional roles played by different isoforms of creatine phosphokinase in the locomotory muscles of Antarctic fish. Results from this study will not only provide insight into the evolutionary biology of the Antarctic notothenioid fishes but will also elucidate important general principles that are applicable to widely different taxa beyond the Antarctic.

## Cruise & Field Research Plan

### Logistics

Dates in Antarctica:	mid-June 2001 to mid-July 2001
Cruise LMG01-05	
Departs:	Punta Arenas, Chile, 10 June 2001
Arrives:	Punta Arenas, Chile, 15 July 2001
Research Locations:	Palmer Station; SE Livingston Island; SW shore of Low Island; Brabant Island; Dallmann Bay

### Team Members

Bruce Sidell	Leonardo Magnoni
Theresa Grove	TBD (2)

### Cruise & Field-Season Operations

The researchers plan to study the physiology and molecular biology of several Antarctic fishes. Specifically, the researchers plan to investigate both myoglobin expression and key energy-metabolism enzymes in several species of red-blooded nototheniid fish and hemoglobinless channichthyid icefish.

Team members will travel to Palmer Station aboard the R/V *Laurence M. Gould* (cruise LMG01-05), and they will conduct fishing operations en route. With the assistance of shipboard contractor personnel, the team members will use benthic Otter trawls to collect a variety of Antarctic fish species, with emphasis on channichthyid icefishes. To limit or prevent benthic damage, the researchers will also use buoyed, anchored, and baited longlines and fish traps. If these capture technologies are successful, the team members may be able to reduce their use of benthic trawls. Fish will be collected at known fishing grounds near Low, Brabant, and Livingston Islands and in Dallmann Bay.

Captured fish will be kept in the ship's aquaria until the ship arrives at Palmer Station. The fish will then be transferred to the Palmer Station aquarium and held there for experimentation.

When the vessel arrives at Palmer Station the first time, the research team will split into two groups. One group will work in the laboratory to conduct experiments, while the other group will deploy on the R/V *Laurence M. Gould* for 2-4 day fishing expeditions. In this way, fishing operations and laboratory work can be accomplished concurrently. The vessel will depart from and return to Palmer Station. Newly captured fish will be added to the collection in the Palmer Station aquarium to be used for experiments. Occasionally, team members will switch between the two groups. Team members may also use Zodiac inflatable boats, fish traps, long lines, and hook-and-line rigs to collect fish within the Palmer two-mile boating limit.

At the Palmer laboratory, the team members will conduct physiological, biochemical, and molecular biological experiments on live fish and on material prepared from their tissues. Samples will be returned to the home institution for additional analyses.

**NSF/OPP Program Manager**  
Dr. Polly Penhale

**RPS Point-of-Contact**  
Mr. Robert Edwards (Palmer)  
Mr. Al Hickey (research vessel)

## Structure, Function, and Expression of Tubulins, Globins, and Microtubule-Dependent Motors from Cold-Adapted Antarctic Fishes

**BO-037-O**

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### Research Objectives

Microtubules, which are subcellular, “pipelike” filaments composed of the protein tubulin, and their associated motors, dynein and kinesin, participate in many fundamental cellular processes, including cell division, nerve growth and regeneration, cell motility, and the organization and transport of organelles within cells. In these processes, microtubules serve as rigid “railroad tracks” for the movement of motors and their cargoes (“trains”), and the motors themselves are efficient, high-velocity, regulative “locomotives.” The microtubules and microtubule motors of cold-adapted Antarctic fishes are unique in their capacity to assemble and function at body temperatures of  $-2^{\circ}\text{C}$  to  $+2^{\circ}\text{C}$ , well below those of warm-blooded and temperate organisms.

The long-range goal of our project is to determine, at the molecular level, the adaptations that enhance the assembly of microtubules, the expression of tubulin genes, and the activity of microtubule motors in Antarctic fishes in this extreme thermal regime. Our objectives are:

- to determine the structural features (e.g., changes in their amino acid sequences) that enable the tubulins of Antarctic fishes to polymerize efficiently at low temperatures;
- to characterize the structure, organization, and expression of an alpha-tubulin gene cluster from an Antarctic rockcod, *Notothenia coriiceps*; and
- to examine the biochemical adaptations required for efficient function of Antarctic fish flagellar dynein motors at low temperatures.

We will determine molecular adaptations of Antarctic fish tubulins by comparing the amino acid sequences of alpha- and beta-tubulins from *N. coriiceps* to those from its temperate relative, the New Zealand black cod, *Notothenia angustata*. We will analyze gene expression in *N. coriiceps* by defining the organization and transcription-regulating elements of an alpha-tubulin gene cluster. In the broadest sense, this research should advance the molecular understanding of the cold-adapted mode of life.

## Cruise & Field Research Plan

### Logistics

Dates in Antarctica:	mid-June 2001 to mid-July 2001
Cruise LMG01-05	
Departs:	Punta Arenas, Chile, 10 June 2001
Arrives:	Punta Arenas, Chile, 15 July 2001
Research Locations:	Palmer Station; SE Livingston Island; SW shore of Low Island; Brabant Island; Dallmann Bay

### Team Members

William Detrich	Sandra Parker	Donald Yergeau
Steve Hann	TBD (2)	

### Cruise & Field-Season Operations

The researchers plan to study some of the molecular and genetic adaptations to cold exhibited by Antarctic fishes. Specifically, the researchers will examine cellular microtubule and microtubule-motor proteins, as well as the expression of genes involved in blood formation, in several species of red-blooded nototheniid fish and hemoglobinless channichthyid icefish.

Team members will travel to Palmer Station aboard the R/V *Laurence M. Gould* (cruise LMG01-05), and they will conduct fishing operations en route. With the assistance of shipboard contractor personnel, the team members will use benthic Otter trawls to collect two Antarctic rockcod species, several icefish species, a species of dragonfish, and other fish species of opportunity. To limit or prevent benthic damage, the team members will also use buoyed, anchored, and baited longlines and fish traps. If these capture technologies are successful, the team members may be able to reduce their use of benthic trawls. Fish will be collected at known fishing grounds near Low, Brabant, and Livingston Islands and in Dallmann Bay.

Captured fish will be kept in the ship's aquaria until the ship arrives at Palmer Station. The fish will then be transferred to the Palmer Station aquarium and held there for experimentation.

When the vessel arrives at Palmer Station the first time, the research team will split into two groups. One group will work in the laboratory to conduct experiments, while the other group will deploy on the R/V *Laurence M. Gould* for 2-4 day fishing expeditions. In this way, fishing operations and laboratory work can be accomplished concurrently. The vessel will depart from and return to Palmer Station. Newly captured fish will be added to the collection in the Palmer Station aquarium to be used for experiments. Occasionally, team members will switch between the two groups. Team members may also use Zodiac inflatable boats, fish traps, long lines, and hook-and-line rigs to collect fish within the Palmer two-mile boating limit.

At the Palmer laboratory, the team members will purify microtubule proteins and nucleic acids from the brain, testes, spleen, head, kidney, blood, and ovarian tissues of captured fishes. They will then conduct biochemical and molecular biological experiments on this material. Samples will also be returned to the home institution for additional analyses.

### NSF/OPP Program Manager

Dr. Polly Penhale

### RPS Point-of-Contact

Mr. Robert Edwards (Palmer)  
Mr. Al Hickey (research vessel)

## **Investigations on Deterioration in the Historic Huts of the Ross Sea Region of Antarctica**

**BO-038-O**

**Dr. Robert Blanchette, Principal Investigator**

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### **Research Objectives**

The explorers of Antarctica's heroic era erected buildings and brought large amounts of supplies to survive the extreme environment during their Antarctic exploration. Huts built by Robert F. Scott and Ernest Shackleton during the early 1900s were abandoned once the expeditions were over, leaving the huts and thousands of artifacts behind. The extreme polar environment has protected many of the artifacts from rapid decay, but over the past 90 years serious deterioration has become apparent. Results obtained through preliminary studies indicate that unique wood-destroying fungi are decaying wood in contact with the ground. Also, various molds and cellulose-degrading fungi are attacking artifacts made of leather, textiles, and other organic materials. Non-biological deterioration processes, including salt, ultraviolet radiation and wind erosion, also are weakening exterior woods. Chemical damage within the huts and soils contaminated with aromatic hydrocarbons from petroleum products have been found as well.

As part of our project, we will identify the biological and non-biological agents responsible for causing the deterioration, study the mechanisms and progressive sequence of events taking place during decay processes, test methods for controlling future deterioration, determine the extent of environmental pollutants in soils at the historic sites, and evaluate chemical spills within the huts. The resulting data will elucidate the unique deterioration processes involved and help conservators to protect these important historic sites for future generations. The data will also add to scientific understanding of the biology of Antarctic microorganisms and the biodiversity of microbes present in this unusual environment.

## **Field Research Plan**

### **Logistics**

Dates in Antarctica: early December 2000 to mid-December 2000  
Research Locations: Cape Evans, Cape Royds, Cape Crozier, Dry Valley site (location with old hut)

### **Team Members**

Robert Blanchette                      Benjamin Held                      Joel Jurgens

### **Field-Season Operations**

In this collaborative project with the New Zealand Antarctic Program project K-021, the researchers plan to study the level of deterioration of the historic huts in the McMurdo Sound region. Team members from both projects will set up tent camps near the historic huts at Cape Evans and Cape Royds, where they will collect soil and wood samples. They will also make a helicopter day trip to Cape Crozier and to the site of a 1960s-era hut in the Dry Valleys, where they will take similar samples.

The soil and wood samples will be returned to the U.S. and to New Zealand, where they will be tested for microbial diversity. Microbe populations from Cape Crozier and the Dry Valleys will be compared to those collected at the hut sites. The researchers will attempt to determine the extent of both non-biological and biologically mediated deterioration in the huts, and then evaluate methods to control this decay.

## **Penguin-Krill-Ice Interactions: The Impact of Environmental Variability on Penguin Demography**

**BO-040-O**

**Dr. Wayne Trivelpiece, Principal Investigator**

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### **Research Objectives**

Long-term seabird research conducted at Admiralty Bay on King George Island in the Antarctic Peninsula region has documented annual variability in the life history parameters of the breeding biology and ecology of the Adelie, Gentoo, and Chinstrap penguins. Twenty-year records acquired on these species—including survival and recruitment, population size and breeding success, and diets and foraging ecology—have enabled scientists to test key hypotheses regarding the links between these predator parameters and variability in the Antarctic marine ecosystem.

Our focus is on understanding the links between the physical environment and the population biology of penguins—in particular, sea-ice cover and its impact on krill availability as a food source for penguins. Krill, a key food web species in the Southern Oceans, accounts for nearly 100 percent of the prey eaten by dominant predators such as baleen whales, seals, and penguins. Analysis of long-term data sets has suggested that years of heavy winter sea ice favor krill recruitment, because larval krill find refuge and food in the sea-ice habitat. Scientists also have observed that years of heavy sea ice favor Adelie penguin recruitment and not that of Chinstrap penguins.

Aspects of our project include analysis of diet samples, shipboard krill sampling, survival and recruitment studies of penguins, satellite-tracking of penguins during the breeding season, and analysis of satellite sea-ice images. Penguins are the key species used to monitor the impact of commercial fisheries activities in the region, so this study will provide useful information to the Convention for the Conservation of Antarctic Marine Living Resources, which is the part of the Antarctic Treaty System and focuses on fisheries management.

## Field Research Plan

### Logistics

Dates in Antarctica: mid-October 2000 to early March 2001  
Research Location(s): Copacabana Field Station on King George Island

### Team Members

Susan Trivelpiece                      Laina Shill                      Ladislav Rektoris  
Magdalena Owczarek                Conrad Thiessen

### Field-Season Operations

The researchers plan to continue a long-term study of the breeding biology and population dynamics of the Adelie, Chinstrap, and Gentoo penguins at King George Island, South Shetland Islands, Antarctica. Team members will monitor several breeding pairs to correlate sex, age, and breeding experience to reproductive success and survival. The researchers seek to understand how these demographic variables interact to affect changes in animal population. The field team will also investigate the relationships between population dynamics, prey availability, and environmental variability in an effort to define how the mechanisms of environmental variation may influence predator dynamics.

Field-team members will travel to the Copacabana Field Camp (Copa) in early October 2000 on board the R/V *Laurence M. Gould* (cruise LMG00-8A). The Co-Principal Investigator will depart the station by commercial tour ship in early December 2000. The field-team leader will arrive at Copa by commercial tour ship in late December 2000 to join the field team.

The team members will capture adult and juvenile penguins periodically throughout the season for banding, weighing, and morphometric measurements. Blood samples will be collected for physiological and genetic studies. Team members will also attach radio tags and satellite transmitters to track bird movements, and time/depth recorders to collect diving and foraging data.

The support contractor plans to complete the power system upgrade of the Copacabana field camp this season. One electrician will travel to Copa on the R/V *Laurence M. Gould* (cruise LMG01-01A) in early February 2001 to install a wind generator. The construction is scheduled to take approximately one month.

The field team will close the Copa camp, and all personnel will depart in early March 2001 on a research vessel chartered by the National Oceanic and Atmospheric Administration's Antarctic Marine Living Resources program.

## **Microbial Mediation of Trace Metal Cycling in Four Stratified Antarctic Lakes**

**BO-041-O**

**Dr. William Green, Principal Investigator**

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### **Research Objectives**

Aquatic environments often stratify; that is, boundaries at different depths indicate changes in the composition of the water. One of the basic processes in nature is reduction by oxidation (redox), and redox boundaries can be found at specific water depths where microbes are implicated in the cycle and fate of a large suite of chemical elements.

The proposed research will examine the role of microbial influences on metal cycling in four stratified lakes in the McMurdo Dry Valleys: Lakes Fryxell, Hoare, Joyce, and Miers. These lakes are characterized by unusually stable redox transition zones, and they are also especially amenable to a finely spaced sampling regime. Collectively, they represent a broad range of water chemistries.

The proposed research will test two hypotheses:

- In stratified water columns, there should be a clear spatial difference between the onset of manganese reduction and the onset of iron reduction. Heavy metals and rare-earth elements will be seen to undergo co-cycling with manganese (Mn) rather than with iron.
- In all four lakes, Mn reduction will be associated with the presence of cyanobacteria or other Mn-reducing organisms.

Dissolved and particulate metal profiles will be examined at depths from the ice-water interface at the top all the way down to the sediments. Profiles will be correlated with microbial Mn-reduction assays, and with the presence of Mn reducers. These can be detected by screening with Mn-oxide overlay agar plates and nucleic acid hybridizations that function as probes for known manganese reducers.

This research will include significant involvement of undergraduates.

## Field Research Plan

### Logistics

Dates in Antarctica: mid-December 2000 to mid-January 2001  
Research Locations: Dry Valleys (Lake Miers, Lake Joyce ); Cray Science and Engineering Center (CSEC)

### Team Members

William Green	Bonnie Bratina	Vincente Trussoni
Chad Galer	TBD (3)	

### Field-Season Operations

The researchers plan to study the microbial influences on metal cycling in two stratified Dry Valley lakes. This will include exploring the role of manganese-reducing organisms in the cycling and fate of a large suite of chemical elements. This should lead to a greater understanding of the limnology and biogeochemistry of these lakes.

In mid-December 2000, the team members will travel via helicopter to Lake Miers in Miers Valley, where they will set up a tent camp. The team members will collect lake-water samples with a pump and limnological data with spectrophotometers; conductivity, temperature, and depth (CTD) meters; and a dissolved-oxygen meter. In early January 2001, the group will move camp (via helicopter) from Lake Miers to Lake Joyce, in Pearse Valley, where they will set up a tent camp and collect water samples and data using the same methods. In mid-January 2001, the team members will break camp and travel via helicopter to McMurdo Station.

At McMurdo Station, the team members plan to work in a chemistry lab in the CSEC to analyze lake-water samples for major ions, nutrients, and metals. They will also filter microorganisms from the lake water and examine them microscopically. Water samples will be returned to the home institution for trace metal analyses.

## **The Influence of Seasonal Ice Cover on Pelagic and Benthic Communities: Long Time-Series Studies**

**BO-050-O**

### **Dr. Kenneth Smith, Principal Investigator**

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### **Research Objectives**

The annual expansion and contraction of ice cover in the Southern Ocean – the largest seasonal process in the world ocean – causes primary biomass production to fluctuate extensively, and it has a strong impact on both pelagic (open, upper sea) and benthic (deeper, at the bottom) communities of fauna. This study at Port Foster, Deception Island, will take advantage of a region that has seasonal ice cover and which supports a pelagic and benthic fauna that are representative of the Antarctic coastal zone.

The study of the water column and seafloor will be structured as a long time-series, employing long-term, autonomous monitoring and sampling systems that were developed especially for use in Antarctica. We will deploy a bottom-moored, upward-looking acoustic instrument on the seafloor for 12 months to monitor the vertical distribution, abundance, and biomass of acoustically detectable macrozooplankton and micronekton in the water column. Collections will be made over this period using newly developed, vertically profiling pump sampling. Simultaneously, a time-lapse camera system will be moored on the seafloor to monitor the spatial distribution, sizes, and movements of the epibenthic megafauna component of the benthic community.

This deployment of instruments will allow us to focus on the effect of the seasonal sea-ice cycle on the distribution, abundance, and biomass of the macrozooplankton and micronekton in the water column. Similar questions about the deeper-dwelling epibenthic megafauna will focus on distribution, size, abundance, and movements. Results from this study should provide a valuable foundation database to evaluate the pelagic and benthic community responses to seasonal variability in the Southern Ocean.

## Cruise Research Plan

### Logistics

Cruise LMG00-10

Departs:

Punta Arenas, Chile, 12 November 2000

Arrives:

Punta Arenas, Chile, 4 December 2000

Research Location:

Port Foster, Deception Island

### Team Members

Kenneth Smith

Roberta Baldwin

Donald Baldwin

Alfred Uhlman

Jan Uhlman

Lawrence Lovell

Jeffrey Drazen

Helene Drazen

Erin Hubbard

Mary Fran Cullen

Matthew Laubacher

Sarah Gray

Kathleen Dykes

Donald Archie McLean

### Cruise Operations

The researchers plan to work on board the R/V *Laurence M. Gould* during cruise LMG00-10 to examine the abundance and distribution of macrozooplankton and micronekton in the water column in Port Foster, Deception Island. Port Foster, the fumarole of an active volcano, is ice-covered in winter and completely ice-free during the summer. The researchers will study the impact of seasonal ice cover on the ecology of animals in the water column. They will also record animal movements on the benthos, and they will measure hydrographic parameters. This is the fifth and final cruise in support of this project.

Data will be collected using Remote-Operated Vehicles (ROVs); 1-meter and 10-meter Multiple Opening and Closing Net and Environmental Sampling System (MOCNESS) tows; otter trawls; and conductivity, temperature, and depth (CTD) meters. In addition, long-term, autonomous monitoring systems attached to moorings will be used to record animal movements on the sea floor. Other sampling systems will record water temperature and other hydrographic data. Water samples will also be drawn and analyzed for nutrients (nitrate, nitrite, phosphate, silicate) and other parameters. A land-based weather station previously installed during the R/V *Laurence M. Gould* cruise LMG99-2 to monitor Port Foster wind conditions and ice cover will be serviced and monitored during cruise LMG00-10.

After arriving at Port Foster, the team members will first deploy the long-term measuring and monitoring systems. They will then begin net tows and other sampling procedures. A technician from the Woods Hole Oceanographic Institution in Massachusetts will assist the team members in deploying the MOCNESS systems. At regular intervals, team members will take a Zodiac inflatable boat to shore to monitor the weather station. At the end of the cruise, all sampling systems, including the weather station, will be removed.

Samples will be returned to the home institution for further analysis.

**NSF/OPP Program Manager**  
Dr. Polly Penhale

**RPS Point-of-Contact**  
Dr. Karl Newyear

## Diving Biology of Emperor Penguins

### BO-197-O

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### Research Objectives

Because the emperor penguin (*Aptenodytes forsteri*) lives within the pack ice zone of Antarctica, its advanced ability to dive has been the subject of interest for many years. Emperor penguins routinely hunt for food for between 2 and 10 minutes, at depths ranging from 50 to 500 meters. These birds have reached a measured depth of nearly 550 meters. The longest dives are not the deepest; however, the longest recorded dive of twenty-two minutes was nowhere near that record depth.

This project will examine the diving physiology and behavior of emperor penguins in the Ross Sea region of Antarctica. We hope to elucidate both the physiological and behavioral mechanisms underlying the breath-holding capacity of these diving birds. Also, we hope to understand how these physiological limits may affect the natural diving behavior and ecology of the penguins. Finally, we intend to use the unique adaptation of these diving birds to explore how organs and tissue tolerate oxygen deprivation.

The emperor penguin provides an excellent model to investigate the physiology and behavior of diving birds and mammals, specifically thermoregulation, underwater behavior, and the homeostatic regulation of myoglobin. We will focus on the role of decreased body temperature in extending the duration of aerobic metabolism during diving. The presence of a small camera will permit us to examine the penguins' behavior during their dives, and to correlate changes in core and muscle temperature with which prey they ingest, as well as with their wing stroke frequency. At the molecular biology level, we will use the high myoglobin concentration in emperors and the large increases in myoglobin concentration during chick development to examine transcriptional control of the myoglobin gene.

## Field Research Plan

### Logistics

Dates in Antarctica: early October 2000 to early February 2001  
Research Locations: Cape Washington, two McMurdo sea ice camps, Cray Science and Engineering Center (CSEC)

### Team Members

Paul Ponganis	Robert van Dam	Katherine Ponganis
David Levenson	Greg Marshall	Gerald Kooyman
Monica Bustamante	Timothy Welch	Walt Campbell

### Field-Season Operations

The researchers plan to study how emperor penguins maintain body temperature while diving in frigid waters and ingesting cold prey. They will also investigate the role of hypothermia in extending dive duration.

In early October 2000, the project team members will set up a camp on the sea ice in McMurdo Sound, about 20 miles northwest of McMurdo Station and a few miles west of Tent Island. Once the camp is established, team members will travel via helicopter to survey the ice edge and locate penguins. Penguins will be captured from near the sea-ice edge, transported back to camp by snowmobile and sled (or helicopter if necessary), and kept in a penguin corral with a dive hole. Team members will observe the birds underwater by use of a sub-ice observation chamber and by SCUBA diving. Underwater behavior will be documented with underwater video.

In mid-November 2000, team members will make a one-day trip via Twin Otter aircraft to Cape Washington to collect biopsy samples. In mid-December 2000, team members will return to Cape Washington for an extended stay to collect additional samples and penguin chicks. At the same time, a second sea-ice camp will be established near Scott Base to house the chicks. The team members will set up the penguin corral at this camp, and support contractor equipment operators will use a trencher to carve a swimming pool and exercise channel into the ice. The chicks from Cape Washington will be transported to this camp via Twin Otter, where the team members will study their growth and development, as well as their swimming behavior.

Tracked vehicles and snowmobiles will be used to transport personnel and equipment between the sea-ice camps and McMurdo Station. At the CSEC laboratory, blood and tissue samples will be analyzed by team members investigating the regulation of myoglobin gene expression in emperor penguins. This work will involve the use of radioisotopes (P32).

All penguins, both adults and chicks, will be released at the ice edge at end of the study. Some penguin blood and tissue samples will be returned to the home institution for further analyses.

**NSF/OPP Program Manager**  
Dr. Polly Penhale

**RPS Point-of-Contact**  
Ms. Robbie Score

## The Role of Oceanographic Features and Prey Distribution on Foraging Energetics and Reproductive Success of Antarctic Fur Seals

BO-267-O

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### Research Objectives

The Southern Ocean enjoys a high seasonal productivity, in both coastal and pelagic environments. But observations over the last several decades show that behind this general productivity lies much variation – during the year, and from year to year. Thus the prey available to vertebrate predators can vary significantly over time, and from place to place.

Since the late 1980s, scientists have recorded this spatial and temporal variability for the northern South Shetland Islands region of the Antarctic Peninsula. The Antarctic fur seal (*Arctocephalus gazella*), a subpolar, migratory otariid with a short lactation period, is an increasingly dominant marine predator of the South Shetlands region. Its life-history pattern is characterized by foraging trips, alternating with short visits to provide for a single offspring. This pattern allows scientists to measure both maternal investment and the distribution/abundance of prey on the same temporal and spatial scales.

This project will quantify the foraging costs and maternal investment associated with different strategies observed in populations of Antarctic fur seals in the South Shetland region. Using state-of-the-art techniques, we will determine the costs and benefits of different foraging patterns, correlated to energy expenditure, food intake, dive depth, dive duration, time of day, dive frequency, swim speed, and foraging location. These measurements will coincide with small- and large-scale oceanographic surveys to be conducted by the National Oceanic and Atmospheric Administration's Antarctic Marine Living Resources program, which also contributes to the support of this project.

The research will provide scientists a clearer picture of the life of a free-ranging marine vertebrate predator. The data should reveal patterns linking the biological characteristics of the prey (composition, distribution, and abundance) and the physical characteristics of the foraging environment with foraging success, maternal investment, and reproductive success.

## Field Research Plan

### Logistics

Dates in Antarctica: mid-January 2001 to late February 2001  
Research Locations: Cape Shirreff on Livingston Island, and the adjacent seas

### Team Members

Matthew Rutishauser                      Alison Banks

### Field-Season Operations

In mid-January 2001, two project team members plan to travel aboard a National Oceanic and Atmospheric Administration (NOAA) Antarctic Marine Life Resources (AMLR) Program research vessel to complete their studies of Antarctic fur seal foraging behavior in the South Shetland Islands. They will work simultaneously on the vessel and at the NOAA field camp at Cape Shirreff, Livingston Island.

One team member, with assistance from NOAA scientists, will travel by foot on the island to work with four different groups of fur seals. The team member will use satellite-linked VHF radio transmitters to study the foraging locations of seals. The transmitters will be placed on the backs of several fur seals, and data will be collected and downloaded from a satellite. The pups of the radio-tracked seals will be marked with hair bleach and regularly monitored for growth and development parameters. A group of pups from mothers without transmitters will be simultaneously monitored as a control. Time-Depth recorders (TDRs) will be attached to some seals to determine the dive depth, frequency, and duration of dives, as well as the time of day the seals forage.

The other team member will work aboard the NOAA/AMLR research vessel to collect and preserve krill and fish samples. These will be used to determine the distribution, abundance, and quality of these prey items. The entire team will depart Antarctica on the NOAA/AMLR vessel in late February 2001. Samples will be returned to the home institution for analysis.

## Natural Product Drugs from Cold-Water Marine Organisms

**BO-282-O**

**Dr. Gregg Dietzman, Principal Investigator**

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### Research Objectives

Our principal objective is to collect samples from five Antarctic species that are emerging as active sources of human cytotoxic compounds in Phase I of our Small Business Innovative Research grant from the U.S. National Cancer Institute. We initially collected samples in the Antarctic Peninsula region in 1994-1995 from aboard the USAP research vessel *Polar Duke*. This austral summer, we plan to collect samples at sites north and west of the Palmer Peninsula, between King George Island and Palmer Station on Anvers Island. Dredging techniques usually used to collect geological samples, as well as trawling, will enable us to collect benthic samples for this investigation of the chemistry and biological activity of Antarctic marine organisms.

## Cruise Research Plan

### Logistics

Cruise LMG00-8A

Departs:

Punta Arenas, Chile, 1 October 2000

Arrives:

Punta Arenas, Chile, 13 October 2000

Cruise LMG00-09

Departs:

Punta Arenas, Chile, 17 October 2000

Arrives:

Punta Arenas, Chile, 8 November 2000

Research Locations:

Anvers Island, King George Island, Deception Island, North and West of the Antarctic Peninsula

### Team Members

Gregg Dietzman

Craig Staude

### Cruise Operations

The researchers plan to work on board the R/V *Laurence M. Gould* during cruises LMG00-8A and LMG00-09 to investigate the chemistry and biological activity of Antarctic marine benthic organisms. The primary objective is to collect 1-20 kg each of five Antarctic species (sponges and anemones) that are emerging as active leads with human solid tumor cytotoxicity studies. (Note: The initial collection took place during the 1994-95 season from the R/V *Polar Duke*.)

At various points around the target islands and along the cruise track, the team members will deploy box dredges, otter trawls, and chain trawls to collect benthic material. Dredges will be made up to 1000 meters in depth, with most collections taking place in the range of 200 meters. Dredged bottom material will be dumped on the aft deck and sorted into buckets for work-up in the laboratory. Samples will be saved in the -80°C ultralow freezer or preserved in formaldehyde or ethyl alcohol. Concurrent with trawling and dredging activities, team members will use the hull-mounted Knudsen 320 B/R 3.5 kHz sonar to take bathymetry profiles. They will also record GPS coordinates for the beginning and end of each trawl or dredge.

At the end of each cruise, samples will be returned to the home institution for further analysis. This project is co-funded by the National Cancer Institute (NCI), of the National Institutes of Health (NIH).

**NSF/OPP Program Manager**  
Dr. Polly Penhale

**RPS Point-of-Contact**  
Dr. Karl Newyear

## **A Training Program in Integrative Biology and Adaptation of Antarctic Marine Organisms**

**BO-301-O**

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### **Educational Objectives**

This international, advanced-level, graduate training course will be organized and taught in Antarctica for one month during the austral summer of 2000-2001. The course introduces students to the diversity of biological organisms in Antarctic regions, and it allows them to study unique aspects of biology that permit life in such extreme environments.

Long-standing questions in evolution and ecology about the biology of Antarctic organisms (such as cold adaptation and food limitation) are examined through physiological experiments with organisms, studies of isolated cells and tissues, experiments on protein structure and function, and molecular analysis of genetic systems. Lectures emphasize physiological, biochemical, and molecular biological approaches to understanding the ecology and biological adaptations of Antarctic organisms.

Student research projects follow these interwoven themes. The students should gain a rigorous understanding of the power – as well as the limitations – of physiological, biochemical, and molecular biological methods that are currently being used to answer research questions in environmental science and the biology of adaptation. The course will be held in the Crary Science and Engineering Center at McMurdo Station, Antarctica. This modern research facility provides state-of-the-art laboratory facilities a short distance from the marine and freshwater environments where biological observations are made and material is collected. The course will be taught in four modules:

- Biological diversity of Antarctic organisms: Evolution and molecular phylogeny;
- Ultraviolet radiation: Effects on Antarctic organisms;
- Invertebrates: Physiology, energy metabolism, and development; and
- Fish: Biochemical adaptations.

By attracting an extremely competitive group of young scientists, this course introduces new researchers to Antarctica and teaches students the modern research methods currently being deployed to study mechanisms that are unique to biology in Antarctica.

## Training Plan

### Logistics

Dates in Antarctica:  
Research Locations:

late December 2000 to early February 2001  
McMurdo Station, Cape Evans, Ice Edge, Bratina Island,  
Crary Science and Engineering Center (CSEC)

### Team Members

#### *Instructors:*

Donal Manahan  
Deneb Karentz  
Gretchen Hofmann  
Craig Marshall

George Somero  
Wade Jeffrey  
Adam Marsh  
Ed DeLong

Lynda Goff  
Robert Maxson  
Alison Murray

#### *Lecturers:*

Chuck Pickering  
TBD (1)

#### *Teaching Assistants:*

TBD (3)

#### *Participants:*

TBD (24)

### Field-Season Operations

The Instructors will offer a graduate and post-graduate level course for study of biological adaptations of Antarctic marine organisms. The course will start on 8 January 2001 and end 8 February 2001. Students will attend lectures and conduct laboratory experiments in the CSEC, using organisms and samples that they will collect from a variety of sites around McMurdo Station.

The aim of the course is to introduce 24 students and postdoctoral-level researchers to the mechanisms of biological adaptation of Antarctic marine organisms by studying these processes at the physiological, biochemical, and molecular biological levels of analysis. Forty people (i.e., instructors, guest lecturers, teaching assistants, and students) will be involved in the course. The course will consist of four different modules taught by ten instructors. The emphasis will be on experimental Antarctic biology, with exposure to field collection techniques. A diverse teaching faculty will offer students the possibility of working on a wide range of Antarctic organisms (bacteria, algae, invertebrates, and fish) and the possibility of working at several levels of analysis (i.e., molecular biology to the whole organism). The specific themes for the 2001 course include biodiversity and molecular phylogeny; energy metabolism; macromolecular synthesis; membrane physiology; temperature adaptation; and UV-photobiology.

Course participants will travel via snowmobile from McMurdo Station to ice holes drilled in the annual sea ice near the Ross Ice Shelf to collect phytoplankton and zooplankton specimens for study. One ice hole near the intake jetty will be accessible by foot.

Students and instructors will travel via helicopter to the ice edge, where they will collect plankton from the sea ice and the Ross Sea for ultraviolet exposure experiments and investigations into the biodiversity of sea-ice communities. The seaward side of Cape Royds will be the back-up site for collecting samples if the ice edge proves to be unstable. Participants will also travel via helicopter from McMurdo to Cape Evans to collect macroalgae for experiments in photoadaptation, and to Bratina Island to study bacterial responses to UV light and microbial diversity in the salt ponds of the island. Six participants and an instructor will travel via helicopter to Lake Fryxell to collect lake algae, bacteria, and protozoa.

Working with the support contractor's Science Diving Coordinator (SDC), the team scuba diver will collect all specimens needed for studies in population genetics. These specimens will be kept in the Phase III aquarium in CSEC for student observation and experimentation.

Frozen samples will be returned to the home institutions for further studies.

**NSF/OPP Program Manager**  
Dr. Polly Penhale

**RPS Point-of-Contact**  
Ms. Robbie Score

# **Benthic-Pelagic Coupling on the West Antarctic Peninsula Shelf: The Impact and Fate of Bloom Material on the Shelf Floor**

**BO-303-O**

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## **Research Objectives**

Primary production in Antarctic coastal waters is highly seasonal; each spring/summer, an intense pulse of biogenic particles is delivered to the floor of the continental shelf. This seasonal pulse may have major ramifications for carbon cycling, benthic (seafloor) ecology, and the nature of material buried on the West Antarctic Peninsula (WAP) shelf. This project brings several disciplines together in an effort to evaluate the bloom material – its fate, accumulation on the seafloor, and impact on the benthic community.

We will work along a transect of three stations crossing the Antarctic shelf in the Palmer Long-Term Ecological Research study area. During our cruises in the 2000-2001 research season, we will test the following hypotheses:

- A substantial proportion of spring/summer export production is deposited on the WAP shelf as phytodetritus or fecal pellets;
- The deposited bloom production is a source of labile particulate organic carbon (POC) for bottom-dwelling organisms for an extended period of time (i.e., months);
- Large amounts of labile bloom POC are rapidly subducted into the sediment column by the deposit-feeding and caching activities of benthic organisms;
- Macrobenthic detritivores undergo rapid increase in numbers and biomass following the spring/summer POC pulse.

To test these hypotheses, we will evaluate seabed deposition and POC lability, patterns of POC mixing into sediments, seasonal variations in macrofaunal and megafaunal abundance, biomass and reproductive condition, and rates of POC and silica mineralization and accumulation in the seabed. We will contrast the fluxes of biogenic materials and radionuclides (into midwater particle traps) with seabed deposition and burial rates. This data should permit us to establish water-column and seabed preservation efficiencies for these materials.

A better understanding of the spring/ summer production pulse on the WAP shelf should enhance our understanding of both carbon cycling in Antarctic coastal systems and the impact of such fluctuations on seafloor communities.

## Cruise Research Plan

### Logistics

Cruise LMG00-09

Departs: Punta Arenas, Chile, 19 October 2000  
Arrives: Punta Arenas, Chile, 8 November 2000

Cruise LMG01-02

Departs: Punta Arenas, Chile, 20 February 2001  
Arrives: Punta Arenas, Chile, 10 March 2001  
Research Location: Palmer LTER area

### Team Members

Craig Smith	Sarah Mincks	Stanley Smith
Elizabeth Galley	Stephanie Suhr	Adrian Glover
Timothy Ferrero	Nicola Mitchell	TBD

### Cruise Operations

The researchers are completing a series of five cruises to study the benthic deposition and effect of particulate organic carbon (POC) that results from the annual summer bloom in the Western Antarctic Peninsula region. The researchers plan to work on board the *R/V Laurence M. Gould* during cruises LMG00-09 and LMG01-02, evaluating the impact of bloom material along a transect of three stations in the Palmer LTER area. Research activities and sample locations will be the same for both cruises.

With the assistance of ship-board contractor personnel, the project team members will deploy a variety of collection and measuring devices to collect samples and data. These will include Kasten cores, box cores, multiple cores, otter trawls, camera sleds, and plankton nets. Time-lapse photography will be used to evaluate the seabed deposition of POC and seasonal variations in benthic macro-invertebrate fauna. Time-lapse cameras and sediment traps will be deployed and recovered together on free vehicles. Depth recorders will be used for bottom surveys, and pingers will mark the position of deployed instruments. Support contractor personnel will assist in the monitoring and recovery of deployed instruments.

The team members will also conduct some sample analyses aboard ship, including respirometry measurements on sediment cores, incubations of live animals, and larval cultures. Neuston and ice-edge observations, and some sampling, will be conducted from Zodiac inflatable boats.

Some samples will be returned to the home institution for further analysis.

**NSF/OPP Program Manager**  
Dr. Polly Penhale

**RPS Point-of-Contact**  
Mr. Don Michaelson

# **Control of Denitrification in a Permanently Ice-Covered Antarctic Lake: Potential for Regulation by Bioactive Metals**

**BO-310-O**

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## **Research Objectives**

Denitrification driven by bacteria is the process by which nitrogen is lost from ecosystems, and thus its rate and regulation may directly affect both primary biological production and carbon cycling, over both short and long time scales. This research investigates a natural experimental system found in permanently ice-covered Lake Bonney in the Taylor Valley of East Antarctica to ask: What is the role of bioactive metals in regulating denitrification?

Lake Bonney has two distinct lobes, but in only one does denitrification occur. Previous study has ruled out most of the obvious biological and chemical variables that usually influence denitrification and that might account for the difference between the two lobes. Denitrifying bacteria are present in both lobes of the lake, where tests of both temperature and salinity reveal conditions in which they can thrive. Thus a paradox presents itself: Despite apparently favorable conditions in both lobes, what is inhibiting denitrification in one lobe and not in the other?

Our study entails a combination of culture experiments and field work to examine this paradox. Specifically, we will be:

- experimenting with the denitrifying isolates to determine metal tolerances and requirements for growth;
- measuring metal concentrations and metal speciation in surface transects and depth profiles; and
- probing how denitrifying bacteria respond to alterations in the availability of certain metals.

By elucidating the relationship between microbial activity and metal distributions in Lake Bonney, we hope to add to scientific knowledge about the cycling of elements in other aquatic systems. We also expect to develop insights useful for evaluating the proposed use of paleo-denitrification indicators for past-climate reconstructions. Finally, our research may shed light on the potential significance of the global marine denitrification/nitrogen fixation ratio to atmospheric carbon dioxide levels.



**Palmer Long-Term Ecological Research (LTER)  
on the Antarctic Marine Ecosystem:  
An Ice-Dominated Environment  
BP-013,016,021,028,032,046-O**

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## **Research Objectives**

The Palmer Long-Term Ecological Research (LTER) project is focused on one major ecological issue: To what extent is the annual advance and retreat of sea ice a major physical determinant of spatial and temporal changes in the structure and function of the Antarctic marine ecosystem?

Evidence shows that this dynamic variability of sea ice has an important (perhaps determinant) impact on all levels of the food web, from total annual primary production to breeding success in top predators. For example, variability in sea ice may affect prey and predators directly by controlling access to open water or preferred habitats, or indirectly, as changes in the sea ice cover affect other species that serve as food. We hypothesize that sea ice is a major factor regulating for:

- the timing and magnitude of seasonal primary production;
- the dynamics of the microbial loop and particle sedimentation;
- krill abundance, distribution, and recruitment; and
- survivorship and reproductive success of top predators.

These factors probably differ for different key species, as the magnitude and timing of sea-ice changes can have very specific local impacts. What remains unclear are the ramifications for the whole Antarctic ecosystem. As one of the basic examples, greater sea-ice areal coverage promotes more available Antarctic krill (a primary food), which enhances the survivorship and reproductive success of Adélie penguins. Thus, the overall objectives of the Palmer LTER project are to:

- document not only the interannual variability of annual sea-ice and the corresponding physics, chemistry, optics, and primary production within the study area, but also the life-history parameters of secondary producers and top predators;
- quantify the processes that cause variation in physical forcing and the subsequent biological response among the representative trophic levels;
- construct models that link ecosystem processes to environmental variables and that simulate spatial/temporal ecosystem relationships; and then
- employ such models to predict and validate ice-ecosystem dynamics.

A key challenge for the Palmer LTER project is to characterize and understand the many cross-linkages that have developed in the Antarctic ecosystem. Environmental phenomena vary, over time and across areas, and these variations have both physical and biological consequences. These changes in turn can develop other loops and linkages that influence each other.

The participants for the 2000-2001 field season will be:

- William Fraser, Montana State University (BP-013-O);
- Maria Vernet, Scripps Institution of Oceanography (BP-016-O);
- Douglas Martinson, Columbia University (BP-021-O);
- Langdon Quetin, University of California at Santa Barbara (BP-028-O);
- Raymond Smith, University of California at Santa Barbara (BP-032-O); and
- David Karl, University of Hawaii (BP-046-O).

The following list contains the Palmer LTER projects' Principal Investigator contact information:

**BP-013-O: Seabird Component**

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**Palmer LTER/ BP-013,016,021,028,032,046-O**  
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**BP-021-O: Modeling Component**

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**BP-028-O: Prey Component**

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**BP-046-O: Microbiology and Carbon Flux Component**

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## Cruise & Field Research Plans

### Logistics

#### BP-013-O

Dates in Antarctica: mid-October 2000 to early April 2001  
Palmer Research Locations: all local islands around Palmer Station (including Torgerson, Humble, Hermit, Stepping Stones, Cormorant, Short Cut, and Litchfield); Dream Island; Biscoe Point; Cape Monaco (on Anvers Island); Joubin Islands

Cruise LMG01-1 (LTER Annual Cruise)

Departs: Punta Arenas, Chile, 30 December 2000  
Arrives: Punta Arenas, Chile, 29 January 2001  
Cruise Research Locations: Palmer LTER Grid Lines 200-500, from Anvers Island to northern Marguerite Bay, south of Adelaide Island

#### BP-016-O

Dates in Antarctica: mid-October 2000 to early April 2001  
Palmer Research Location: Palmer Inshore Sampling Grid

Cruise LMG01-1 (LTER Annual Cruise)

Departs: Punta Arenas, Chile, 30 December 2000  
Arrives: Punta Arenas, Chile, 29 January 2001  
Cruise Research Locations: Palmer LTER Grid Lines 200-500, from Anvers Island to northern Marguerite Bay, south of Adelaide Island

#### BP-021-O

Cruise LMG01-1 (LTER Annual Cruise)  
Departs: Punta Arenas, Chile, 30 December 2000  
Arrives: Punta Arenas, Chile, 29 January 2001  
Cruise Research Locations: Palmer LTER Grid Lines 200-500, from Anvers Island to northern Marguerite Bay, south of Adelaide Island

#### BP-028-O

Dates in Antarctica: mid-October 2000 to early April 2001  
Palmer Research Locations: Palmer Inshore Sampling Grid (stations A-J), from Wylie Bay to east of Cormorant Island

Cruise LMG01-1 (LTER Annual Cruise)

Departs: Punta Arenas, Chile, 30 December 2000  
Arrives: Punta Arenas, Chile, 29 January 2001

**Palmer LTER/ BP-013,016,021,028,032,046-O**  
**Palmer Station & R/V Laurence M. Gould**

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Cruise Research Locations: Palmer LTER Grid Lines 200-500, from Anvers Island to northern Marguerite Bay, south of Adelaide Island

**BP-032-O**

Dates in Antarctica: mid-October 2000 to early April 2001  
Palmer Research Locations: Palmer Station; Palmer Inshore Sampling Grid (stations A-J)

Cruise LMG01-1 (LTER Annual Cruise)

Departs: Punta Arenas, Chile, 30 December 2000  
Arrives: Punta Arenas, Chile, 29 January 2001  
Cruise Research Locations: Palmer LTER Grid Lines 200-500, from Anvers Island to northern Marguerite Bay, south of Adelaide Island

**BP-046-O**

Cruise LMG01-1 (LTER Annual Cruise)  
Departs: Punta Arenas, Chile, 30 December 2000  
Arrives: Punta Arenas, Chile, 29 January 2001  
Cruise Research Locations: Palmer LTER Grid Lines 200-500, from Anvers Island to northern Marguerite Bay, south of Adelaide Island

**Team Members**

**BP-013-O**

William Fraser	Donna Patterson	Christopher Denker
Matt Irinaga	Eric Chapman	Heidi Geisz

**BP-016-O**

Maria Vernet	Wendy Kozlowski	Karie Sines
Silvia Rodriguez	Michael Thimgan	TBD (1)

**BP-021-O**

No deploying project members

**BP-028-O**

Langdon Quetin	Robin Ross	Dan Martin
Stephanie Oakes	TBD (5)	

**BP-032-O**

Ray Smith	Kirk Ireson	Sara Searson
William Swanson (Teacher Experiencing Antarctica)		

### BP-046-O

David Karl

Christopher Carrillo Matthew Church

Terrence Houlihan

TBD (2)

## Cruise and Field-Season Operations

### BP-013-O: Seabird Component

Researchers in this component of the Palmer LTER plan to continue their studies of seabird communities, emphasizing the sources and quantity of food consumed within the foraging range of the birds. The season will consist of two parts: a Palmer Station program and a research cruise aboard the R/V *Laurence M. Gould*. Three team members will arrive at Palmer Station in mid-October 2000 (cruise LMG00-9). Two additional members will arrive in mid-December 2000 (cruise LMG00-11) and two will depart mid-season, one in mid-December (cruise LMG00-11) and one in late January 2001 (cruise LMG01-1). The remaining team members will depart in early April 2001 (cruise LMG01-3).

During the Palmer Station program, several team members will travel daily via Zodiac inflatable boats from the station to local islands to monitor seabird (e.g., penguin, skua, kelp gull) colonies. The team members will observe banded penguins before they pick their nesting sites in an effort to determine if the birds pick the same nesting sites and the same mates from year to year. Colony boundaries and nest locations will be mapped using differential GPS. The field-team members will weigh, size, and band hatchlings late in the season.

Remote sensing via radio telemetry will be used to document the feeding behavior of Adelie penguins. The researchers will determine how often the penguins feed and how long foraging trips last. Team members will also attach satellite transmitters to penguins and giant petrels to track the large scale movements of individuals. These transmitters will be removed when the birds return to the colony. Team members will extract the stomach contents of birds in the field and analyze them in the Palmer Station laboratory in an effort to determine the sources, quantity, and quality of food consumed.

Two team members will join the annual LTER research cruise aboard the R/V *Laurence M. Gould* (cruise LMG01-1) on 4 January 2001 to conduct general observational studies of the foraging range of seabirds in the Bellingshausen Sea. Team members will travel from the research vessel in Zodiac boats to follow feeding penguins and observe their foraging behavior.

### BP-016-O: Phytoplankton Ecology Component

Researchers in this component of the Palmer LTER plan to continue their investigation of primary production rates, phytoplankton community structure and light absorption properties, and the relationship of these parameters to physical forcing. The season will consist of two parts: a Palmer Station program and a research cruise aboard the R/V *Laurence M. Gould*. Team members will arrive at Palmer Station in early October 2000 (cruise LMG00-8A).

While at Palmer Station, two team members will conduct water-column sampling two or three times weekly within the LTER near-shore sampling area

near the station. The team members will use a specially equipped Zodiac inflatable boat to collect water samples with Go-Flo bottles, collect plankton with nets, and conduct underwater irradiance measurements.

Samples will be returned to the laboratory at Palmer Station for analysis. Water samples will be placed in outdoor incubators with running seawater at ambient temperatures to expose the phytoplankton to varying light conditions. The researchers will conduct metabolic assays to determine photosynthetic rate changes as the ambient light is artificially varied. Team members will filter seawater to collect phytoplankton, then use photomicroscopy for identification and High Pressure Liquid Chromatography for pigment analysis. Seawater samples will be stored for later nutrient content analysis on the R/V *Laurence M. Gould*.

Between 4 January and 24 January 2001, team members will join the annual LTER cruise aboard the R/V *Laurence M. Gould* (cruise LMG01-1) to carry out collection and experimental protocols identical to those performed at Palmer Station. As the ship travels along five transect lines between Anvers and Adelaide Islands, the team members will collect water-column samples and incubate phytoplankton for primary production experiments and pigment analyses. A shipboard contractor technician will analyze both new seawater samples and previously collected Palmer Station samples for nutrients (nitrate, nitrite, phosphate, silicate, etc.). Frozen water-column samples from all sites will be shipped to the home institution for further studies.

#### **BP-021-O: Modeling Component**

For this component of the Palmer LTER, shipboard contractor personnel will sample the temperature and salinity of the water column at each LTER station, and at other sites that may be of interest. No project members will deploy this season. Researchers in this project will also continue compiling, modeling, and managing the data collected by all Palmer LTER projects.

During the annual Palmer LTER cruise, a support contractor technician will deploy the SBE911+ dual-sensor equipped conductivity, temperature, and depth (CTD) instrument. The instrument is incorporated into a "rosette" with niskin bottles for water sample collection. The technician will also deploy expendable bathythermographs and expendable CTDs along the cruise track while the vessel is underway.

The LTER cruise will travel along five transect lines, primarily in the shelf and slope waters west of the Antarctic Peninsula, between Anvers and Adelaide Islands. The lines are spaced 100 kilometers apart, and 9 to 13 stations lie along the transect lines, each 20 kilometers apart. The ship will spend a minimum of four hours at each station, where the technician will deploy the CTD rosette and collect data on wind speed, wind direction, air temperature, and humidity.

The data will be transmitted to the researchers at the home institution, who will compile water-column data, along with weather data and readings from the shipboard acoustic doppler current profiler (ADCP), for future modeling and interpretation.

### BP-028-O: Prey Component

Researchers in this component of the Palmer LTER plan to continue their investigation into the effects of interannual variations in pack ice extent and food resources on the macrozooplankton. The emphasis will be on Antarctic krill recruitment and production, as well as interactions among krill, its food sources, and its predators. The season will consist of two parts: a Palmer Station program and a research cruise aboard the R/V *Laurence M. Gould*. Team members will arrive at Palmer in mid-October 2000 (cruise LMG00-9).

At Palmer Station, the team members plan to use a specially equipped Zodiac inflatable boat that integrates trawling and bioacoustic survey functions. Team members will conduct two bioacoustic surveys each week and other surveys on an opportunistic basis. The purpose of these surveys is to reveal patterns in the timing of seasonal events, as well as patterns in the physiological condition, growth, and availability of Antarctic krill. Team members will conduct weekly krill net tows, and the captured animals will be used in growth experiments in the Palmer Station aquarium. Specimens will also be frozen for future analyses. In addition, cultures of Antarctic phytoplankton species will be grown in incubators in the laboratory, and in large volume cultures in the aquarium. A fluorometer will be used to analyze samples taken from these experiments.

In early spring, when the pack ice is still present around Palmer Station, SCUBA divers working from the ice near shore and from Zodiac inflatable boats plan to collect young krill from under the ice. They will also conduct ice surveys with an underwater digital video camera to document the density of krill and their feeding behavior.

Between 4 January and 24 January 2001, team members will join the annual LTER cruise aboard the R/V *Laurence M. Gould* (cruise LMG01-1) to study the macrozooplanktonic community, particularly the Antarctic krill, in the upper 300 meters of the water column. The interactions between krill, its food source (phytoplankton), and one of its major predators (Adelie penguins) will be emphasized.

While on board the R/V *Laurence M. Gould*, research team members will assess interannual variability in the Antarctic ecosystem, sampling on scales of (1) hundreds of kilometers on the shelf and outer shelf break, and (2) tens of kilometers within the foraging range of the Adelie penguins nesting near Palmer Station. The team members will travel along five transect lines, primarily in the shelf and slope waters west of the Antarctic Peninsula, between Anvers and Adelaide Islands. The lines are spaced 100 kilometers apart, and 9 to 13 stations lie along the transect lines, each 20 kilometers apart. The ship will spend a minimum of four hours at each station, where the team members will deploy a series of different sized nets to collect zooplankton, krill, and fish larvae to document the distribution and abundance of these populations. The cruise team members will conduct reproduction-rate and growth experiments on live krill in the vessel's aquarium room to document variation in the crustacean's biological condition and fecundity.

**Palmer LTER/ BP-013,016,021,028,032,046-O**  
**Palmer Station & R/V Laurence M. Gould**

Between some stations, a 120-kilohertz acoustic transducer will be towed behind the research vessel to document spatial patterns in krill distribution. In mid-to-late January 2001, team members from this project will work with members from project BP-013-O to search for high concentrations of seabirds. When high concentrations of birds are found, members of project BP-013-O will conduct a bird census while team members from this project conduct a high-density foraging grid in the vicinity of the birds to study krill distribution.

The R/V *Laurence M. Gould* will return to Palmer Station on 24 January 2001, where some team members will join the Palmer Station research team and some will remain on board the vessel for return to Punta Arenas, Chile. All remaining members of the field team will depart Palmer Station in early April 2001 (cruise LMG01-3). Frozen krill will be returned to the home institution for further studies.

**BP-032-O: Bio-optical Component**

Researchers in this component of the Palmer LTER plan to continue their investigation into the processes controlling the space/time variability of phytoplankton productivity and biomass. The season will consist of two parts: a Palmer Station program and a research cruise aboard the R/V *Laurence M. Gould*. Research team members will arrive at Palmer Station in mid-October 2000 (cruise LMG00- 9).

At Palmer Station, the team members plan to conduct studies within the LTER near-shore sampling area. They will use a specially outfitted Zodiac inflatable boat to conduct in-water bio-optical profiling and to measure hydrographic properties. Team members will also collect water samples and return them to the station's aquarium for filtration. In the laboratory, team members will use the fluorometer to analyze filtered phytoplankton samples for chlorophyll content. Water samples will also be analyzed for dissolved organic matter. The resulting data will be used to "ground truth" satellite measurements of ocean productivity.

The support contractor's science technician will assist this project by collecting satellite and Automatic Weather Station (AWS) data, including sea surface temperatures, ozone concentrations, ocean color, cloud cover and other weather parameters, and images of Antarctic Peninsula sea ice. Team members will use the data in predictions of sea-ice formation. Other support contractor personnel will assist the research team in maintaining three AWS systems for project OO-283-P, one each at Bonaparte Point, Hugo Island, and Racer Rock.

Between 4 January and 24 January 2001, team members will join the annual LTER cruise aboard the R/V *Laurence M. Gould* (cruise LMG01-1) to make sea-ice observations in accordance with international protocols. They will measure bio-optical properties using a free-fall profiling system, in an attempt to link shipboard surface observations to satellite observations of sea-ice coverage, phytoplankton productivity, and phytoplankton biomass within the LTER large-scale grid.

(Note: Teachers Experiencing Antarctica (TEA) participant William Swanson will be a member of the research team this season. He will assist in the Palmer-based research and report discoveries to his students.)

**BP-046-O: Microbiology and Carbon Flux Component**

Researchers in this component of the Palmer LTER plan to continue their study of the microbiology and carbon flux of the Southern Ocean. Team members will travel to Antarctica aboard the R/V *Laurence M. Gould* (annual LTER cruise, LMG01-1) to collect data during the LTER segment, from 4 January to 24 January 2001.

During the cruise, team members will recover two sediment traps, one moored near Palmer Station and the other near Victor Hugo Island. They will use an acoustic release mechanism to free the traps from their anchors on the ocean floor and a winch to pull them onto the ship's deck. Team members will recover the sediment samples, clean and service the traps, and reset the release mechanisms before they redeploy the sediment traps for another year.

The research vessel will travel along five transect lines, primarily in the shelf and slope waters west of the Antarctic Peninsula, between Anvers and Adelaide Islands. The lines are spaced 100 kilometers apart, and 9 to 13 stations lie along the transect lines, each 20 kilometers apart.

When the vessel is on station, the team members will perform conductivity, temperature, and depth (CTD) measurements at discrete depths in the water column, and they will take water samples using niskin bottles on the CTD rosette. When the vessel is underway, team members will sample surface seawater using the underway seawater flow-through system. They will analyze water samples in the ship's laboratories to determine solute and gas concentrations. Ice, sediment, and seawater samples will be returned to the home institution for further analyses.

**NSF/OPP Program Manager**  
Dr. Polly Penhale

**RPS Point-of-Contact**  
Mr. Robert Edwards (Palmer)  
Mr. Bob Kluckhohn (research vessel)



## Overview of the Antarctic Environmental Monitoring Program

Recognizing that scientific research and related logistic support can have effects on the Antarctic environment, the Antarctic Treaty Consultative Parties adopted recommendations on environmental monitoring in Antarctica to verify predicted effects and detect unforeseen effects. The Protocol on Environmental Protection to the Antarctic Treaty also requires monitoring of environmental impacts. The U.S. Antarctic Program (USAP) is developing an environmental monitoring program to measure the impacts from science and operations at its research stations in Antarctica. The primary purpose for developing a monitoring program is to provide the basis for sound environmental management decisions and improvements in management activities. Data obtained from the monitoring program will be used to document baseline conditions, verify operational impact, and monitor recovery from accidental impacts to the environment.

## **Spatial and Temporal Scales of Human Disturbance -- McMurdo Station, Antarctica**

**EO-318-0**

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### **Research Objectives**

Antarctica represents perhaps one of the most carefully tended and strictly monitored habitats on Earth. Aside from the obvious desire to protect the flora, fauna, and atmosphere of a relatively pristine environment, there is a value the extreme southern latitudes provide as a virtual baseline barometer of global pollution. The Antarctic Treaty's Protocol on Environmental Protection, supplemented by the policies and practices of the nations who work and do science there, have combined to focus scrutiny on any anthropogenic (exogenous) impacts that can be foreseen or detected.

This three year project will establish a system of observations that should enable the United States Antarctic Program to be more aware of any such impacts – on both marine and terrestrial habitats – in and around McMurdo Station, locating them precisely and tracking them over time.

Using a combination of aerial photography and point-data sampling grids at various spatial scales, we will measure a series of attributes indicative of change within these two habitats. Our objectives are to determine:

- the spatial and temporal scales of change and its origin;
- the efficiency of this observational system in documenting relevant changes in important habitat characteristics; and
- the usefulness of various approaches to reference or control locations.

We will use modern GIS techniques and geostatistical methods to organize these diverse data sets into a coherent, coordinated framework. The results should provide fundamental scientific information for developing a long-term strategy to document and minimize the impacts of future science and support operations on Antarctic resources and values.

## Field Research Plan

### Logistics

Dates in Antarctica: mid-November 2000 to late December 2000  
Research Locations: Cape Royds, Cape Bird, Bratina Island, Cape Evans, Taylor Valley, McMurdo Station, Winter Quarters Bay, Hut Point, sewage outfall, Cray Science and Engineering Center (CSEC)

### Team Members

Mahlon Kennicutt II	Stephen Sweet	Dianna Alsup
Gary Wolff	RJ Wilson	Guy Denoux
Andrew Klein	Wonchoel Lee	Sally Morehead
Paul Montagna		

### Field-Season Operations

The researchers plan to document the spatial and temporal scales relevant to monitoring change in selected Antarctic habitats: marine, terrestrial, and ice-covered. A network of observation stations will be established to provide thematic maps of habitat characteristics and anthropogenic stressors, such as contaminants. The results of this study are expected to assist the USAP in developing a quantitative environmental monitoring program.

This project will be composed of two teams. The first team will make day trips by helicopter to Cape Royds, Cape Bird, Bratina Island, Cape Evans, and locations in Taylor Valley to establish reference controls and to collect soil samples. Members from this team will also collect 20-gram soil samples on a grid of locations around McMurdo Station. The soil samples will be analyzed in the CSEC for grain size, total organic carbon, total inorganic carbon, moisture, salt content, snow/ice particulates, pH, and salinity.

The second team will collect surface ice cores at the ice runway, water samples, and marine benthic sediment samples. Support contractor personnel will use the Reed Drill to make approximately 18 holes through the sea ice in Winter Quarters Bay, around Hut Point, and near the McMurdo Station sewage outfall. Team members will collect water samples with niskin bottles and sediment samples with a grab sampler. The support contractor's Scientific Diving Coordinator will dive to collect additional marine benthic sediment samples.

In the CSEC, team members will analyze seawater samples for nutrients, biological oxygen demand, COD, major ions, coliform bacteria, dissolved oxygen, temperature, salinity, chlorophyll a; and they will make toxicological measurements. Benthic sediment samples will be analyzed for the biotic indicators of both infauna and epifauna. These analyses will include community structure, species diversity, abundance, biomass, and toxicological response. The sediment will also be tested for contaminants, such as hydrocarbons, organochlorines (PCB, PCT), and trace metals (lead, mercury, cadmium, iron, and aluminum).

The field team plans to use aerial photographs taken in past years by the U.S. Geological Survey (project GO-052-M) to accompany the ground sampling data. Data will be compiled into a GIS database. GPS surveys will be performed to tie collection sites to previous studies conducted at McMurdo Station.

Some soil samples will be returned to the home institution for further studies.

**NSF/OPP Program Manager**  
Ms. Joyce Jatko

**RPS Point-of-Contact**  
Ms. Robbie Score



## Overview of the Antarctic Geology and Geophysics Program

Antarctica represents about 9 percent of Earth's continental crust and has been in a near-polar position for more than 100 million years. It is covered by a continental ice sheet with an average thickness of three kilometers. There is unequivocal evidence that for a long period after the continent arrived at its high-latitude position, extensive continental ice sheets did not exist there. The ice sheets, through their interaction with and effect on oceanic and atmospheric circulation, play a key role in modulating global climate.

Some important program goals include the following:

- determining the tectonic evolution of Antarctica and its relationship to the evolution of the continents from Precambrian time to the present;
- determining Antarctica's crustal structure;
- determining the effect of the dispersal of antarctic continental fragments on the paleocirculation of the world oceans, on the evolution of life, and on global paleoclimates and present climate;
- reconstructing a more detailed history of the ice sheets, identifying geological controls to ice sheet behavior, and defining geological responses to the ice sheets on regional and global scales; and
- determining the evolution of sedimentary basins within the continent and along continental margins.

All of these problems involve the need for an improved understanding of where, when, and how Antarctica and its surrounding ocean basins were accommodated in the interplate movements inferred from studies of global plate kinematics. In short, the program encourages investigation of the relationships between the geological evolution of the Antarctic plate and paleocirculation, paleoclimate, and the evolution of high-latitude biota.

In geophysics, the continent and its environs have a central role in the geodynamic processes that have shaped the present global environment. The tectonic role of the Antarctic continent in the breakup of Gondwanaland, the close interaction of the Antarctic crust and ice sheet with their attendant effects on the planet's fluid systems, and Antarctica's present-day seismically quiescent role defines the important thrusts of geophysical research in the high southern latitudes.

## **GPS Measurement of Isostatic Rebound and Tectonic Deformation in Marie Byrd Land, West Antarctica**

**GF-121-O**

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### **Research Objectives**

The Ross embayment and western Marie Byrd Land are part of the west Antarctic rift system. Most scientists agree that this region is undergoing active deformation, but the rates and causes of deformation remain essentially unknown. Tectonic extension may be occurring in the Ross embayment as West and East Antarctica continue to separate. Crustal uplift could be occurring in western Marie Byrd Land due to isostatic rebound following the last glacial age.

If tectonic extension is occurring in the embayment, it could, depending on its magnitude, greatly influence global plate circuit calculations. It could also constrain our understanding of the history of extension in the embayment and the consequent uplift history of the Transantarctic Mountains. Postglacial rebound in western Marie Byrd Land would depend on when and how the ice sheet was configured during the Last Glacial Maximum. The big question is whether the ice sheet collapsed in mid-Holocene time.

This study will install three continuous and autonomous global positioning system (GPS) stations on outcrops in western Marie Byrd Land, on baselines of around 100 kilometers. These stations will gather data over a 4-year period and operate in concert with GPS stations being installed in the Transantarctic Mountains in a separate project; the result will be a baseline array all across the Ross embayment. The array will also detect strain gradients in western Marie Byrd Land. This system should determine crustal strain rates to an accuracy of 1 millimeter per year for horizontal, and 2 millimeters per year for vertical. The strain data from western Marie Byrd Land and the Transantarctic Mountains should enable us to construct both tectonic extension and glacial rebound models.

This joint project between Bruce Luyendyk of the University of California at Santa Barbara and a team at the Jet Propulsion Laboratory at the California Institute of Technology – Andrea Donnellan, Carol Raymond, and Erik Ivins – brings together experts in western Marie Byrd Land geology and tectonics, tectonic geodesy, and lithospheric deformation.

## **Field Research Plan**

### **Logistics**

Dates in Antarctica: late October 2000 to late November 2000 AND  
early January 2001 to late January 2001

Research Locations: Rockefeller, Phillips, and Clark Mountains

### **Team Members**

Bruce Luyendyk                      Andrea Donnellan  
Shannon Jackson                    Tom Rebold

### **Field-Season Operations**

The team members will work in Antarctica at two separate times this field season: during November 2000 and during January 2001. They will visit three autonomous Global Positioning System (GPS) stations installed in Marie Byrd Land, West Antarctica. These GPS stations are used to measure glacio-isostatic rebound and tectonic deformation.

In early November 2000, the team members will travel via LC-130 aircraft from McMurdo Station to the Siple Dome field camp, which will be their staging point for their field work. A couple of days later, they will travel via Twin Otter aircraft—with tent camping gear and cargo—to the Rockefeller Mountains to assess the GPS station located in that region, retrieve data from the station, and make any necessary repairs to the station. Approximately two days later, the team members will travel via Twin Otter aircraft to the Phillips Mountains to assess the GPS station located in that region, retrieve data, and make any necessary repairs. Then two days later, the team members will travel via Twin Otter aircraft to the Clark Mountains to assess the GPS station located in that region, retrieve data, and make any necessary repairs. The team members will travel back to the Siple Dome field camp two days later via Twin Otter aircraft. Then, two to four days later, they will return to McMurdo Station via LC-130 aircraft and then return to the United States.

The team members will return to Antarctica in early January 2001. They will repeat the same logistics (i.e., travel sites and aircraft transport) and work (i.e., assess GPS stations, retrieve data, and make necessary repairs) as was done in November 2000. The only difference is that they will make more extensive repairs on the GPS stations as needed, based on the assessments made in November. The team members will leave Antarctica in late January 2001.

**NSF/OPP Program Manager**  
Dr. Scott Borg

**RPS Point-of-Contact**  
Ms. Alana Jones

## **2000-2001 Geodesy, Remote Sensing, and Digital Mapping Program**

### **GO-052-M**

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Permanent GPS Observatory Sites: [www.scar-ggi.org.au/geodesy/perm\\_ob/gps/gps.htm](http://www.scar-ggi.org.au/geodesy/perm_ob/gps/gps.htm)

Permanent Tide Gauge Observatory: [www.scar-ggi.org.au/geodesy/perm\\_ob/tide/tide.htm](http://www.scar-ggi.org.au/geodesy/perm_ob/tide/tide.htm)

U.S. Antarctic Resource Center: [usarc.usgs.gov/](http://usarc.usgs.gov/)

Antarctic Atlas: [usarc.usgs.gov/antarctic\\_atlas/start.html](http://usarc.usgs.gov/antarctic_atlas/start.html)

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### **Research Objectives**

Geodetic surveying, aerial photography, remote sensing (principally using several varieties of satellite imagery), and mapping are all activities necessary for the successful operation of a multifaceted scientific and exploration effort in Antarctica. The U.S. Geological Survey provides these support activities to the U.S. Antarctic Program.

Year-round data acquisition, cataloging, and data dissemination activities for geospatial information will continue in the U.S. Antarctic Resource Center. Field surveys will be conducted in support of specific research projects, and as part of a continuing program to collect the ground-control data necessary to transform existing geodetic data to an earth-centered system suitable for future satellite mapping programs.

LandSat data will be collected as part of satellite image mapping activities. This will permit continued publication of 1:50,000 scale topographic maps of the McMurdo Dry Valleys region. Such topographic maps provide a uniform base map on which to portray spatially accurate, scientific information (from geology, glaciology, biology and other studies). These maps, as well as satellite image maps, are used by scientists to plan and execute future research work. Spatially-referenced, digital, cartographic data will be produced in tandem with the published maps.

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### **Field Research Plan**

#### **Logistics**

Dates in Antarctica:

early November 2000 to mid-January 2001

Research Location(s):

Transantarctic Mountains, South Victoria Land; Ross Island; Dry Valleys; Cape Roberts; Franklin Island; Mount Discovery; Mount Morning; Deep Freeze Mountains; Southern Cross Range; Eisenhower Mountains; Prince Albert Mountains (north & south of Drygalski Ice Tongue); Terra Nova Bay; McMurdo Station

## Team Members

Jerry Mullins	Larry Hothem	Bradish Johnson
John Ritchie	Mike Willis	Tony Bevin
TBD		

## Field-Season Operations

The field team will consist of two groups: a Geodetic Team and a Remote Sensing Team. The Remote Sensing Team will continue the work of accurately establishing geographic positions in Antarctica, while the Geodetic Team will deploy instruments for the continuous, remote acquisition of geographic and geophysical data. Though the teams may act independently, team members from both groups will interact to assist each other in completing the planned projects.

The 2000-2001 program includes the following:

*Cooperative GPS observations for the Transantarctic Mountain Deformation Monitoring Network (TAMDEF):* During mid-November to late December 2000, USGS Geodetic Team members, in coordination with an Italian Geodetic Team, plan to deploy GPS receivers at several TAMDEF stations. These receivers will permit team members to make observations simultaneous with those of the Italian GPS campaign (in the North Victoria Lands of the Transantarctic Mountains [VLNDEF] Monitoring Network). Geodetic team members will also make repeat "footprint" measurements while they are on site at selected TAMDEF stations.

The team plans to work at as many of the following sites as possible: Brimstone Peak, Esser Hill, Mason Spur, Minna Bluff, Cape Ross, Mount Fleming, Mount Crean, Ant Hill, Warren Range, and Fishtail Point. These sites are within helicopter day trip distances of McMurdo Station.

*Image mapping control:* Concurrent to the TAMDEF GPS receiver installation, Remote Sensing Team members plan to travel via helicopter from Terra Nova Bay Station to establish several remote, photo-identifiable positions for georeferencing satellite imagery. The researchers will use GPS on the ground to establish positions, then they will fly over the positions to take special, airborne digital images of the sites. Sites to be visited include locations in the Deep Freeze Mountains, the Southern Cross Range, the Eisenhower Mountains, and the Prince Albert Mountains (north and south of the Drygalski Ice Tongue).

*Removal of drum beacons:* Between late November 2000 and early January 2001, team members will make day trips via helicopter to 3-5 sites where previously deployed drum beacons are still in the field. These rock-filled, 55-gallon drums were once used for georeferencing, but they are now superfluous. Depending on available helicopter hours, as many of the drums as possible will be removed and transported by helicopter to McMurdo Station.

*Cape Roberts permanent GPS/GLONASS and tide gauge observatory:* Between mid-November 2000 and early December 2000, Remote Sensing Team members will travel via helicopter to Cape Roberts to deploy a continuously operating GPS observatory system. This GPS/GLONASS system will be established near the Cape Roberts permanent tide gauge station, and it will be incorporated into the continent-wide network of permanent and co-located geodetic observatories. In addition, this GPS/GLONASS system will serve as a primary reference station in the long-term TAMDEF program for monitoring deformation in the Transantarctic Mountains. Researchers will return by helicopter to the site several times, in December 2000 and January 2001, to monitor the station and retrieve data.

While they are on site at Cape Roberts, the team members will assist a New Zealand Team perform a calibration and upgrade to the Cape Roberts permanent tide gauge system.

*International GLONASS Service Pilot Project (IGLOS-PP):* The team members plan to perform general maintenance and upgrades to the IGLOS-PP GPS/GLONASS, dual frequency, receiver/antenna system in the Crary Science and Engineering Center (CSEC) (Station CRAR). The system is used to provide high accuracy, orbital coordinates for the GLONASS satellites, referenced to the International Terrestrial Reference Frame. Station CRAR is monitored by the support contractor's science technician.

**NSF/OPP Program Manager**  
Dr. Scott Borg

**RPS Point-of-Contact**  
Ms. Karen Joyce

## **Differential GPS Cores Base Station GO-052-P**

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Permanent GPS Observatory Sites: [www.scar-ggi.org.au/geodesy/perm\\_ob/gps/gps.htm](http://www.scar-ggi.org.au/geodesy/perm_ob/gps/gps.htm)

Permanent Tide Gauge Observatory: [www.scar-ggi.org.au/geodesy/perm\\_ob/tide/tide.htm](http://www.scar-ggi.org.au/geodesy/perm_ob/tide/tide.htm)

U.S. Antarctic Resource Center: [usarc.usgs.gov/](http://usarc.usgs.gov/)

Antarctic Atlas: [usarc.usgs.gov/antarctic\\_atlas/start.html](http://usarc.usgs.gov/antarctic_atlas/start.html)

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### **Research Objectives**

The U.S. Geological Survey work pertains to management of GPS continuously operating reference stations (CORS). For more information, please refer to the research objectives for project GO-052-M.

## **Field Research Plan**

### **Logistics**

Research Location(s): Palmer Station and local islands

### **Team Members**

No deploying project personnel

### **Field-Season Operations**

The support contractor's science technician will maintain the continuously operating GPS reference station at Palmer Station. The technician may also assist researchers from various other projects with establishing GPS coordinates for study sites in the local Palmer area as needed throughout the season.

## **Maintenance of South Pole Geodetic Position GO-052-S**

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TAMDEF: [www-bprc.mps.ohio-state.edu/GDG/tamdef.htm](http://www-bprc.mps.ohio-state.edu/GDG/tamdef.htm)

Permanent GPS Observatory Sites: [www.scar-ggi.org.au/geodesy/perm\\_ob/gps/gps.htm](http://www.scar-ggi.org.au/geodesy/perm_ob/gps/gps.htm)

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U.S. Antarctic Resource Center: [usarc.usgs.gov/](http://usarc.usgs.gov/)

Antarctic Atlas: [usarc.usgs.gov/antarctic\\_atlas/start.html](http://usarc.usgs.gov/antarctic_atlas/start.html)

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### **Research Objectives**

The U.S. Geological Survey work pertains to management of GPS continuously operating reference stations (CORS). For more information, please refer to the research objectives for project GO-052-M.

## **Field Research Plan**

### **Logistics**

Dates in Antarctica: mid-December 2000 for approximately 3 days  
Research Location: Geographic South Pole area

### **Team Members**

Larry Hothem Brad Johnson

### **Field-Season Operations**

The project team members plan to conduct a special GPS survey to establish the new location of the geographic South Pole. (*Note:* Every year, the ice at the South Pole migrates up to 30 feet across the continent, requiring a new GPS survey to determine the exact location of the geographic South Pole.) The South Pole marker will be moved to the new location on the first day of the year 2001.

The project team members will return to McMurdo Station via LC-130 aircraft in late December 2000 to join fellow U.S. Geological Survey team members as they complete several mapping and GPS projects around the continent.

# **Stability of Land Surfaces in the Dry Valleys, Antarctica: Insights Based on the Dynamics of Sub-Surface Ice and Sand-Wedge Polygons**

**GO-053-O**

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research.html](http://depts.washington.edu/qrc/research/research.html) (in development)

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## **Research Objectives**

We are studying features of the landscape and soils of the Dry Valley region of Antarctica to provide a more complete understanding of past climatic and environmental conditions. The dynamic nature of climate has received growing public attention because of the recent occurrence of seemingly extreme weather events, and because of growing concerns about warming. In this context, understanding the inherent variability of Earth's climate and how humans can affect Earth's environment is becoming increasingly more important.

One important means of improving our understanding of the Earth's climate system is to treat the Earth as a natural laboratory and examine its past behavior. One of the most extreme changes in the Earth's climate system during the last few million years has been the transition from a warm period in the Pliocene to an ice-age world. Scientists believe that during this interval in Antarctica, relatively mild conditions gave way rapidly to intense glacial conditions that catalyzed the growth of the largest ice sheet on Earth. This inference is based on geologic indicators of past climate from which some scientists suggest that East Antarctica was relatively warm and largely free of glaciers about 3 to 4 million years ago (during parts of the Pliocene). The mild conditions ended abruptly with rapid ice-sheet growth and development of the very cold, dry climate that now characterizes this region. A contrasting view, based on substantial geologic evidence, suggests that East Antarctica has been cold and the ice sheet stable for at least 8 million years, and perhaps considerably longer. These views lead to drastically different interpretations of the stability of Earth's climate.

We hope our research will contribute to resolving this important dilemma by introducing independent new evidence and insights derived from studies of the stability of ground ice and land surfaces in the McMurdo Dry Valleys of Antarctica. We will study modern-day processes that have important implications for understanding the occurrence of buried ice, found recently in Beacon Valley. This ice may be the oldest ice on Earth and, if so, it will provide strong evidence of long-term stability of the East Antarctic Ice Sheet and may provide a rare glimpse at atmospheric conditions millions of years ago. Specific processes to be investigated include:

- exchange at the ground surface that affects ground temperature;
- water-vapor transport and other processes leading to the formation or loss of ice in the soil; and
- frost cracking due to contraction during rapid cooling of the frozen ground in the winter and its resulting disruptions of the soil.

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## **Field Research Plan**

### **Logistics**

Dates in Antarctica: early December 2000 to late January 2001  
Research Locations: Beacon Valley, Victoria Valley, Cray Science and Engineering Center (CSEC)

### **Team Members**

Ronald Sletten	Margaret Smith	Howard Conway
Tony Gades	TBD	

### **Field-Season Operations**

The researchers plan to study the polygon (contraction-crack) dynamics, water, and energy balances of soils and the micrometeorology at selected sites in the McMurdo Dry Valleys. In mid-December 2000, the team members will travel via helicopter from McMurdo Station to their primary study site in Beacon Valley, where they will set up a field tent camp.

The team members will remeasure Global Positioning System (GPS) markers that were established in 1998 to track movements on the floor of Beacon Valley. They will also use Ground Penetrating Radar (GPR) to profile the ground ice, soil, and bedrock. Soil pits will be made; and soil, rock, and ground ice samples will be collected for subsequent analysis.

In early January 2001, the team members will travel via helicopter to Victoria Valley. At this site, they will collect data from automated instruments and maintain the instrumentation and collect soil and rock samples.

In mid-January 2001, the team members will travel from Victoria Valley via helicopter to McMurdo Station. They will work in a CSEC laboratory to process samples for return to the home institution.

**NSF/OPP Program Manager**  
Dr. Scott Borg

**RPS Point-of-Contact**  
Ms. Rhonda Rodriguez

## **Response of the East Antarctic Ice Sheet to Middle Miocene Global Change**

**GO-054-O**

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### **Research Objectives**

As evidence of global climate change continues to accumulate, scientists concentrate on models that might indicate the impacts of such change. For example, how will the East Antarctic Ice Sheet respond to future global-climate change? Insight comes from examining the response of the East Antarctic Ice Sheet to past global change. One of the largest known global-climate shifts occurred in middle Miocene time (between about 15.6 and 12.5 million years ago). The magnitude of this shift is recorded in marine microfossils that show dramatic enrichment of oxygen-18 in Miocene oceans. This dramatic and irreversible shift set the stage for modern oceanic and atmospheric circulation, and for Quaternary bipolar glaciation. What caused this irreversible climate shift? Could growth of the Antarctic ice sheet have initiated the change? If so, how might future fluctuations in the volume of ice in East Antarctica influence atmospheric and oceanic circulation? The recent discovery of Miocene-age volcanic ashes within terrestrial glacial deposits in southern Victoria Land provide unambiguous evidence for Miocene-age ice sheet fluctuations and coeval changes in Antarctic climate. For the first time we can now determine the role of the East Antarctic Ice Sheet in the middle Miocene climate shift.

Specific questions include:

- What contributing factors in Antarctica led to the abrupt global cooling about 14 million years ago?
- Did major expansion of ice in East Antarctica initiate middle Miocene global-climate change, or rather did ice expansion occur as a response to this change?
- Conversely, does the isotopic shift during middle Miocene time solely reflect a change in ocean temperature and/or circulation without a concomitant change in the volume of ice in East Antarctica?
- And a related question -When did cold, hyper-arid, polar-desert conditions (signifying the development of the modern polar East Antarctic Ice Sheet) first evolve in Antarctica?

We expect to obtain precise chronological control for ice-sheet fluctuations on the basis on 50 laser-fusion isotopic analyses of in-situ volcanic ashes and 20 cosmogenic exposure-age analyses of ancient deposits. We also expect to develop a coeval record of the Miocene paleoclimate based on textural changes in alpine drifts, the areal distribution of ice-marginal lakes, the abundance of dated, patterned ground and ventifact pavements, and the geochemistry of buried soils and volcanic-ash deposits.

## Field Research Plan

### Logistics

Dates in Antarctica: early October 2000 to early February 2001  
Research Locations: Pivot Peak; Convoy, Western Asgard, and Western Olympus Ranges; Beacon Valley

### Team Members

David Marchant Adam Lewis Jane Willenbring  
William Phillips Brett Vandenneuvel

### Field-Season Operations

The team members plan to work in the Western Asgard Range, the Western Olympus Range, the Pivot Peak region, and the Convoy Range of the Transantarctic Mountains to date the land surface and develop an integrated model of landscape evolution that is tied to paleoclimate change and glacial geology. Direct examination of recently discovered Miocene-age volcanic ashes interbedded with surficial sediments in southern Victoria Land makes it possible to generate precise climatological and glaciological reconstructions of the Antarctic during that period in Earth's history.

In mid-October 2000, the team members plan to travel via helicopter from McMurdo Station to the Western Olympus Range to establish the first of a series of remote field camps that they will occupy as they work. Field-team members will receive the close support of helicopters as they map the alpine boulder-belt moraines in the Western Olympus Range. The researchers will collect exposure-age rock from each moraine crest, and they will excavate volcanic-ash horizons located at depth in the soil. The excavations will be filled in and the desert pavement replaced, a technique that allows for rapid surface recovery.

With the help of UNAVCO and McMurdo surveyors, two team members will acquire high-precision elevation data for up to 50 sites within the Western Dry Valleys region. These data will be used to produce high-resolution, 1-meter-contour maps of selected study areas.

In early November 2000, the team will travel via helicopter to set up tent camps at sites on Pivot Peak and on the Quartermain Mountains, where they will map alpine boulder-belt moraines in the Kennar and Turnabout Valleys, as well as near Pivot Peak. They will also collect ash, soil, and exposure-age samples from moraine crests and exposed striated dolerite bedrock.

In early December 2000, the team members will move by helicopter to a study site in the Asgard Mountains, where they will set up a tent camp and conduct more mapping and sample collections. Between early and late January 2001, the researchers will take day trips by helicopter from their Asgard Mountains field camp to other study sites in the Western Dry Valleys region, including Beacon Valley. In late January 2001, the researchers will return by helicopter to McMurdo Station.

Rock samples will be returned to the home institution for laser fusion isotopic analyses of *in-situ* volcanic ashes and cosmogenic exposure-age analyses of ancient deposits.

**NSF/OPP Program Manager**  
Dr. Scott Borg

**RPS Point-of-Contact**  
Ms. Rhonda Rodriguez

## **ANSMET: The Antarctic Search for Meteorites / NASA Robotics in Allen Hills**

**GO-058-O**

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### **Research Objectives**

Since 1976, the Antarctic Search for Meteorites program (ANSMET) has recovered more than 10,000 meteorite specimens from locations along the Transantarctic Mountains. Antarctica is the world's premier meteorite hunting ground for two reasons:

- Although meteorites fall all over the globe at random, the likelihood of finding a meteorite is enhanced if the background material is plain and the accumulation rate of terrestrial sediment is low; this makes the East Antarctic Ice Sheet the perfect medium.
- Along the margins of the sheet, ice flow is sometimes blocked by mountains, nunataks, and other obstructions; this exposes slow-moving or stagnant ice to fierce katabatic winds that can erode the ice and expose what is known as a "lag deposit" of meteorites (a representative portion of those that were sprinkled throughout the volume of ice lost to the wind). When such a process continues for millenia, the concentration of meteorites unveiled can be spectacular.

It is important to continue recovering Antarctic meteorites because they are the only currently available source of new, non-microscopic extraterrestrial material. As such, they provide essential "ground truth" (existence proof) about the composition of asteroids, planets, and other bodies of our solar system. ANSMET recovers samples from the asteroids, the Moon, and Mars at a tiny fraction of the cost of a sample return mission.

During the 2000-2001 field season, ANSMET will visit the Meteorite Hills region at the headwaters of the Darwin Glacier. This site has been visited twice previously for reconnaissance purposes, yielding about 60 meteorites during a few days searching. A systematic search of this important icefield will be the primary focus of the upcoming season. Other nearby targets will be explored during extended, helicopter-supported reconnaissance missions. For example, we anticipate visiting Bates Nunataks, Butcher Ridge, and other nearby icefields.

## Field Research Plan

### Logistics

Dates in Antarctica: late November 2000 to late January 2001  
Research Locations: Meteorite Hills, Bates Nunatak, Butcher Ridge

### Team Members

Ralph Harvey	John Schutt	Sara Russell
Larry Nittler	Jeff Byrnes	Rick Linnehan
Melissa Strait	Bill Hasskamp	

### Field-Season Operations

The project team members plan to travel to several icefields in the Meteorite Hills area, Bates Nunatak area, and Butcher Ridge area to fully characterize the potential of these icefields in light of possible future work and to make additional meteorite recoveries, if possible.

In early December 2000, the project team members—along with their remote field equipment—will travel via Twin Otter aircraft from McMurdo Station to Meteorite Hills. They will set up a tent camp at Meteorite Hills and travel by snowmobiles to survey ice fields in the vicinity and collect meteorites from the surface. GPS receivers will be used to pinpoint and record the location of meteorites.

In mid-December 2000, several team members will receive helicopter close support for reconnaissance efforts in the general Meteorite Hills area. Several days later, two members of the field team will travel by helicopter to Butcher Ridge and two other members will travel by helicopter to Bates Nunatak. These team members will set up tent camps at these areas and conduct meteorite surveys using snowmobiles.

About a week later, these team members will return by helicopter to the Meteorite Hills camp. Then, another week later, two field-team members will return to McMurdo Station via Twin Otter aircraft and then leave the continent.

The rest of the field team will remain at the Meteorite Hills camp to continue their field studies until mid-January 2001, when they will return to McMurdo Station via Twin Otter aircraft. Collected samples will be returned to the home institution for analysis.

## **Tracking the West Antarctic Rift Flank**

**GO-059-O**

**Dr. Paul Fitzgerald, Principal Investigator**

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### **Research Objectives**

Scientists believe that the uplifted Cenozoic rift shoulder of the West Antarctic rift system extends along the Transantarctic Mountains and the northwestern flank of the Ellsworth–Whitmore Mountains crustal block. Available fission track data from the Ellsworth–Whitmore Mountains block indicate that, although most of the erosion exposing the rock strata there (denudation) occurred in the Late Jurassic–Early Cretaceous, a significant component of denudation is permissible in the Cenozoic. In contrast, most of the rock uplift and denudation in the Transantarctic Mountains occurred in the Cenozoic. The timing of uplift and denudation at key localities and the patterns of uplift and denudation along the West Antarctic rift shoulder revealed from the thermochronologic studies we will conduct will be used to address this hypothesis.

Our objectives are to determine the extent and timing of denudation of the West Antarctic rift flank, to further delineate patterns of uplift and denudation along the length of the Transantarctic Mountains, to document the thermal history of basement rocks from different crustal blocks, and to compare and contrast the thermal histories of East Antarctica (Transantarctic Mountains) and West Antarctica (Ellsworth–Whitmore Mountains crustal block). We will address these objectives using thermochronologic techniques, namely, apatite fission track thermochronology and argon-40/argon-39 ( $^{40}\text{Ar}/^{39}\text{Ar}$ ) thermochronology. We are alternating between a season of field work and a year of sample preparation, data collection and analysis, and ongoing interpretation and presentation of results. All laboratory work will be conducted at the Center for Thermochronology and Noble Gas Studies at the University of Arizona. The application of low-temperature thermochronologic methods has made fundamental contributions to our understanding of the uplift and denudation history of the Transantarctic Mountains and the Ellsworth Mountains. It is expected that additional data that integrates both fission track and  $^{40}\text{Ar}/^{39}\text{Ar}$  thermochronology will lead to a better understanding of the geological evolution of the region, as well as the relationship between the West Antarctic rift system, its uplifted rift shoulder, and East and West Antarctica.

## **Field Research Plan**

### **Logistics**

Dates in Antarctica: mid-December 2000 to late January 2001  
Research Locations: Reedy Glacier area

### **Team Members**

Paul Fitzgerald Suzanne Baldwin  
Graeme Dingle Jarg Pettinga

### **Field-Season Operations**

The project team members will conduct geologic research in the Reedy Glacier area, in an effort to determine if the Cenozoic expression of the West Antarctic rift flank (i.e., the Transantarctic Mountains) extends across Antarctica or curves into West Antarctica along the northwest flank of the Ellsworth-Whitmore Mountains crustal block.

In late December 2000/early January 2001, the Air National Guard and the principal investigator will travel via LC-130 aircraft to conduct a landing-site reconnaissance and to perform a fuel-cache airdrop for future Twin Otter aircraft work. Several days later, the team members will travel from McMurdo Station via LC-130 aircraft to the selected Reedy Glacier camp location to put in a tent camp, along with snowmobiles, sleds, and equipment. From this field camp, the team members will travel via snowmobiles to access rock outcrops in the area and gather rock samples. About a week later, the team members will receive Twin Otter aircraft close support for several days to access various rock outcrops and take samples in areas further from the tent camp.

In mid-January 2001, the team members will move their camp via Twin Otter aircraft to the Olenyok Glacier area. They will set up their tent camp at this site and travel via snowmobiles to nearby areas to conduct their field work. Five days later, the team members will again move their camp via Twin Otter aircraft to the Gardiner Glacier area. They will set up their tent camp at this site and travel to nearby areas via snowmobiles to conduct their field work.

A week later, the team members will travel back to the Reedy Glacier camp area for two days and then return to McMurdo Station via LC-130 aircraft. Rock samples will be returned to the home institution.

## **Global Climate Change and the Evolutionary Ecology of Antarctic Mollusks in the Late Eocene**

**GO-065-O**

**Dr. Richard Aronson, Principal Investigator**

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### **Research Objectives**

Global climate change late in the Eocene epoch had an important influence in Antarctica. This was the beginning of the transition from a cool-temperate climate in Antarctica to the polar climate that exists there today. The cooling trend strongly influenced the structure of shallow-water, Antarctic marine communities, and these effects are still evident in the peculiar ecological relationships among species living in modern Antarctic communities. Cooling late in the Eocene reduced the abundance of fish and crabs, which in turn reduced skeleton-crushing predation on invertebrates. Reduced predation allowed dense populations of ophiuroids (brittlestars) and crinoids (sea lilies) to appear in shallow-water settings at the end of the Eocene. These low-predation communities appear as dense fossil echinoderm assemblages in the upper portion of the late Eocene La Meseta Formation on Seymour Island, off the Antarctic Peninsula. Today, though predators generally have eliminated them from shallow-water habitats at temperate and tropical latitudes, dense ophiuroid and crinoid populations are common in similar habitats in Antarctica. Their persistence in Antarctica is an important ecological legacy of climatic cooling in the Eocene. Although the influence of declining predation on Antarctic ophiuroids and crinoids is now well documented, the effects of cooling on the more abundant mollusks have not been investigated. Our investigation will examine the evolutionary ecology of gastropods (snails) and bivalves (clams) in the late Eocene.

We will test a series of hypotheses, based on the predicted responses of mollusks to declining temperature and changing levels of predation, in the La Meseta Formation. The shapes of gastropod shells, the activities of gastropods that prey on other mollusks by drilling holes in their shells, and the effects of predation on the thickness of mollusk shells should have changed significantly through late Eocene time. First, defensive features of gastropod shells, such as spines and ribbing, should decline as both temperature and the activity of skeleton-crushing predators declined. Second, drilling of bivalve prey by predatory gastropods should increase with time since the drillers should themselves have been subject to

lower predation pressure as temperature declined. Drilled shells, therefore, should become more common through time. Third, patterns in the thickness of shells through time will make it possible to separate the direct, physiological effects of declining temperature (shells should be thinner because they are more difficult to produce at cooler temperatures) from the indirect effects of temperature on evolving biological interactions (increased drilling predation should result in thicker shells).

Seymour Island contains the only fossil outcrops readily accessible in Antarctica from this crucial period in Earth's history; consequently, the La Meseta Formation on Seymour Island provides a unique opportunity to learn how climate change affected Antarctic marine communities. In practical terms, global climate change will probably increase upwelling over the next few decades or centuries in some temperate coastal regions. Recent ecological evidence suggests that the resultant lowering of sea temperatures could lower predation in those areas. Understanding the response of the La Meseta faunas to global cooling in the late Eocene will provide direct insight into the rapidly changing structure of modern benthic communities.

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## Field Research Plan

### Logistics

Dates in Antarctica: mid-December 2000 to late December 2000  
Research Location: Seymour Island

### Team Members

Richard Aronson Daniel Blake  
Alexander Glass Linda Ivany

### Field-Season Operations

The researchers plan to study the fossil mollusks on Seymour Island to document the effects of early Cenozoic Period cooling on the biota. The results of the research are expected to bear on potential future climatic changes and extinctions.

In mid-December 2000, the team members will travel on board the R/V *Laurence M. Gould* (cruise LMG00-11) to Seymour Island, where they will make several day trips to the island via Zodiac inflatable boat. Team members will travel by foot on the northern portion of the island to collect fossil samples. The samples will be used for morphological and geochemical studies designed to elucidate the effect of Cenozoic climate change on mollusk abundance. Team members will also identify a camp location and potential study sites for next year's more extensive research activities.

Samples will be returned to the home institution for analysis.

**NSF/OPP Program Manager**  
Dr. Scott Borg

**RPS Point-of-Contact**  
Mr. John Evans

# **Formation of the Dry Valleys, Antarctica: Linking Thermochronometric (U-Th/He) and Cosmogenic Constraints on Landscape Development**

**GO-066-O**

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## **Research Objectives**

The time when mountains form as topographic features (known as orogenesis) is a crucial factor for understanding their role as gravitational driving forces for crustal deformation, as well as for assessing their influence or dependence on climate variations. Yet, this aspect of orogenesis remains poorly documented because later erosion may modify the geomorphologic expressions or sedimentation record associated with increasing surface elevations. Similarly, geochemical tools used for tracking erosion and landform development (e.g., surface-exposure dating) are seldom useful for this purpose because they usually provide information on only the most recent history (less than 1 million years). As a result, a large gap remains in our understanding of the temporal and physiographic/ tectonic evolution of mountain belts. In the absence of direct constraints on the geomorphology of evolving mountain ranges, episodes of rapid cooling deduced from techniques like apatite fission track thermochronometry are often attributed to the topographic rise of mountain belts. This practice assumes that exhumation (movement of a rock upward with respect to the earth's surface) and bedrock uplift (movement of the rock upward with respect to the geoid), both inferred from cooling data, represent equivalent increases in elevation at Earth's surface (and relief), even though workers have shown that such a correlation does not always hold.

One way to address the problem of long-term landscape evolution is to combine low-temperature thermochronometry with surface-exposure dating. The McMurdo Dry Valleys region of the Transantarctic Mountains is an ideal place for such an exercise because many of the modern land surfaces in the region may be as old as 15 million years, and they have clearly experienced very low erosion rates since the mid-Miocene. Apatite fission tracks indicate that rocks in the McMurdo Dry Valleys cooled through approximately 105° C as recently as about 45 million years, leaving a gap of about 30 million years in our knowledge of the



## Late Cretaceous and Cenozoic Reconstructions of the Southwest Pacific

GO-071-O

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### Research Objectives

Crustal plate motion is never as predictable as earth scientists would like – witness the devastation wrought by unpredicted earthquakes. In Antarctica, there is controversy regarding a possible missing plate boundary, as well as tectonic uncertainties in the motion between East and West Antarctica. In particular, there are questions about the relative drift between major hotspot groups. The plates of the Southwest Pacific region are rotational, so earthquakes are relatively rare. Still, the models that describe the motion of the Pacific, Antarctic, and Australian plates – and the continental fragments of New Zealand, West Antarctica, Iselin Bank, East Antarctica, and Australia – could be improved. This is the object of this research.

Previous work has documented mid-Tertiary seafloor spreading in a NNW-striking direction, producing magnetic anomalies between East and West Antarctica. This would explain the approximately 150 km opening of the Adare Trough, north of the Ross Sea. The hypothesized motion, however, is insufficient to resolve the apparent discrepancy between the actual plate motions and those that would follow from the assumption that the hotspots were fixed.

The motion between East and West Antarctica indicates a very small rotation. Thus, scientists would like to develop models of finite plate rotation in this area to a high degree of accuracy, particularly for older times. This goal is now attainable, based on the analysis and interpretation of data that should result from this project, in conjunction with other data sets compiled by Japanese and Italian scientists on recent cruises in the region.

Our new marine geophysical data will be collected on selected transits of the R/V *Nathaniel B. Palmer*. We hope to:

- improve the rotation model for mid-Tertiary extension between East and West Antarctica by directly considering the plate boundary between the Pacific and Australia plates in the calculation of Australia-West Antarctica motion;

- improve the reconstructions for Late Cretaceous and Early Tertiary times by including new constraints on several boundaries not previously used in the reconstructions;
  - address the issue of the fixed position of global hotspots through the implications of new rotation models; and,
  - re-examine the geophysical data from the western Ross Sea embayment in light of a model for substantial mid-Cenozoic extension.
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## **Cruise Research Plan**

### **Logistics**

Cruise NBP00-07B

Departs:

Ushuaia, Argentina, 19 November 2000

Arrives:

Hobart, Tasmania, 16 December 2000

Research Location:

transit area from Argentina to Tasmania

### **Team Members**

William Keller

Julie Bowles

Francis Macdonald

TBD (1 or 2)

### **Cruise Operations**

The project team members plan to work aboard the R/V *Nathaniel B. Palmer* (cruise NBP00-07B) to collect marine geophysical data along a transect between Argentina and Tasmania, in an effort to improve plate reconstructions linking the Pacific and Antarctic plates.

The team members will collect the following:

- magnetic data, using a magnetometer deployed overboard;
- gravity data, using a gravimeter;
- bathymetric data, using Seabeam 2112 sonar and Bathy 2000 sonar; and
- navigation data, using a GPS instrument.

The collected data will be returned via CDs and tapes to the home institution for analysis.

**NSF/OPP Program Manager**  
Dr. Scott Borg

**RPS Point-of-Contact**  
Mr. David Leger

**Bio-optical Properties  
of Southern Ocean Waters**

**GO-073-A**

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**Research Objectives**

As more ocean-color satellites become operational, the need for high-quality, bio-optical data for sensor intercalibration and for algorithm development and validation is greater than ever. Unfortunately, relatively few bio-optical measurements in high-latitude waters are currently available, due in large part to the logistical difficulties of conducting field programs in such remote and often inaccessible regions of the Earth. On this cruise, we plan to collect high-quality, bio-optical data from the high-latitude waters of the Southern Ocean. Since we will cover a very large area (Australia – Prydz Bay – South Africa), we will encounter many different water types and masses with different bio-optical properties. The data we generate will be very useful for algorithm development and satellite data validation.

## Cruise Research Plan

### Logistics

Cruise NBP01-01

Departs:

Hobart, Australia, 29 January 2001

Arrives:

Capetown, South Africa, 29 March 2001

Research Locations:

East Antarctic Continental Margin from south of Hobart to south of Cape Town, to include Porpoise Bay, Vincennes Bay, McDonald Bay, Barrier Bay, Prydz Bay, and the Mac.Robertson shelf.

### Team Member

Gert Van Dijken

### Cruise Operations

The one deploying member of this project will work on board the *R/V Nathaniel B. Palmer* during Cruise NBP01-01 to collect baseline bio-optical data. The data will be used to calibrate ocean satellite sensors that measure primary productivity. The data will also be used to validate satellite data and assist in algorithm development. The team member will collaborate with members of project GO-073-O (Dr. Leventer) to deploy the Biospherical Instruments PRR600 multi-wavelength radiometer and generate a bio-optical profile of the water column at each daylight station and at 1 degree latitude intervals while underway.

## Quaternary Glacial History and Paleoenvironments of the East Antarctic Margin

GO-073-O

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### Research Objectives

During a 60-day cruise aboard the icebreaking research ship *Nathaniel B. Palmer*, we will conduct a multi-institutional, international (US - Australia) marine geologic and geophysical investigation of Prydz Bay and the MacRobertson Shelf. Our primary objective is to develop a record of climate and oceanographic change during the Quaternary by using sediment cores collected via kasten and jumbo piston coring. We will select our core sites by using seismic profiling (Seabeam 2112 and Bathy2000). Primarily from data collected along the West Antarctic margin, scientists have come to recognize that the Antarctic ice sheet has a central role in global oceanic and atmospheric systems. Similar extensive and high-resolution data sets from the much more extensive East Antarctic margin are sparse. Goals of our project include:

- (1) developing a century- to millennial-scale record of Holocene paleoenvironments,
- (2) testing of hypotheses concerning the sedimentary record of previous glacial and interglacial events on the shelf and evaluating the timing and extent of maximum glaciation along this 500 km stretch of the East Antarctic margin.

We will generate high-resolution seismic maps and take cores of sediments deposited in inner shelf depressions, then use both data sets to reconstruct Holocene paleoenvironments. In similar depositional settings in the Antarctic Peninsula region and in the Ross Sea, sedimentary records demonstrate millennial- and century- scale variability in primary production and sea-ice extent during the Holocene. These factors have been linked to chronological periodicities in radiocarbon distribution, suggesting that solar variability may have a role in driving some changes in Holocene climate. Using the high-resolution Holocene records we obtain from the East Antarctic margin, we will develop a circum-Antarctic suite of data regarding the response of southern glacial and oceanographic systems to late Quaternary climate change. In addition, these data will help us to evaluate the response of the East Antarctic margin to global warming.

Initial surveys of the Prydz Channel–Amery Depression region revealed sequences deposited during previous Pleistocene interglacials. The upper Holocene and lower (undated) siliceous units can be traced over 15,000 square kilometers of the Prydz Channel, but more sub-bottom seismic reflection profiling in conjunction with dense coring over this region is needed to define the spatial distribution and extent of the units. Chronological work will determine the timing and duration of previous periods of glacial marine sedimentation on the

East Antarctic margin during the late Pleistocene.

Our analyses will focus on detailed sedimentological, geochemical, micropaleontological, and paleomagnetic techniques. This multi-parameter approach is the most effective way to extract a valuable paleoenvironmental signal in these glacial marine sediments. These results are expected to significantly advance our understanding of the behavior of the Antarctic ice-sheet and ocean system in the recent geologic past.

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## Cruise Research Plan

### Logistics

Cruise NBP01-01

Departs:

Hobart, Australia, 29 January 2001

Arrives:

Capetown, South Africa, 29 March 2001

Research Locations:

East Antarctic Continental Margin from south of Hobart to south of Cape Town, to include Porpoise Bay, Vincennes Bay, McDonald Bay, Barrier Bay, Prydz Bay, and the Mac.Robertson shelf.

### Team Members

Amy Leventer

Charlie McClennen

Pat Manley

Rob Dunbar

Stefanie Brachfeld

Gene Domack

Dave Mucciarone

Peter Harris

Peter Sedwick

Ian Goodwin

Fiona Taylor

Leanne Armand

Tom Janacek

Wendy Slijik (Teacher Experiencing Antarctica)

TBD (14)

### Cruise Operations

The team members plan to work on board the *R/V Nathaniel B. Palmer* (cruise NBP01-01) to collect deep benthic sediments, marine geophysical data, and water column data in an effort to reconstruct the climatic and oceanographic history along a relatively understudied region of the Antarctic Continental Margin. Data and sample collection will occur along a cruise transect from south of Hobart, Australia, to south of Capetown, South Africa, concentrating on the region between 80 degrees and 57 degrees east longitude.

With the assistance of the support contractor's ship-board personnel, the researchers will use the SeaBeam 2112 Multibeam sonar system, the ODEC Bathy2000 Chirp Sonar, the Datasonics sidescan, and the Simrad EK-500 Echo Sounder to collect geophysical data on the ocean floor. The resulting high resolution seismic and benthic maps will be used to guide the selection of core sites, particularly in inner continental shelf depressions, such as in the Svenner Channel, Iceberg Alley, Nielson Basin, and the Amery Depression. The sonar equipment will also be used to map moraines and guide selection of core sites in the Prydz Channel. Team members may also use the seismic air gun and the acoustic streamer array to collect seismic data from Ocean Drilling Program (ODP) legs 119 and 188, for members of the ODP community.

Ship-board contractor personnel will assist the researchers in deploying the Jumbo Piston Core, the Kasten Core, the Gravity Core, and the Mega-core to collect marine sediment samples. Water column samples and conductivity, temperature, and depth (CTD) profiles will be collected with the SeaBird 911 Plus and Rosette with twenty-four 10-liter Niskin bottles.

Researchers from project OO-278-O (Dr. Pilskaln) will accompany project GO-073-O on this cruise in order to recover a sediment trap moored at 63°27.69' S; 76°09.45' E. Project OO-278-O personnel will collaborate with members of project GO-073-O to collect sediment cores, CTD profiles, transmissometer profiles, and water samples from the above site as well as others along the cruise track.

Sediment and other samples will be returned to the home institution for further analysis.

**NSF/OPP Program Manager**  
Dr. Scott Borg

**RPS Point-of-Contact**  
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## **Dry Valleys Seismic Project**

**GO-078-O**

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### **Research Objectives**

One recurrent issue in seismography is “noise” – background phenomena that can interfere with clear and precise readings. The Dry Valleys Seismograph Project – a cooperative undertaking with the New Zealand Antarctic Program – was established to record broadband, high-dynamic-range, digital seismic data from the remote Wright Valley, a site removed from the environmental and anthropogenic noise ubiquitous on Ross Island.

The Wright Valley site provides one of the few locations on the continent with direct access to bedrock. The station there consists of a triaxial, broadband, bore-hole seismometer, 100 meters deep, and a vertical, short-period instrument at 30 meters. The seismological data are digitized at the remote location, telemetered by repeaters on Mount Newell and Crater Hill, and received eventually by the recording computer at the Hatherton Laboratory at Scott Base, where a backup archive is created.

These data will eventually reach the international seismological community. From Hatherton, they pass via a point-to-point protocol link to the Internet at McMurdo Station and thence to the Albuquerque Seismological Laboratory for general distribution. This data set has beautifully complemented the data from other seismic stations operated by the Albuquerque Seismological Laboratory at Amundsen-Scott South Pole Station, Palmer Station, and Casey Station, an Australian base.

## Field Research Plan

### Logistics

Dates in Antarctica: late October 2000 to late November 2000 AND late December 2000 to late January 2000

Research Locations: Mt. Newall Repeater Site, Bull Pass Seismic Site in the Dry Valleys, and Scott Base

### Team Members

Kenneth Oliver	Jeffery Roberts	Charlie Lurton
Jason Motyka	Clay Himmelsbach	Don Byrd
Anna Stegemoeller		

### Field-Season Operations

In late October 2000, five project team members will arrive at McMurdo Station. In early November 2000, the team members plan to travel via helicopter from McMurdo Station to the Bull Pass Seismic Site in the Dry Valleys. They will establish a tent camp at this site and base their operations there for approximately two weeks. Their primary objectives will be to perform corrective maintenance on the station, refuel the station, and upgrade the communication system.

In mid-November 2000, the team members plan to travel via helicopter to the Mount Newall Repeater Site. They will establish a tent camp at this site and base their operations there for approximately two weeks. Their primary objectives will be to perform corrective maintenance on the station, refuel the station, and upgrade the communication system.

In late November 2000, the team members will depart Mount Newall and travel via helicopter to McMurdo Station and then redeploy to the United States. In late December 2000, four project team members (including two from the earlier field team) will return to McMurdo Station. Shortly thereafter, they plan to return via helicopter to the Bull Pass Seismic Site in the Dry Valleys. They will re-establish a tent camp at this site and base their operations there for approximately two weeks. Their primary objectives will be to modify the remote power system, top off the fuel tanks, complete testing of seismic and radio communication equipment, and close up the site for the winter.

In mid-January 2001, the team members will travel via helicopter to the Mount Newall Repeater Site. They will re-establish a tent camp at this site and base their operations there for approximately two weeks. Their primary objectives will be to modify the remote power system, perform annual maintenance on the wind generator, test the radio communication equipment, and close up the site for the winter.

In late January 2001, the team members will depart Mount Newall and return to McMurdo Station via helicopter. Two of the team members from Northern Power System will transfer over to support the University of Alaska's Windless Blight Infrasound Array. The other team members will complete seismic system work at Scott Base. They will also provide training to winter-over McMurdo Station and Scott Base personnel on how to operate the seismic and remote power systems.

**NSF/OPP Program Manager**  
Dr. Scott Borg

**RPS Point-of-Contact**  
Dr. Don Atwood

## **Mount Erebus Volcano Observatory: Gas Emissions and Seismic Studies**

**GO-081-O**

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### **Research Objectives**

Mount Erebus on Ross Island is Antarctica's most active volcano. It is also the only one with a persistently convecting lake of molten, alkali-rich phonolitic magma in its summit crater. This makes Erebus one of the few volcanoes on Earth with nearly continuous small-explosive activity and continuous internal earthquake (seismic) activity. As such, it provides the ideal natural laboratory to study magma gas release, as well as the seismic activity that results from a convecting magma conduit.

This project entails a combination of seismic studies and gas emission rate measurements designed to elucidate the nature and dynamics of the magmatic plumbing system, as well as eruptions and degassing from the lava lake.

The gas studies will provide some of the first data available on carbon dioxide degassing from a highly alkaline magma system. They should also help to evaluate how much lead from Mount Erebus (relative to lead released by marine aerosols) gets into the snow on the East Antarctic Ice Sheet, and thus shed light on hypotheses about the anthropogenic origins of lead. Further goals of the gas studies are to:

- examine the role of Erebus as a source of gas and aerosols for the Antarctic environment;
- understand the role of volcanism as a source of carbon dioxide emissions to the atmosphere, especially for a highly alkaline magma;
- understand the evolution of the main volatile substances (water vapor, carbon dioxide, total sulfur, fluorine, and chlorine) in the Erebus magmatic system, as well as their role in the eruptive behavior of Erebus; and
- correlate the nature of the gas emissions with the observed seismic activity.

The seismic studies of the volcano will:

- add a permanent broadband seismic station to the array and update the present data acquisition system;
- expand development of current software to allow automatic and precise timing of earthquake occurrences and thus allow precise locations to be determined.

Deformation studies to monitor the movement of magma inside the volcano will be made using GPS, campaign-style geodetic measurements. These measurements will be supplemented by an array of permanent, continuously operating GPS stations. With the addition of 2 new stations in the 2000/2001 field season, the array will consist of three, single-frequency L1 stations and one dual-frequency station with an associated meteorological package. The latter station will be part of the global SuomiNet array that provides real-time, atmospheric, precipitable water vapor measurements and other geodetic and meteorological information.

The resultant data should enhance the collection of earthquakes that we are using in a computer model of the interior of the volcano, as well as provide a tool scientists can use for volcano surveillance, eruption monitoring, and detecting subtle changes in the internal behavior of volcanoes. The broadband data will support a detailed study of the explosion mechanism, especially the very-long-period signals they emit. It should also help us detect temporal and spatial variability in earthquake mechanisms, which in turn might provide more insights into how variations in gas emissions may be implicated.

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## Field Research Plan

### Logistics

Dates in Antarctica: mid-November 2000 to late December 2000  
Research Locations: Mount Erebus, Seismic Stations on Erebus, Fang Glacier, South Pole; Cray Science and Engineering Center (CSEC)

### Team Members

Phil Kyle	Richard Aster	Lois Jean Wardell
Jessie Crain	Richard Karstens	William McIntosh
Nelia Dunbar		

### Field-Season Operations

The researchers plan to continue to monitor Mount Erebus volcanic activity and evaluate the impact of gas emissions on the Antarctic environment. They will use a network of nine permanent seismic stations to provide an understanding of the eruptive behavior and dynamics of the mountain.

In mid-November 2000, team members will arrive at McMurdo Station and test their seismic equipment in the CSEC. They will then travel via helicopter to the Fang Glacier on Mt. Erebus, at 10,000 feet, where they will acclimate to the altitude for two days in a camp erected by the support contractor's field-services personnel. Team members will then be transported via helicopter to the Lower Erebus Hut, located at 11,300 feet, where they will stay for four weeks.

During this time, the team members will travel by snowmobile from the Lower Erebus Hut to sampling areas around the rim, where they will measure the emission rates of carbon dioxide, sulfur dioxide, radionuclides, trace gases, and metals from the volcano. From a helicopter, team members will profile the volcano's gas plume and measure carbon dioxide emission rates with an on-board carbon dioxide analyzer. These data will be used to evaluate the potential impact of gas emission from Erebus on the snow chemistry of the East Antarctic Ice Sheet. The researchers will also measure short-term variations in the emission rates of fluorine, chlorine, sulfur dioxide, and metals to examine volatile zoning in the magma chamber supplying the lava lake.

With helicopter support, team members will install a new, permanent, broad-band, digital-telemetry seismic station at site E1, near the summit of the mountain. They will travel by helicopter to inspect and maintain the array of nine permanent seismic stations located around the flanks and summit of the volcano, and they will re-occupy a GPS network on the flanks and summit to determine if any deformations have occurred over the winter.

The researchers also plan to collaborate with scientists from other projects to sample aerosols at South Pole Station, in an effort to determine if the plume gases and aerosols from Mount Erebus are transported for long distances over Antarctica.

During the field season, team members from this project plan to assist the support contractor's construction crew in erecting a new Upper Hut on Mount Erebus. The support contractor's science technician will maintain the seismic monitoring equipment in the CSEC year-round and periodically send data to the home institution.

**NSF/OPP Program Manager**  
Dr. Scott Borg

**RPS Point-of-Contact**  
Ms. Rhonda Rodriguez

## **Global Positioning System Measurements of Crustal Motion in Antarctica**

**GO-082-O**

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### **Research Objectives**

Geodesy is the mathematically-grounded science of using measurements to map the positions and shapes of the Earth's surface features. The satellite-based global positioning system (GPS) has revolutionized the techniques and enhanced the accuracy of geodetic work. This project has established a geodetic network in the Trans Antarctic Mountains of Antarctica to measure both vertical and horizontal crustal velocities:

- The vertical crustal velocities measured by GPS reflect the viscoelastic response of the solid Earth to Antarctic deglaciation. That data will enable us to evaluate discrepancies between models that describe when Antarctic deglaciation probably occurred, either in Late Pleistocene-Early Holocene (about 10,000 years ago) or later, in Late Holocene time. These data will also constrain the length of time over which the Antarctic ice sheet disintegrated, and should provide a reconstruction of its changes. If Antarctic deglaciation occurred in the mid-Holocene, we would expect a specific pattern of uplift, near the Trans Antarctic Mountains. This new, high-precision GPS geodetic system should be able to pin that event within a time span of 4 years.
- Horizontal deformation induced by rebound can also be measured. These data help constrain models of present-day changes in Antarctic ice mass by monitoring how the lithosphere is deformed by ongoing glacial loading and unloading. We predict that horizontal component (the lithospheric response to ongoing ice-mass changes) to be an order of magnitude smaller than the vertical (the viscoelastic response to Late Pleistocene-Holocene deglaciation). Conversely, that predicted rebound signal should be much larger than the associated tectonic uplift rates. Our baseline measurements will cross known fault lines in the Trans Antarctic Mountains, and may capture co-seismic motion, in the event of an aseismic slip or an earthquake.

This autonomous GPS station (AGS) network sends daily data reports to McMurdo Station. It has been designed as a permanent installation that will continue to monitor motion in the region. Advanced processing techniques – such as orbit modeling, troposphere correction, ionosphere correction, and extraction of annual and seasonal solid Earth and ocean tidal signals – have been developed to refine the accuracy of these crustal velocity measurements, especially for the vertical component.

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## **Field Research Plan**

### **Logistics**

Dates in Antarctica: early November 2000 to late November 2000;  
early January 2001 to early February 2001

Research Locations: Mt. Coates, Mt. Cocks

### **Team Members**

Carol Raymond                      Michael Masterman  
John Keough                         TBD

### **Field-Season Operations**

The researchers plan to continue using GPS equipment to measure rates of vertical and horizontal motion of bedrock surfaces in the Transantarctic Mountains. This season, the team members plan to perform maintenance and repair on two autonomous GPS stations—one located at Mt. Coates in the Dry Valleys and one at Mt. Cocks in the Royal Society Range. Team members will make two day trips via helicopter to each of the GPS stations between mid- and late November 2000 to check battery electrolyte levels, charge batteries, and inspect the data acquisition and transmission systems. Faulty components will be replaced or repaired in the field.

The researchers may also perform modifications and upgrades to the wind turbine, solar panel, and electronic systems to allow operations to continue during the austral winter. This additional work would likely take place in mid- to late January 2001. If the upgrades are not done, the GPS sites will be decommissioned at the end of the season, though the GPS antennas will be left mounted at each site.

The researchers will continue development of the wind generators at T-site in McMurdo, and they will train the support contractor's science technician to operate the data receiving equipment and the wind generators. The science technician will report on the condition of the site through the austral winter and monitor the receiving radio modems at the McMurdo Ground Station.

**NSF/OPP Program Manager**  
Dr. Scott Borg

**RPS Point-of-Contact**  
Ms. Rhonda Rodriguez

# TAMSEIS: A Broadband Seismic Experiment to Investigate Deep Continental Structure Across the East-West Antarctic Boundary

GO-089-O

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## Research Objectives

Our project focuses on evaluating geodynamic models for the tectonic development of Antarctica by investigating crust and upper mantle structure beneath the East-West Antarctic boundary. We will use a focused broadband seismograph to address two outstanding problems concerning the tectonic development of the Antarctic continent:

(1) *The origin of the Transantarctic Mountains:* Even though the Transantarctic Mountains are widely considered a classic example of rift-flank uplift, there is little consensus about the exact uplift mechanism. Many mechanisms, ranging from delayed phase changes to transform-flank uplift, have been proposed. All of these make various assumptions about upper mantle structure beneath and adjacent to the rift-side of the mountain front.

(2) *The structure of the East Antarctic craton:* East Antarctica displays the greatest modal elevation of any major cratonic block when corrected for glacial loading. The anomalous elevation of East Antarctica may have been an important factor in the onset of continental glaciation. However, the support mechanism for this anomalous topography is unknown. Possible models include isostatic uplift from thickened crust, anomalously depleted upper mantle, and thermally modified upper mantle, as well as dynamic uplift. The lateral extent of the very old continental lithosphere is also uncertain. In particular, it is unknown whether the old lithosphere extends to the western edge of East Antarctica beneath the crustal rocks deformed during the Ross Orogeny.

To examine details of the crust and upper mantle structure across the East-West Antarctic boundary, we will conduct a massive seismic experiment comprised of three elements:

- (1) A 1,400-kilometer linear array of 17 broadband seismic stations extending from the high central regions of the East Antarctic craton to the Transantarctic Mountains (Array 1).
- (2) An intersecting 400-kilometer linear array of 16 broadband seismic stations extending from the coast across the Transantarctic Mountains nearly perpendicular to the strike of the range in the McMurdo Dry Valleys (Array 2).
- (3) An array of 11 broadband stations in coastal regions around Ross Island and Terra Nova Bay (Array 3).

We will begin in November 2000, and we will conduct this experiment over three years to allow sufficient data collection from naturally occurring earthquakes. To support the project, we will also complete airborne surveys for surface elevation and ice thickness. If feasible, aerogravity and aeromagnetism data will also be collected. To analyze the data, we will use a variety of proven modeling techniques, including body- and surface-wave tomography, receiver function inversion, and shear-wave splitting analysis. The results of these analyses will be maps of the variation in crustal thickness, upper mantle structure, anisotropy, and mantle discontinuity topography across the boundary of East and West Antarctica. These results will provide a solid foundation for understanding the geodynamics of the Antarctic.

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## Field Research Plan

### Logistics

Dates in Antarctica: late November 2000 to late December 2000 AND mid-January 2001 to late January 2001  
Research Locations: McMurdo area, Transantarctic Mountains, East Antarctic Plateau

### Team Members

Douglas Wiens	Patrick Shore	Jesse Fisher
Don Voight	Sridhar Anandakrishnan	Jerry Bowling

### Field-Season Operations

The project team members plan to install broadband seismic stations at several locations in an effort to conduct a passive seismic experiment. The experiment will address the following issues (which cannot be addressed by existing data), in regard to evaluating geodynamic models for the tectonic development of Antarctica by investigating crust and upper mantle structure beneath the East-West Antarctic boundary: 1) the structure of the Antarctic craton and its anomalously high average elevation, and 2) the origin of the Transantarctic Mountains.

During late November 2000-late December 2000, the team members will be based at McMurdo Station. They will install one broadband seismic station in the McMurdo Station area, and they will receive four days of Twin Otter aircraft day-trip support to install four broadband seismic stations at the following coordinates (2 stations in the Transantarctic Mountains and 2 stations on the East Antarctic Plateau):

- 75.7 south, 152.5 east
- 78.6 south, 151.4 east
- 79.5 south, 160.1 east
- 76.6 south, 158.5 east

Each station will take about eight hours to install. When the installations have been completed, the team members will leave McMurdo Station in late December 2000.

In mid-January 2001, two team members will return to McMurdo Station. These team members will receive two days of Twin Otter aircraft day-trip support to revisit the remote seismic station sites (2 sites during each day trip) to check the stations and make repairs as necessary. The team members will also train the support contractor's winter-over science technician to download data and make repairs as necessary to the seismic station installed at McMurdo. These team members will then leave McMurdo Station in late January 2001.

**NSF/OPP Program Manager**  
Dr. Scott Borg

**RPS Point-of-Contact**  
Ms. Alana Jones

## **Global Seismograph Station at Palmer Station, Antarctica**

**GO-090-P**

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### **Research Objectives**

Seismology, perhaps more than any other science, is a global enterprise. Seismic waves resulting from earthquakes and other events can only be interpreted through simultaneous measurements at strategic points all over the planet. The measurement and analysis of these seismic waves are fundamental not only for the study of the earthquakes, but also because they serve as the primary data source for the study of the Earth's interior. To help establish the facilities required for this crucial scientific mission, the Incorporated Research Institution for Seismology (IRIS) was created in 1985.

IRIS is a consortium of universities with research and educational programs in seismology. Ninety-seven universities are currently members, including nearly all U.S. universities that run seismological research programs. Since 1986 IRIS, through a Cooperative Agreement with the National Science Foundation and in cooperation with the US Geological Survey, has developed and installed the Global Seismographic Network (GSN). The GSN is now approaching about 135 broadband, digital, high-dynamic-range, seismographic stations globally distributed. Real-time communications to all GSN sites is currently being implemented.

IRIS and USGS installed and now operate and maintain the GSN seismic equipment at Amundsen-Scott South Pole Station and at Palmer Station, Antarctica. This capability is essential for seismic studies of Antarctica and the southern hemisphere. The state-of-the-art seismic instrumentation is an intrinsic component of the National Science Foundation's effort to advance seismology and Earth science globally, and it serves as a crucial element of the GSN.

## Field Research Plan

### Logistics

Dates in Antarctica: early February 2001 to early March 2001  
Research Location(s): Palmer Station

### Team Member

Jeff Idol

### Field-Season Operations

This ongoing research project operates a seismic station to collect digital seismic data as part of a global data collection network. Three seismometers—one measuring up/down, one measuring north/south, and one measuring east/west—continuously monitor and record seismic activity in the region. Palmer Station provides a unique opportunity to gather data in an extremely remote part of the world where the station can be maintained year-round by highly qualified staff.

This season, one team member will travel to Palmer Station on board the R/V *Laurence M. Gould* (cruise LMG01-1A) to upgrade the seismic system. In order to support the International Monitoring System of the Comprehensive Test Ban Treaty, the team member will add a seismometer for recovering high-frequency information, and he will upgrade the acquisition system.

The support contractor's science technician will perform daily operations and periodic maintenance of the seismic station. This will include changing data tapes and leveling the seismometers. The technician will receive three to five days of training from project personnel at the Albuquerque Seismological Laboratory prior to traveling to Palmer Station.

The seismic station's data acquisition system is maintained by U.S.-based researchers via the Internet.

**Global Seismograph Station  
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GO-090-S**

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## **Research Objectives**

Seismology, perhaps more than any other science, is a global enterprise. Seismic waves resulting from earthquakes and other events can only be interpreted through simultaneous measurements at strategic points all over the planet. The measurement and analysis of these seismic waves are fundamental not only for the study of the earthquakes, but also because they serve as the primary data source for the study of the Earth's interior. To help establish the facilities required for this crucial scientific mission, the Incorporated Research Institution for Seismology (IRIS) was created in 1985.

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## Field Research Plan

### Logistics

Dates in Antarctica: early January 2001 to early February 2001  
Research Location(s): UCLA seismic vault in the Quiet Sector

### Team Members

Kyle Persefield Don Anderson

### Field-Season Operations

The project team members plan to work in the Quiet Sector at South Pole from early January 2001 to early February 2001 to repair the prototype borehole seismometer (which was previously damaged) in the vault near the existing seismometers. These repairs will permit continued investigation into the year-round operations of this type of seismometer in this environment. This experiment will be conducted to determine the feasibility of placing a borehole seismometer package at the proposed new seismic station, which will be approximately 5-10 miles from the existing station.

The support contractor's winter-over science technician will perform daily operations and maintenance of the seismic station year-round. Twice a year, the science technician will calibrate the gravity meters. This technician will also check the vault equipment in the Quiet Sector twice a month. (*Note:* The science technician will undergo five days of training at the home institution in Albuquerque, New Mexico, before to deploying to South Pole.)

# **Paleoceanography of Eocene Decapod-Rich Rocks in Antarctica and Southern South America**

## **GO-093-O**

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### **Research Objectives**

To evaluate the question of whether intervals of relative warmth in polar latitudes were seasonal or year-round, to determine seasonal temperature estimates for near-shore marine habitats, and to refine global paleoceanographic models, our field team will collect fossil mollusks that are known to contain decapod crustaceans (crabs and lobsters) from Eocene rocks in Antarctica and southern South America. We are targeting the sites where decapod-rich rocks occur because the decapods provide a unique, diverse database on biogeographic distribution throughout the high southern latitudes. By collecting mollusks intimately associated with the decapods, we will be able to determine the oxygen isotopic compositions ( $\delta^{18}\text{O}$  values) necessary to estimate seasonal temperature at the time and in the precise habitat in which the decapods lived. Concomitant with that work, we will run a series of oceanic and atmospheric circulation models. In these models, boundary conditions of atmospheric carbon dioxide and mean heat transport in climate model simulations of water circulation will be adjusted by using the GENESIS v. 2.0 atmospheric and GFDL MOM v. 2.0 ocean models. The water temperature data derived from analysis of fossil material will be used to select the most reasonable atmospheric and oceanic circulation models and to evaluate the effects of various gateways to circulation in the Antarctic region.

Our work will provide detailed information on seasonal variation in water temperature in the near-shore environments of high southern latitudes and will refine the paleoecological interpretations for decapods that will be essential for comparing related fossil and extant species. The study provides a unique opportunity for paleontologists and modelers to work together to develop efficient ways to use specified seasonal sea-surface temperature data when models are constructed. During this project, we will collaborate not only with colleagues at Woods Hole Oceanographic Institution but also with scientists from the Instituto Antartico Argentino.

## **Field Research Plan**

### **Logistics**

Dates in Antarctica: January and/or February 2001 (exact dates to be determined)  
Research Locations: Seymour Island, Antarctic Peninsula

### **Team Members**

Rodney Feldmann Carrie Schweitzer

### **Field-Season Operations**

In this collaborative project between the USAP and the Instituto Antartico Argentino (IAA), the researchers plan to study the decapod-rich, Eocene fossil beds on Seymour Island, Antarctica. Team members will collect fossils of fauna preserved in the same beds as the decapods. They will also use GPS to precisely map the geographic position and elevation of the fossil sites, and the stratigraphic position of the occurrences will be reconfirmed.

The team members will travel on an Argentine C-130 aircraft from Rio Gallegos in southern Argentina to Marambio Base on Seymour Island. They will then travel via Argentine helicopter to study sites away from the base. The U.S. team members will be joined by scientists from the IAA, and the two groups will collaborate on sample collections and later analysis. When the field study is complete, an Argentine C-130 will transport all researchers to Argentina.

Some samples will be returned to the home institution for analysis.

**Collaborative Research:  
Permian-Triassic Basin History of Southern  
Victoria Land and the Darwin Mountains**

**GO-094-O**

**Dr. John Isbell, Principal Investigator**

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## **Research Objectives**

Our project is a collaborative sedimentological, palynological, and paleomagnetic study of Permian and Lower Triassic strata in southern Victoria Land and the Darwin Mountains. Results of the study will help constrain the paleoenvironmental, tectonic, biotic, and paleogeographic histories of southern Pangea and provide a unique polar view of the world during an icehouse-to-greenhouse transition.

The assembly and drift of Pangea resulted in heightened orogenic activity and the associated development of numerous depositional basins. One of the largest basins, the “Gondwanide foredeep,” was more than 10,000 kilometers long and extended across southern South America, South Africa, the Falkland Islands, Antarctica, and Australia. Antarctica’s central location between South Africa and Australia make southern Victoria Land and the Darwin Mountains key areas for testing paleogeographic and paleoclimatic models.

Upper Paleozoic and Lower Mesozoic rocks in southern Victoria Land and the Darwin Mountains were deposited during Gondwanaland’s drift across the South Pole. Based on present plate reconstructions, geologists suggested that southern Victoria Land and the Darwin Mountains were located at a latitude higher than 75° S from 320 to 210 million years ago. Despite the putatively high-latitude position, southern Victoria Land and Darwin Mountains sedimentary successions record a change from Lower Permian glacial deposits to Permian fluvial coal measures, to Lower Triassic non-carbonaceous fluvial deposits, and finally to Middle and Upper Triassic fluvial coal measures, with well-developed vegetation during much of this time. Present climatic simulations suggest seasonal climatic extremes within Pangea’s polar interior. Discrepancies between the geological evidence and the climate simulations may be magnified by an incomplete understanding of the influence of paleotopography, large lakes, and river systems at the time of deposition, as well as by incomplete documentation of paleoenvironmental conditions. Furthermore, Late Permian and Triassic mean pole positions for Gondwanaland are not tightly constrained. As part of this project, we will recover paleomagnetic signatures from Permian and Triassic petrified



## **A Broadband Seismic Experiment for the Study of the Tectonics and Structure of the Antarctic Peninsula and Scotia Plate**

**GO-097-O**

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### **Research Objectives**

The present-day tectonics and the seismological structure of the Antarctic Peninsula and the Scotia Plate region are among the most poorly understood of any location in the world. This region offers a unique and complex geodynamic setting, as illustrated by recent changes in the pattern of volcanism and other tectonic activity. We constitute the U.S. component of an international effort – using a large-scale deployment of broadband seismographs – to study the seismotectonics and seismic structure of these regions.

During 1997 and 1998, a network of 11 broadband seismographs were installed in the Antarctic Peninsula region and southernmost Chilean Patagonia and have since been maintained. Data return from these seismographs has been excellent, producing some interesting initial results. We need to extend these observations, however, because there have been few large-magnitude regional earthquakes and thus internal strain can be presumed to be increasing, a longer time frame should elicit data on more revealing events.

Continued operation of these stations should enhance understanding of the seismicity of the South Shetland Trench, an unusual subduction zone where young lithosphere is subducting very slowly. The continuing collaboration between Washington University and the Universidad de Chile will contribute important seismological data to the Incorporated Research Institution for Seismology data center, as well as to other international seismological collaborators.

Such mutual exchanges with other national, Antarctic-seismology research programs will accumulate data from a variety of other proprietary broadband stations in the region. These data will support seismic studies of the upper mantle velocity structure of several complicated tectonic regions in the area, including the

South Shetland subduction zone, the Bransfield backarc rift, and diffuse plate boundaries in the areas around Patagonia, the Drake Passage, and along the South Scotia Ridge. Such studies should provide important constraints on the crustal structure beneath the stations. In turn, improved structural models will help to pinpoint better locations for future instruments.

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## **Field Research Plan**

### **Logistics**

Dates in Antarctica: TBD  
Research Locations: Chilean Bases: Frei Base, King George Island; Prat Base, Greenwich Island; O'Higgins Base, Antarctic Peninsula

### **Team Members**

Gideon Smith (USAP) Stacey Robertson (USAP)  
Emilio Vera (INACH) Rodrigo Adaros (INACH)

### **Field-Season Operations**

This collaborative project, jointly supported by the USAP and the Instituto Antartico Chileno (INACH), continues an investigation into the structure and tectonics of the Antarctic Peninsula and the Scotia Arc. Data is collected by four broadband seismographs that were deployed during the 1996-1997 field season. One seismograph is on the tip of South America, while the other three are located in the South Shetland Islands and on the Antarctic Peninsula.

The team members plan to retrieve all data collected by the seismographs over the previous season, repair any damage that may have occurred to the instruments over the winter, and train Chilean station personnel at Frei Base, Arturo Prat Base, and O'Higgins Base on how to maintain the seismic equipment.

Team members plan to obtain transport to and from the bases through the INACH, and two scientists from the Universidad de Chile will accompany the U.S. scientists. The team members will stay ashore overnight at each station, in berthing provided by the station, in order to complete their work.

## **Neogene-Quaternary Volcanic Alignments in the Transantarctic Mountains-Ross Sea Region**

**GO-099-O**

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### **Research Objectives**

The “Antarctic Stress Map Project” (ASMAP) initially will obtain data from Neogene-Quaternary volcanic vent alignments within the Transantarctic Mountains and adjacent West Antarctic rift system in the Ross Sea region. The distribution, alignments, and morphologies of volcanic cones and other volcanic features will be mapped using high-resolution satellite imagery (SPOT, SAR) and aerial photographs. Field tests will assess structural associations of faults and volcanic vent alignments. These data will be coupled with existing chronological and petrological information on the volcanic rocks, as well as other dike and fault data, to interpret alignments and define neotectonic stress states throughout this sector of Antarctica. Our analysis of the stress regime will be interpreted in conjunction with other ongoing studies of contemporary tectonics and paleokinematics of the Transantarctic Mountains rift flank and adjacent rift system. New stress field data from Antarctica will help to constrain the role of plate-boundary and crustal buoyancy forces in actively deforming intraplate regions.

## Field Research Plan

### Logistics

Dates in Antarctica: early December 2000 to late December 2000  
Research Locations: Cape Crozier; Mt. Terror; Cape Royds; Cape Bird; Mt Erebus; Hut Point; Black Island; White Island; Brown Peninsula; Mt Discovery; Minna Bluff; Hurricane Ridge; Riviera Ridge; Mason Spur; The Bulwark; Pyramid Trough; Hooper Crags; Chancellor Ridge; Howchin Glacier

### Team Members

Terry Wilson Timothy Paulsen  
Peter Braddock Yaron Felus

### Field-Season Operations

The researchers plan to map the position and shape of young volcanic cones and volcanoes throughout southern Victoria Land, in an effort to understand the tectonic dynamics of the Transantarctic Mountains rift flank and adjacent rift system. Mapping linear arrays of cones and elongate volcano shapes will provide information on the orientation and nature of the recent stress field within the Transantarctic Mountains and adjacent West Antarctic rift system in the Ross Sea region.

Prior to the field work, team members will construct maps of volcanic cones and volcanoes throughout southern Victoria Land from satellite imagery and aerial photography. During the month of December 2000, the team members will make day flights in helicopters from McMurdo Station to the site of volcanic cones around Ross, Black, and White Islands, on the Scott Coast, and in nearby regions of the Transantarctic Mountains, including the Royal Society Range, to check their maps for accuracy. They will pay particular attention to the cone shapes, which may be incompletely resolved from the satellite imagery alone. The team members will photograph the cones from the air and from the ground for further documentation of cone shapes, and they plan to do most of this work at night, when lighting conditions are best for photographing the shapes of the cones.

For selected sites, the team members plan to use real-time GPS equipment to obtain highly accurate GPS positions. This will provide ground control points for satellite imagery.

Team members will also use GPS to map faults and fractures in the vicinity of the volcanic vents. In doing so, they plan to test whether pre-existing bedrock structures controlled the positions and orientations of the volcanic vents and whether there are very young faults that formed together with the volcanoes. The team members will collect a small number of rock samples, and these will be returned to the home institution for analysis.

**NSF/OPP Program Manager**  
Dr. Scott Borg

**RPS Point-of-Contact**  
Ms. Rhonda Rodriguez

## **Geology and Geochronology of the Byrd Glacier Discontinuity, Antarctica: A Pilot Study**

**GO-116-O**

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### **Research Objectives**

Our project is a pilot study to investigate a major geological discontinuity in the Ross orogen of the Transantarctic Mountains, located beneath Byrd Glacier. Concentrating on the eastern portion of the area immediately to the south of Byrd Glacier, we will begin with a 6-week field study focusing on two distinctly different rock groups. During this first phase, we will structurally map the Byrd Group (Early Cambrian Shackleton Limestone and younger Douglas Conglomerate) toward an understanding of its kinematic evolution. We will also map in detail and collect samples of the amphibolite-grade metamorphic rock (Selbourne Marble) that crops out around Mt. Madison to characterize its structural and metamorphic history, as well as its geochronology. Helicopter reconnaissance will be conducted along the southwestern side of Byrd Glacier to investigate Shackleton Limestone and on the north side of Byrd Glacier in the Britannia Range to examine igneous and high-grade metamorphic rocks (Horney Formation). Structural data will be reduced at Arizona State University and metamorphic studies of the Selbourne Marble will be conducted at the University of Siena. Isotopic studies will be conducted at Ohio State University ( $^{40}\text{Ar}/^{39}\text{Ar}$ , Sm-Nd) and the University of Kansas (U-Pb) in an effort to determine the thermochronology of the Selbourne Marble and constrain the provenance age of the Douglas Conglomerate.

## **Field Research Plan**

### **Logistics**

Dates in Antarctica: late October 2000 to mid-December 2000  
Research Locations: Byrd Glacier area

### **Team Members**

Edmund Stump Brian Gootee  
John Roberts Franco Talarico

### **Field-Season Operations**

The project team members plan to conduct a pilot study to investigate a major geological discontinuity in the Ross orogen of the Transantarctic Mountains, located beneath Byrd Glacier. They will work around the Byrd Glacier region from early November 2000 to mid-December 2000.

The team members will travel via Twin Otter aircraft from McMurdo Station to Byrd Glacier in early November 2000. They will set up a tent camp at this site and use snowmobiles to travel to study sites in the area, where they will use GPS units and collect rocks. In late November 2000, the team members will receive three days of helicopter close support to conduct their studies in areas further from the camp.

About a week later, the team members will move via helicopter to Mt. Madison. They will set up another tent camp at Mt. Madison and conduct studies in that area using snowmobiles for travel. Another week later, the team members will receive two days of helicopter close support for work on the south side of Byrd Glacier. Then about another week later, they will receive two more days of helicopter close support for work on the north side of Byrd Glacier. Several days later (mid-December 2000), the team members will return to McMurdo Station via Twin Otter aircraft.

Rock samples will be returned to the home institution for analysis.

## **Antarctic Network of Unattended Broadband Integrated Seismometers (ANUBIS)**

**GO-180-O**

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### **Research Objectives**

Despite much attention in recent years, the structure and dynamics of the Antarctic crust and the composition and geometry of the mantle are still poorly understood. Seismology remains the primary method for studying these structures, as well as processes in the Earth's deeper asthenosphere, but Antarctica lags far behind in the effort to improve global seismic imaging and tomography. On this huge continent, there are only eight broadband seismic observatories. Except for the installation at South Pole, those stations are along the margins of the continent and none are in West Antarctica. By contrast, there are 200 permanent stations worldwide in the Federation of Digital Seismograph Networks (FDSN), and some 1,000 more, in national networks not yet integrated into the FDSN.

This project has developed a passive seismic network of 11 long-term broadband seismic stations on the Antarctic continent itself. Because 98 percent of the continent is ice covered, these stations will be installed at the surface of the ice sheet. The body-wave data thus recorded from regional and teleseismic earthquakes can be analyzed at each station for local crustal thickness, lamination, Poisson's ratio (a measure of crustal composition), crust and mantle anisotropy (a measure of current and former stress regimes), and identification of rift zones and crustal block boundaries. In addition, the data from all stations (including the existing peripheral ones) can be used for seismic tomographic analysis to detail lateral variations in these properties.

Four of the stations will be installed at existing automatic geophysical observatory sites (in East Antarctica), which will provide heat and power for the data loggers. The remaining seven stations will be established in West Antarctica, where they will be powered and heated by wind turbines during the austral winter.

## **Field Research Plan**

### **Logistics**

Dates in Antarctica: late October 2000 to mid-December 2000  
Research Locations: Byrd Surface Camp, Siple Dome Camp, Central West Antarctica, Marie Byrd Land, Ice Stream D, Mt. Moulton

### **Team Members**

Sridhar Anandakrishnan      Donald Voigt      Jerry Bowling

### **Field-Season Operations**

The project team members plan to continue developing a passive seismic network for the Antarctic interior by servicing and collecting data from several working long-term, broadband seismic stations and by deploying several temporary GPS receiver stations.

From late October 2000 to early November 2000, the team members will conduct project preparations at McMurdo Station. In early November 2000, the team members will travel via LC-130 aircraft from McMurdo Station to the Siple Dome Camp, from which they will base their field work. From Siple Dome, the team members will travel via Twin Otter aircraft to deploy three GPS receiver stations at the following three locations: 50 kilometers downstream of the grounding line of Ice Stream D, 50 kilometers upstream from the grounding line of Ice Stream D, and 100 kilometers upstream from the grounding line of Ice Stream D. Then, from either Siple Dome or Byrd Surface Camp, the team members will travel via Twin Otter aircraft to make a sweep of the existing seismic stations. During this sweep, they will complete station servicing, data retrieval, and site installation. The team members will set up tent camps at these sites when necessary.

Upon completion of this work, two of the team members will return via LC-130 aircraft to McMurdo Station. The other member will stay in the field to retrieve the temporary GPS stations. Following the retrieval of these GPS stations, the remaining team member will return via either LC-130 aircraft or Twin Otter aircraft to McMurdo Station.

**University NAVSTAR Consortium (UNAVCO)  
GPS Survey Support  
GO-295-O**

**Mr. Bjorn Johns, Project Manager**

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## **Research Objectives**

UNAVCO provides year round support for scientific applications of the Global Positioning System (GPS) to the National Science Foundation's Office of Polar Programs (NSF/OPP) Antarctic Program. This support includes pre-season planning, field support, and post-season follow-up, as well as development work for supporting new applications. UNAVCO maintains a "satellite" facility at McMurdo Station during the austral summer research season that provides a full range of support services, including geodetic GPS equipment, training, project planning, field support, technical consultation, data processing, and data archiving.

UNAVCO also operates a community differential GPS (DGPS) base station that covers McMurdo Sound and Taylor Valley, provides maintenance support to the MCM4 continuous GPS station as contractual support to the NASA GPS Global Network (GGN), and supports remote continuous GPS stations for scientific investigations.

Using GPS, vector baselines between receivers separated by 100 kilometers or more are routinely measured to within 1 centimeter (that is, 100 parts per billion). UNAVCO is also able to support researchers who are investigating global, regional, and local crustal motions where maximum accuracy (in the millimeter range) of baseline measurement is required. GPS measurements using portable equipment can be completed in a few hours or less. Such expediency lends itself to research applications in global plate tectonics, earthquake mechanics, volcano monitoring, and regional tectonics.

## **Field Research Plan**

### **Logistics**

Dates in Antarctica: mid-October 2000 to early February 2001  
Research Locations: Various field locations; Crary Science and Engineering Center (CSEC)

### **Team Members**

Bjorn Johns Charles Kurnik

### **Field-Season Operations**

UNAVCO will have 2 team members based in the CSEC at McMurdo Station throughout the 2000-2001 field season to provide technical support and manage the GPS equipment pool. Team members will occasionally travel to various field locations to assist researchers with GPS operations, as support requirements dictate.

In late October 2000, one team member will travel via helicopter (on a day trip) from McMurdo Station to Peak 1882 to re-install a differential GPS repeater. This repeater will allow GPS users in Taylor Valley to make precise meter-level accuracy measurements using handheld GPS units. Another team member will travel via helicopter (on a day trip) from McMurdo Station to Peak 1882 in late January 2001 to dismantle and remove the repeater.

Throughout the season, team members will work in the CSEC to test, repair, and stage GPS equipment.

# **The Young Marginal Basin as a Key to Understanding the Rift-Drift Transition and Andean Orogenesis: OBS Refraction Profiling for Crustal Structure in Bransfield Strait**

**GO-306-O**

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## **Research Objectives**

Bransfield Strait, in the northern Antarctic Peninsula region, is one of a small number of modern basins that may be critical for understanding ancient, mountain-building processes. The Strait is an actively-extending marginal basin in the far southeast Pacific, between the Antarctic Peninsula and the South Shetland Islands (an inactive volcanic arc). Widespread crustal extension, accompanied by volcanism along the Strait's axis, may be associated with slow underthrusting of oceanic crust at the South Shetland Trench. Similar "back-arc" extension occurred along the entire Pacific margin of the supercontinent Gondwanaland (now western South America/West Antarctica) during the Jurassic-Early Cretaceous. Mid-Cretaceous deformation of these basins some 100 million years ago initiated uplift of the Andes. By understanding the deep structure and evolution of the Bransfield rift, we hope to evaluate the crustal precursor to the Andes and gain a fuller understanding of the early evolution of this globally important mountain chain. Years of international earth sciences research in Bransfield Strait has produced consensus on important aspects of its geologic environment:

- It is probably a young rift (perhaps 4 million years old) in preexisting Antarctic Peninsula crust. Continued stretching of this crust results in complex fault patterns and associated volcanism. The volcanism, high heat flow, and mapped crustal trends are all consistent with the basin's continuing evolution as a rift.
- The volcanism, which is recent and continuing, occurs along a "neovolcanic" zone centralized along the basin's axis. Multichannel seismic data collected aboard the research ship Maurice Ewing in 1991 illustrate the following basin-wide characteristics of Bransfield Strait: widespread extension and faulting, the rise of crustal diapirs or domes associated with flower-shaped normal-fault structures, and a complicated system of fault-bounded segments across strike. The geophysical evidence also suggests northeast-to-southwest propagation of the rift, with initial crustal inflation/doming followed by deflation/subsidence, volcanism, and extension along normal faults.

Although Bransfield Strait exhibits geophysical and geologic evidence for extension and volcanism, continental crust fragmentation does not appear to have gone to completion in this "back-arc" basin and ocean crust is not yet being generated. Instead, the Bransfield rift lies

near the critical transition from intracontinental rifting to seafloor spreading. The basin's asymmetry and seismic evidence for shallow intracrustal detachment faulting suggest that it may be near one end of the spectrum of models proposed for continental break-up. Therefore, this basin is a "natural lab" for studying diverse processes involved in forming continental margins. Understanding the Bransfield rift's deep crustal structure is the key to resolving its stage of evolution and should also provide a starting point for models of Andean mountain-building. By collecting and analyzing high-quality, high-density profiles from ocean bottom seismometers (OBS) both along and across the Strait's strike, we will define the deep structure of the rift. Our objectives are as follows:

- Develop a detailed seismic velocity model for this rift;
- Calibrate velocity structure and crustal thickness changes associated with presumed northeast-to-southwest rift propagation, as deduced from the multichannel seismic interpretations;
- Document the degree to which deep velocity structure corresponds to along- and across-strike crustal segmentation; and
- Assess structural relationships between the South Shetland Islands "arc" and Bransfield rift.

The proposed OBS data, integrated with interpretations of both Ewing profiles and those from other high-quality geophysical coverage in Bransfield Strait, will complement ongoing deep seismic analysis of Antarctic Peninsula crust to the southwest and additional OBS monitoring for deep earthquakes to understand the complex plate tectonic evolution of this region.

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## Cruise Research Plan

### Logistics

Cruise NBP00-07A

Departs:

Punta Arenas, Chile, 27 October 2000

Arrives:

Ushuaia, Argentina, 18 November 2000

Research Locations:

Bransfield Strait and Scotia Sea

### Team Members

James Austin

Daniel Barker

Gail Christenson

Yosio Nakamura

Ben Yates

Jim Dolan

Steffen Sastrup

Yann Hello

Carrie Olsen

Susan Herr

### Cruise Operations

The project team members plan to continue their investigation of the deep crustal structure beneath Bransfield Strait. They will work on board the R/V *Nathaniel B. Palmer* (cruise NBP00-07A) to shoot the remaining four Ocean Bottom Seismograph (OBS) profiles within and close to the Strait. (*Note:* This project completed some of the OBS profiles during cruise NBP00-02. However, due to some equipment failure and lack of time, all of the research work was not completed during that cruise.)

During cruise NBP00-07A, for each of the remaining four transect lines, the team members will deploy an OBS instrument attached to a mooring. The vessel will then reverse course and the team members will shoot an underwater, 3000-cubic-inch, air-gun array as they pass over the instruments on the bottom. The vessel will then turn around a second time for recovery of the OBS.

The OBS data will be transferred to the home institution for analysis, in regard to deriving the deep structure of the Bransfield rift.

**NSF/OPP Program Manager**

Dr. Scott Borg

**RPS Point-of-Contact**

Dr. Jim Holik

## **Support Office for Aerogeophysical Research (SOAR)**

**GS-098-O**

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### **Research Objectives**

**Continuation of Activities for the Support Office for Aerogeophysical Research (SOAR)** *D.D. Blankenship, D.L. Morse, I.W.D. Dalziel, J.W. Holt., University of Texas at Austin*

Since 1994, the Support Office for Aerogeophysical Research (SOAR) has operated and maintained an aerogeophysical instrument package (aboard a de Havilland Twin Otter aircraft) that consists of an ice-penetrating radar sounder, a laser altimeter, a gravimeter, and a magnetometer that are tightly integrated with each other as well as with the aircraft's avionics and power packages. In addition, an array of aircraft and ground-based GPS receivers have supported kinematic differential positioning using carrier-phase observations. SOAR activities have included: developing aerogeophysical research projects with NSF/OPP investigators, upgrading the aerogeophysical instrumentation package to accommodate new science projects and advances in technology, fielding this instrument package to accomplish SOAR-developed projects, and management, reduction, and analysis of the acquired aerogeophysical data. Since its inception, SOAR has carried out six field campaigns over a six-year period and accomplished approximately 200,000 line kilometers of aerogeophysical surveying over both East and West Antarctica in 377 flights.

During the 2000-2001 austral summer, The University of Texas at Austin will conduct an aerogeophysical campaign to accomplish surveys for two SOAR-developed projects: "Understanding the Boundary Conditions of the Lake Vostok Environment: A Site Survey for Future Studies" (Bell and Studinger, LDEO), and "Collaborative Research: Seismic Investigation of the Deep Continental Structure Across the East-West Antarctic Boundary" (Weins, Washington U. and Anandakrishnan, U. Alabama). After configuration and testing of the survey

aircraft in McMurdo, we will conduct survey flights from an NSF-supported base adjacent to the Lake Vostok drilling camp and briefly occupy one or two remote bases on the East Antarctic ice sheet. We will also reduce these aerogeophysical data and produce profiles and maps of surface elevation, bed elevation, gravity, and magnetic field intensity for use by these investigators as well as for publication and release to national geophysical and glaciological data centers.

**Understanding the Boundary Conditions of the Lake Vostok Environment;  
A Site Survey for Future Work** *Robin Bell, Lamont-Doherty Earth Observatory*

Subglacial ecosystems, in particular subglacial lake ecosystems, are deficient in plant nutrients (oligotrophic), and they have extremely high levels of dissolved oxygen. These environments, and the ecosystems that may exist within them, should provide key insights into a range of fundamental questions about the development of life on Earth and other bodies in the solar system, including:

- 1) the processes associated with rapid evolutionary radiation after the extensive Neoproterozoic glaciations;
- 2) the overall carbon cycle through glacial and interglacial periods;
- 3) the possible adaptations organisms may require to thrive in environments such as Europa, the ice covered moon of Jupiter.

Over 70 subglacial lakes have been identified beneath the 3-4 kilometer thick ice in Antarctica. One lake, Lake Vostok, is sufficiently large to be clearly identified from space with satellite altimetry. Lake Vostok is similar to Lake Ontario in area but with a much larger volume, including measured water depths of 600 meters. The overlying ice sheet is acting as a conveyor belt that continually delivers new water, nutrients, gas hydrates, sediments, and microbes as the ice sheet flows across the lake.

Our goal is to determine the fundamental boundary conditions for this subglacial lake as an essential first step toward understanding the physical processes within the lake. To accomplish this, we will conduct an aerogeophysical survey over the lake and into the surrounding regions. The data set will include gravity, magnetic, laser-altimetry and ice-penetrating-radar data and will be used to compile a basic set of ice-surface elevation, subglacial topography, gravity, and magnetic anomaly maps.

To estimate the subglacial topography from gravity data in areas where the ice-penetrating radar will be unable to recover the depth of the lake, we will modify and use field methods widely used in the oil industry. A similar, modified method can be employed to estimate the thickness of the sediments beneath the lake from magnetic data. These methods will be tested and applied to subglacial lakes near South Pole before the Lake Vostok survey, which will provide valuable comparisons. Once the methods have been adjusted for the Lake Vostok application, maps of the water cavity and sediment thickness beneath the lake will be produced.

These maps will become tools to explore the geologic origin of the lake. The two possible models are that:

- the lake is an active tectonic rift, like Lake Baikal; or
- the lake is the result of glacial scouring.

The distinct characteristics of an extensional rift can be easily identified with our aerogeophysical survey. The geological interpretation of the airborne geophysical survey will provide the first geological constraints of the interior of the East Antarctic continent based on modern data. In addition, the underlying geology will influence the ecosystem within the lake.

One of the critical issues for the ecosystem within the lake will be the flux of nutrients. We will make a preliminary estimate of the regions of freezing and melting, based on the distance between distinctive internal layers observed on the radar data. These basic boundary conditions will improve our understanding of East Antarctic geologic structures, and they will provide guidance for a potential international effort aimed at *in situ* exploration of the lake.

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## Field Research Plan

### Logistics

Dates in Antarctica: late October 2000 to late January 2001  
Research Locations: Vostok, AGO-4, Seismic Center

### Team Members

Donald Blankenship	David Morse	Jack Holt
Thomas Richter	Matthew Peters	Scott Kempf
John Gerboc	Effie Jarrett	Lena Krutikov
Martha McConnell	Ben Farrow	TBD (10)

### Field-Season Operations

The SOAR team members plan to conduct approximately 69 aerogeophysical survey flights in support of the following two research projects:

- Understanding the Boundary Conditions of the Lake Vostok Environment: A Site Survey for Future Studies, by R.E. Bell
- Collaborative Research: Seismic Investigation of Deep Continental Structure Across the East-West Antarctic Boundary, by D. Wiens, S. Anandkrishnan, and A. Nyblade.

During late October 2000 to mid-November 2000, the project team members plan to work at Williams Field to reconfigure the SJB Twin Otter aircraft (known as the multi-instrumented, airborne geophysical platform) with instruments. Also during this time frame, LC-130 aircraft personnel will make three airdrops to stage fuel at the AGO-4 site and the Seismic Center, which is located midway between Taylor Dome and AGO-4, for future survey work by the SJB Twin Otter aircraft.

In late November 2000, support contractor personnel will travel via LC-130 aircraft to Vostok Station to put in a Jamesway camp (East Camp). In early December 2000, the team members will travel via LC-130 aircraft, accompanied by the SJB Twin Otter aircraft, to East Camp, where they will base their operations.

The team members plan to do 69 survey flights in the SJB Twin Otter aircraft between early December 2000 and early January 2001. Survey flights in the Lake Vostok area grid will begin in early December 2000. During this time, team members will also use the SJB Twin Otter aircraft to fly three survey lines between AGO-4 and Taylor Dome. The SOAR team members will collect geophysical data from the instruments on board the aircraft and hand the data out to the researchers as needed.

In early January 2001, the SOAR team members will pull out of East Camp via LC-130 aircraft and return to McMurdo Station. The SJB Twin Otter aircraft will also pull out at this time and return to Williams Field, where the instruments will be removed and shipped to the home institution.



## Overview of the Antarctic Glaciology Program

The Antarctic Glaciology (AG) program is concerned with the study of the history and dynamics of the antarctic ice sheet including the study of near-surface snow and firn, floating glacier ice (ice shelves), glaciers, ice streams, and continental and marine ice sheets. Program emphases include paleoenvironments from ice cores, ice dynamics, numerical modeling, glacial geology, and remote sensing of ice sheets.

Some specific objectives include the following:

- the correlation of climatic fluctuations evident in antarctic ice cores with data from arctic and lower-latitude ice cores;
- the integration of the ice record with the terrestrial and marine records;
- the investigation of the physics of fast glacier flow with emphasis on processes at glacier beds; and
- the investigation of ice-shelf stability and the identification and quantification of the feedback between ice dynamics and climate change.

These topics come together in the multidisciplinary West Antarctic Ice Sheet program (WAIS) which is a major initiative of the Office of Polar Programs. The goal of the WAIS program is to predict the ice sheet's future behavior by developing an understanding of its history, current state, internal dynamics and its coupling to the current global climate. The Antarctic Glaciology Program also funds much of the land-based glacial geology supported by the U.S. Antarctic program, especially more geologically recent events during the last 3 million years (between the Pliocene and Recent epochs).

## **History and Evolution of the Siple Coast Ice Stream System as Recorded by Former Shear-margin Scars**

**II-163-O**

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### **Research Objectives**

The focus of our 3-year investigation is scar-like features that are well known from the Siple Coast ice stream system in West Antarctica. Our objective is to identify the nature of several as-yet-unvisited scars and to further characterize previously-identified margin scars that are poorly dated. To locate and map these features, we will use Advanced Very High Resolution Radiometer (AVHRR) and Radarsat image data, which will enable us to place the features in a regional context. Our goal is to describe the recent history of the Siple Coast glaciers and investigate the causes of their changes in configuration. The main investigative tools will be low-frequency RES and high-frequency ground-penetrating radar (GPR) profiles to image internal layers and measure the depths of buried crevasses or disrupted layering. This, coupled with accumulation rates determined from shallow ice cores, will provide “shutdown” ages for the margin features. The field data will provide input parameters for simple ice-flow models for margins and inter-ice stream ridges during active shearing and after shutdown. Through modeling, we will estimate the elevations of the scars and their corresponding ice-streams at the time of shut down.

## Field Research Plan

### Logistics

Dates in Antarctica: early November 2000 to mid-December 2000  
Research Locations: Icestream C Camp, Downstream Ridge B/C, Siple Dome Duckfoot

### Team Members

Howard Conway	Ted Scambos	Maurice Conway
Ginny Catania	Tony Gades	

### Field-Season Operations

The researchers will work in Antarctica to survey several former glacier margins, now buried, to determine when their active flow ceased. Their main tools for determining the location and shutdown age of the margins are ground-based, radio echo sounding (at low and high frequency) and GPS surveys. Vertical ice motion survey sites (coffee cans) will be set up at a few selected locations to determine the rate of uplift of the ice in the aftermath of flow shutdown. The researchers will also collect firm cores at several areas to determine accumulation rates, which will allow them to infer an age of shutdown based on burial depth.

In mid-November 2000, the team members will travel via LC-130 aircraft from McMurdo Station to Ice Stream C. They will set up a tent camp at Ice Stream C and use snowmobiles to travel to their research sites in that region. (*Note:* Support contractor personnel will travel via Twin Otter aircraft to set up fuel caches at Downstream Ridge B/C and Siple Dome Duckfoot for the researchers to use for their snowmobiles.)

After approximately two weeks, the team members will traverse with their snowmobiles, sleds, and mobile camp equipment to the Downstream Ridge B/C site to conduct their research efforts in that region. After approximately one week, the team members will traverse to the Siple Dome Duckfoot site to conduct their research efforts in that region.

In mid-December 2000, the team members will travel via LC-130 aircraft from the Siple Dome Duckfoot site to McMurdo Station. Firm core filtrates will be returned to the home institution for analysis.

## **West Antarctic Ice Sheet Surface Melting: Recognition, Controls, and Significance**

**II-168-O**

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### **Research Objectives**

Glaciologists work to discover the history of dynamic processes, such as ice melting and climate. For example, surface melting on polar ice sheets can be said to occur when the temperature increases above some threshold. With data on these parameters, scientists try to link observed patterns to detectable changes in the macro glacial terrain, in hopes of developing models that may predict the future of Antarctic ice.

This project focuses on the critical Ross Ice Shelf and Siple Dome regions of West Antarctica. There are currently in use several different procedures to measure melting:

- space-based microwave sensors record the occurrence of liquid water or refrozen ice layers in the near surface;
- Automatic Weather Stations (AWS) record the high temperatures that are linked to development of liquid water; and
- snow-pit and ice-core studies show layers where re-freezing of sufficient liquid water has caused a visibly distinct layer to form.

Each approach is different, and they are presently not well calibrated to one another. We hope to determine how the different measures of melting may be correlated, using a combination of techniques: Snow-pit, ice-core, AWS, remotely sensed data, and experiments on melt generation. By looking at a variety of records of past surface melting events in Antarctica, we hope to develop a context that will pinpoint especially high temperatures. With all of this data, we hope to develop a model for a seasonally resolved paleothermometry, based on a joint approach to measuring ice melt, as well as complementary paleothermometers, such as borehole temperature and isotopes.

## Field Research Plan

### Logistics

Dates in Antarctica: mid-November 2000 to early December 2000  
Research Locations: Siple Dome field camp and surrounding area

### Team Members

Sarah Das Andrew Kurtz

### Field-Season Operations

In mid-November 2000, the team members will travel via an LC-130 aircraft from McMurdo Station to the Siple Dome field camp. They will be based at the Siple Dome field camp from mid-November 2000 to early December 2000. During this time, they will use snowmobiles to make daily trips between the Siple Dome camp and their 6 study sites—1 site near the Siple Dome AWS station and 5 other borehole sites. These sites are located in a transect approximately 30 kilometers north to 30 kilometers south of the Siple Dome camp. During these trips to the study sites, the team members may set up tent camps and stay overnight at the sites, if necessary. However, they will typically spend nights at the Siple Dome field camp.

There are three primary research objectives. First, at the study site near the Siple Dome AWS station, the team members will download the previous year's data from a meteorological station and snow temperature network that was installed last year. They will then disassemble and move this station to the J-core borehole site, 32 km south of the camp, where they will install the system to record meteorological and snow temperature data for the 2000-2001 summer season. Second, they will continue a series of artificial melt experiments to investigate melt initiation mechanisms, melt water flow, and the formation of melt layers in polar snow. Third, they will complete a transect of snow-pits at 5 borehole sites across Siple Dome, where they will be collecting snow samples and measuring density and temperature profiles, as well as doing visual stratigraphy at each site.

In early December 2000, the team members will travel via LC-130 aircraft to McMurdo Station. Frozen snow samples will be returned to the home institution for further analysis.

## **High-Precision Borehole Temperature Measurements at Siple Dome, Antarctica, for Paleoclimate Reconstruction and Ice-Dynamics Studies**

**II-171-O**

**Dr. Edwin Waddington\***, Principal Investigator

**Dr. Gary Clow\*\***, Co-Principal Investigator

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(currently under construction)

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### **Research Objectives**

One of the procedures involved in ice coring is high-precision borehole temperature profiling. By constructing continuous temperature logs, scientists can develop data vital to paleoclimate reconstruction and ice dynamics studies. This project will work in the 1 kilometer (km) deep, fluid-filled, Siple Dome borehole and in several 160 meter-deep holes along a 20 km north-south transect across Siple Dome. The borehole temperature data will be used to:

- establish the conductive heat flux across the basal interface of the ice sheet;
- reconstruct the surface temperature history at Siple Dome, using geophysical inverse methods known as borehole paleothermometry;
- constrain how thick the ice sheet was during the late Wisconsin, the magnitude of the Wisconsin/Holocene deglacial warming, and the background geothermal heat flux;
- determine calibration constants for the oxygen-isotope paleothermometer at Siple Dome in the past; and
- establish the spatial variability of surface temperature over the last century on the 20 km scale near the main drill site.

We expect the results to provide information needed to assess the short-term stability of the West Antarctic Ice Sheet, as well as enable improved estimates of the pore close-off ages in the past, which should in turn provide an improved age-scale for the Siple Dome ice core. Ultimately, this work should enhance our understanding of the magnitude of past temperature changes at this significant Southern Hemisphere site.

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## **Field Research Plan**

### **Logistics**

Dates in Antarctica: early November 2000 to mid-December 2000  
Research Locations: Siple Dome region

### **Team Members**

Gary Clow Robert Hawley  
Rolf Tremblay Ryan Bay

### **Field-Season Operations**

This is the second field season in this project's three-year research effort. This project's objective is to reconstruct past climatic (surface temperature) changes in the Siple Dome region of Antarctica using "borehole paleothermometry." The project team members plan to work in the Siple Dome region from mid-November 2000 to mid-December 2000.

The team members will travel via LC-130 aircraft from McMurdo Station to the Siple Dome camp in mid-November 2000. They will base their operations at this camp for four weeks. They will use snowmobiles to travel and to move equipment to and from the camp and the borehole study sites. The team members will take high-precision temperature measurements in the 1-kilometer-deep SDM-A borehole and in an array of 200-meter-deep boreholes within 35 kilometers of the ice divide. They will also take vertical strain measurements in the 107-meter-deep borehole near SDM-A. A logging Weatherport structure will be used over the hole for conducting temperature measurements.

One field-team member will do dust logger tests at the boreholes by attaching a logger to the logging winch that others are using.

The team members will travel back to McMurdo Station, via LC-130 aircraft, in mid-December 2000.

**NSF/OPP Program Manager**  
Dr. Julie Palais

**RPS Point-of-Contact**  
Ms. Alana Jones

## **Basal Conditions in Ice Stream C and Related Borehole Studies of Antarctic Ice Stream Mechanics**

**IO-157-O**

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### **Research Objectives**

To obtain observational evidence for the cause of rapid flow of the great ice streams in the West Antarctic Ice Sheet, we have drilled a number of boreholes through ice streams B, C, and D. We have used these boreholes to measure physical conditions and to sample materials at the base of the ice, where lubrication of the rapid ice-stream motion (approximately 1 meter per day) is thought to take place.

Ice Stream C poses a special problem. Though it has nearly stopped streaming, its basal materials and physical conditions are scarcely if at all different from those in the other ice streams, which are moving rapidly. We plan therefore to return to Ice Stream C in the 2000-2001 field season to study the ice stream intensively, trying to reveal what physical conditions differ enough from those in Ice Streams B and D to cause C to stop while B and D continue to stream. In particular there is a need for more accurate measurements of the basal water pressure and ice overburden pressure and for more accurate measurements of the strength of the basal till.

Using a new borehole video camera developed at JPL, we will observe the basal zone, including ice structure, rock debris in basal ice, the basal water-conduit system in the gap between ice and till, and, finally, the basal till itself. These observations will be interpreted in terms of basal sliding, basal melting or freeze-on, and deformation of basal ice. We will study the variation in basal conditions in the transition from unfrozen to frozen bed along a traverse from Ice Stream C across the shear margin to Ridge BC and along a traverse from UpC to a major "sticky area" about 10 kilometers north of UpC, where the flow velocity drops from about 20 meters per year to 3 meters per year.

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### **Field Research Plan**

#### **Logistics**

Dates in Antarctica:

early November 2000 to late January 2001

Research Locations:

Siple Dome, Ice Stream C, Ice Stream D

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**Team Members**

Barclay Kamb	Hermann Engelhardt	Robin Bolsey
Shulamit Gordon	Matt Bachmann	Slawek Tulaczyk
Daniel Abrams	Stefan Bogel	Michele Koppes
Kate Batten	Alberto Behar	

**Field-Season Operations**

The researchers plan to continue their study of the physical mechanism of rapid motion of the West Antarctic ice streams, in order to assess the stability or instability of the ice sheet in relation to global change. This season they will study the basal conditions of Ice Stream C, which ceased its rapid motion about 150 years ago. The researchers will attempt to identify the change in physical conditions responsible for the cessation of rapid motion by comparing the current conditions at and near the base of Ice Stream C with those in rapidly moving Ice Stream B and D, which were previously studied.

In early November 2000, the field team will travel via LC-130 aircraft to their camp site near the middle of Ice Stream C (Mid-C), where they will begin drilling the first of several boreholes through the ice. In all, the team members intend to drill a minimum of three holes, and more if possible. The first hole will be in the center of the ice stream's slow moving area, the second at the edge of the slow moving area (approximately 5-7 km from camp), and a third hole will be drilled outside of the slow moving region. A GPS technician will assist in locating potential drill sites. Some boreholes may be as far as 50 km from the camp. Drilling equipment will be moved to the drill sites on a ski-mounted modular structure towed by a large tracked vehicle. The team members will travel between camp and drill sites via snowmobiles when necessary.

The team members will measure the basal temperature and thermal gradient in each hole to determine whether the bed is frozen. If it is, team members will attempt to ascertain the thickness of the frozen zone by hot-water drilling. If attempts to penetrate the frozen zone are successful, the team members plan to measure the basal water pressure, the rate of basal freezing or basal melting, and the shear strength of the subsole till, all of which are factors likely to control ice-stream motion. The team members also plan to drill into the bed below the glacier to ascertain whether it consists of frozen till, unfrozen till, or bedrock. This will be done by a combination of hot-water drilling, piston coring, and cable tooling to break up oversized clasts. If they are able to penetrate into bedrock, they will sample it for study. Other planned borehole experiments include borehole logging of basal ice rock debris, measurement of borehole water-level fluctuation, and measurement of the rheology and pore pressure of basal till. Ice and subglacial till cores will be processed and packed for return to the home institution.

During the field season, team members will travel via Twin Otter aircraft on a day trip from the Mid-C camp to their instrument sites at Upstream D and Siple Dome. There, they will collect data and remove dataloggers, batteries, and solar panels from the instruments. The timing of this trip will depend upon Twin Otter scheduling.

In late January 2001, the team members will return to McMurdo Station via LC-130 aircraft, and the Mid-C camp will be closed. Ice samples will be shipped to the United States via the resupply vessel. Departing team members will handcarry the till samples to the home institution for further study.

**NSF/OPP Program Manager**  
Dr. Julie Palais

**RPS Point-of-Contact**  
Mr. Andy Young

## **Firn Air Sampling**

**IO-162-O**

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### **Research Objectives**

We will conduct high-resolution studies of variations in the concentration of methane, the oxygen-isotope composition of paleoatmospheric oxygen, and the total gas content of deep Antarctic ice cores, and we will continue our study of the concentration and isotopic composition of air in the firn layer of the Antarctic ice sheet. Our project has four major objectives:

- to use the methane concentration and oxygen-isotope composition of the air in ice as time-stratigraphic markers for precise intercorrelation of Greenland and Antarctic ice cores, as well as the correlation of ice cores to other climatic records;
- to use variations in the concentration and interhemispheric gradient of methane measured in ice cores from Greenland and Antarctica to deduce the changes in continental climates and biogeochemistry on which the atmospheric methane distribution depends;
- to use data on the variability of total gas content in the Siple Dome ice core to reconstruct aspects of the glacial history of West Antarctica during the last glacial maximum; and
- to participate at Vostok, Siple Dome, and South Pole in collaborative studies of firn-air chemistry, which will yield much new information about gas trapping in ice, as well as the concentration history and isotopic composition of greenhouse gases, oxygen, trace biogenic gases and trace anthropogenic gases during the last 100 years.

## **Field Research Plan**

### **Logistics**

Dates in Antarctica: late December 2000 to late January 2001  
Research Locations: along the Clean Air Sector

### **Team Members**

Mark Battle	Jesse Bastide	Andy Clarke
James Butler	TBD (2) (drillers)	

### **Field-Season Operations**

The project team members plan to work at the South Pole Station from late December 2000 to late January 2001 to conduct firm air sampling in three holes along the edge of the Clean Air Sector.

The support contractor will supply the team members with mobile field-camp gear at the research sites, including two buildings (one of which will be heated), an electric generator, tents, stove, food, communications equipment, and GPS equipment. The contractor will also provide two tracked vehicles for the team members to use for travel between the station and the research sites.

Two team members from the drilling technical project will drill a shallow (less than 150 meters), four-inch hole at three sites: 2 kilometers, 12 kilometers, and 20 kilometers away from the station along the edge of the Clean Air Sector. After drilling for a specified depth (5-20 meters), the team members will interrupt the drilling and insert a sampling bladder. This bladder will be inflated using tubes that feed through the bladder and extend to the surface, and then the team members will collect samples of the air trapped in the firm that is accessible through the gap between the bottom of the bladder and the bottom of the hole. When the sampling is completed, the team members will deflate the bladder and remove it from the hole and then resume drilling.

Some of the samples will be checked in the heated building at the site, using sampling equipment and computers. Most samples will be returned to the home institution for analysis.

## **Ice Dynamics, the Flow Law, and Vertical Strain at Siple Dome**

**IO-164-O**

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### **Research Objectives**

Ice flow near a divide such as Siple Dome is unique because it is predominantly vertical. As ice is deformed vertically, the vertical strain rate component is the dominant one, and it must be known in order to calibrate dynamic models of ice flow. This 5-year project – a collaboration between the Universities of Alaska, Washington, and California (UC San Diego) – is measuring the vertical strain rate (as a function of depth) at two sites on Siple Dome, Antarctica. We hope to use the results to develop a better analysis of the Siple Dome ice core than was possible from recent coring sites in central Greenland, to interpret the shapes of radar internal layering as indicators of the accumulation patterns and dynamic history of Siple Dome over the past 10,000 years, to interpret deep temperatures, and to address a more fundamental problem, the appropriate form of the flow law of ice at low effective stress.

During the 1997-98 field season we installed two relatively new, high-resolution systems for measuring strain rate, using holes drilled with the Caltech hot water rig. The data are being read in subsequent seasons. One system measures strain over a gauge length of 1 meter by electrical methods, and the other over a length of 200 meters by optical methods. The former system has the advantage of high spatial resolution but is more subject to the effects of installation transients and requires several years of data.

## **Field Research Plan**

### **Logistics**

Dates in Antarctica: early November 2000 to anywhere from early December 2000 to mid-December 2000 (depending on flight availability)

Research Locations: Siple Dome field camp area

### **Team Members**

John Morack Mark Zumberge

### **Field-Season Operations**

The researchers plan to measure the vertical distribution of ice-strain rate with depth at Siple Dome, where the ice is about 1000 meters thick. Instruments to do this work were installed during the 1997-98 field season, using the Caltech hot water rig. The instruments consist of two different systems: 1) a thermocouple wire with one-meter scale, and 2) a 200-meter fiber-optic system. Both of these systems are connected to data loggers. Brief annual visits have been made to read the instruments and download data from the loggers.

This season, the team members will travel via LC-130 aircraft from McMurdo Station to Siple Dome in mid-November 2000. They will base their operations at the Siple Dome field camp and travel via snowmobiles to the research sites, which are several miles from the Siple Dome camp. At the research sites, they will dig out the instruments, download data, and make adjustments to the instruments as necessary. The team members plan to work at the site for approximately two weeks and then return via LC-130 aircraft to McMurdo Station when a flight is available.

## **West Antarctic Glaciology-V**

### **IO-173-O**

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### **Research Objectives**

The West Antarctic Ice Sheet (WAIS) shows patterns of ice flow that are not fully understood. One so-called surge hypothesis has been put forth to explain these patterns. To test this hypothesis, two critical questions must be answered:

- Are ice streams B, D, and E currently surging?
- What has been the buttressing effect of an enlarging Cray Ice Rise on the flow of ice stream B?

This 3-year project is addressing these questions by collecting data from the air, from space, and from the surface. Many of the studies of change in West Antarctica have been based on interpolations and calculations with large uncertainties. We hope to take advantage of global positioning system data to minimize field logistic requirements and collect more accurate data. Specifically, we plan to obtain direct measures of (expected) thinning in the upper portion of ice stream D, as well as repeat satellite image measurements at the heads of ice streams B, D, and E. If these measurements reveal inland migration of the onset area, sustained surging may be verified and the hypothesis strengthened.

We will also take new measurements of the thickness, surface elevation, and velocity of the ice in order to compare the buttressing impact of the Cray Ice Rise on ice stream B's flow with data collected during the 1950s, 1970s, and 1980s. This part of the study should yield a time series of change in the WAIS over the last half century.

## **Field Research Plan**

### **Logistics**

Dates in Antarctica: early January 2001 to late January 2001  
Research Locations: Remote sites on Ice Stream D

### **Team Members**

Steve Price Patricia Vornberger

### **Field-Season Operations**

The project team members plan to travel to three sites on Ice Stream D to conduct a local survey of surface topography, as well as a precise GPS determination of a series of markers in the ice. They plan to occupy each site for one and a half days, during which they will set up a tent camp and use a snowmobile for the ground survey.

In early January 2001, the team members will travel via LC-130 aircraft from McMurdo Station to Siple Dome. In the next day or two, the team members will travel via Twin Otter aircraft to upper Ice Stream D, where they will begin their field work. Two days later, they will travel via Twin Otter aircraft to their study site at middle Ice Stream D, and two days after that to lower Ice Stream D. Once they've completed their field work at lower Ice Stream D (about two days), they will travel via Twin Otter aircraft back to Siple Dome, and then return shortly via LC-130 aircraft to McMurdo Station.

## **Retreat History of the West Antarctic Ice Sheet, Marie Byrd Land**

**IO-175-O**

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### **Research Objectives**

During our 2-year investigation, we will focus on reconstructing from the last glacial maximum to present the retreat history of the West Antarctic Ice Sheet, along a flowline through the Ford Ranges in Marie Byrd Land. Using cosmogenic-isotope exposure dating of moraine boulders and ice-abraded bedrock surfaces in the Clark, Allegheny, and Sarnoff Mountains, we will reconstruct the ice surface-elevation history of the region. Altitude transects will date the thinning of the ice sheet at each of these three sites, where the present ice surface stands at about 1200 meters, 800 meters, and 200-400 meters, respectively. The results of our research will be a deglaciation chronology for Marie Byrd Land capable of resolving competing models of ice-sheet retreat. We will also generate a data set for testing numerical models of the West Antarctic Ice Sheet through the glacial cycle. In addition, the results will help constrain the past ice load in West Antarctica and therefore help to predict the effect of glacioisostatic motion on geodetic surveys being carried out in the region.



## **Iceberg Drift in the Near-Shelf Environment: Ross Ice Shelf, Antarctica**

**IO-190-O**

**Dr. Douglas MacAyeal, Principal Investigator**

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### **Research Objectives**

The recent calving of a large iceberg (B15) from the Ross Ice Shelf presents a unique opportunity to measure the processes that control the drift of large tabular icebergs, including wind-driven and thermohaline currents, tides, sea ice, and winds. The calving of such an extraordinarily large iceberg within the logistics reach of the U.S. Antarctic Program is rare and provides us with the opportunity to study iceberg drift, as well as other aspects of iceberg behavior that are associated with the long-term stability of the antarctic environment.

The extraordinary freshwater volume of large tabular icebergs has in the past been identified as a natural resource of human economic value (e.g., for water-poor regions of the earth). Feasibility studies of iceberg towing to water-poor regions have largely been dismissed as science fiction. Nevertheless, tabular icebergs commonly travel thousands of miles as a result of natural processes, which, if understood, could perhaps be harnessed for human economic and social value. We propose to make direct measurements of the drift of icebergs B15a, B15b and a smaller iceberg (either B16, B17 or B18, depending on circumstances) to:

- observationally constrain parameters that will improve the models of iceberg drift, e.g., by determining drag coefficients appropriate to atmospheric and oceanic interactions, including drag induced by sea ice;
- improve our ability to predict calving events and the subsequent iceberg drift trajectory;
- complement ongoing remote sensing study of the iceberg and its behavior; and
- measure the progress of the berg(s) toward logistically sensitive areas.

The last point reflects the fact that interest in B15's drift in the immediate future is not restricted to basic science. Conceivably, B15 and its progeny (it is now in two pieces and has caused smaller bergs to calve from the Ross Ice Shelf) could complicate normal shipping to and from McMurdo Station on Ross Island, the main U.S. research and logistics station in Antarctica.

## **Field Research Plan**

### **Logistics**

Dates in Antarctica: mid-January 2001 to mid-February 2001  
Research Location: Iceberg B-15 on the Ross Ice Shelf

### **Team Members**

Douglas MacAyeal                      Andrew Bliss                      Benjamin Kerman

### **Field-Season Operations**

The project team members will travel to McMurdo Station around mid-January 2001. They will then travel to Iceberg B-15 near the Ross Ice Shelf to place automatic weather station (AWS) and geographic positioning system (GPS) instruments on the iceberg. The data from these instruments will be transmitted via ARGOS satellite to the home institution. The researchers will use this data to determine the iceberg's location over a period of time, how the iceberg rotates, and the weather conditions during the time the iceberg is tracked.

There are several possible ways for the team members to travel to the iceberg, depending on ship schedules and on the location of the iceberg. The team members may travel via the U.S. Coast Guard Icebreaker from McMurdo Station to the vicinity of Iceberg B-15, and then travel via Icebreaker-based helicopter to place the instruments on the iceberg. Another option will be for the team members to travel between McMurdo Station and Iceberg B-15 on a U.S. Coast Guard helicopter.

It is estimated that placing the instruments on the iceberg will take approximately four, 3-hour missions over a time period of about five to seven days.

## **Collecting Micrometeorites from the South Pole Water Well**

**IO-192-O**

**Dr. Susan Taylor, Principal Investigator**

USA-CRREL

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### **Research Objectives**

In 1995, thousands of micrometeorites were collected from the bottom of the South Pole water well. Using these samples, we were able to determine a precise flux and mass distribution for 50-700 millimeter cosmic spherules (melted micrometeorites) for 1100-1500 A.D. This austral summer, we will collect new samples with four goals in mind: to verify that the polar plateau preserves the original surface flux of micrometeorites, to quantify both melted and unmelted micrometeorites for the 400-1100 A.D. time frame, to determine the flux for 1-50 millimeter interplanetary dust particles (IDPs), and to assess whether the latter are a subclass of micrometeorites or derive from different cosmic sources. We will also quantify variations (if any) in the flux or compositional distribution of micrometeorites on 10- to 100-year scales, and recover as many micrometeorites from the well as possible. Besides micrometeorites, we will collect diatoms, opal phytoliths, and terrestrial mineral grains from the well. Such collections will help researchers determine the sources of terrestrial particles landing on the Antarctic plateau. Arrangements have been made for Johnson Space Center (JSC)/NASA personnel to curate the samples and make them readily available to researchers in Earth and planetary sciences.

## **Field Research Plan**

### **Logistics**

Dates in Antarctica: early November 2000 to late November 2000  
Research Location: South Pole water well

### **Team Members**

Susan Taylor                                  James Lever                                  John Govoni

### **Field-Season Operations**

The project team members plan to work at South Pole Station during the month of November 2000 to conduct a final collection of micrometeorites and terrestrial dust from the South Pole water well before the well is closed. In 1995, the researchers collected thousands of well-preserved micrometeorites from the bottom of the South Pole water well.

Support contractor personnel will reinstall the laboratory building that was used in 1995 over the water well and connect power and the furnace to this building. The field-team members will work from this building to drill an access hole into the existing water well bulb. They will then lower equipment into the well to recover micrometeorites that have settled to the bottom of the well over the past five years. The collected micrometeorites will be returned to the home institution for analysis.

**AMS Radiocarbon Chronology of Glacier  
Fluctuations in the South Shetland Islands  
During the Last Glacial/Interglacial Hemicycle:  
Implications for the Role of Antarctica in Global  
Climate Change**

**IO-196-L**

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## **Research Objectives**

The question of what drives glacial cycles is a fundamental problem in global climate change. Detailed, well-dated, paleoclimate data from the Southern Hemisphere are rare and yield conflicting interpretations of interhemispheric synchrony/asynchrony of the climate system. Broecker (1997, 1998) has suggested that there is an asymmetry in the climate system between Antarctica and the rest of the globe that is related to deep-ocean circulation. To test this hypothesis, we must first determine whether or not the climate of Antarctica is truly out of phase with that of South America.

Our goal is to document the paleoclimatic history of the South Shetland Islands, located just south of the Antarctic Convergence and the Drake Passage. This field season, we will map the areal extent and geomorphology of glacial deposits and erosional features related to the last glacial maximum. We also will develop relative sea-level curves from numerous flights of raised beaches to determine the timing of ice unloading.

This research will produce a new reconstruction of ice extent, elevation, and thickness at the last glacial maximum in the South Shetland Islands that can then be used in studies of ocean circulation and ice dynamics. It also will produce a deglacial chronology, which will afford important clues about the mechanism(s) controlling ice retreat. This chronology is key for relating climate changes in the South Shetland Islands to the global framework necessary to test hypotheses of the inter- and intrahemispheric synchrony of climate change.

## Field Research Plan

### Logistics

Dates in Antarctica: late March 2001 to early June 2001  
Research Locations: Fildes Peninsula (King George Island), Barton Peninsula (King George Island), Byers Peninsula (Livingston Island)

### Team Members

Brenda Hall Ethan Perry

### Field-Season Operations

The researchers plan to study the glacial and sea-level history of the South Shetland Islands, with a particular focus on establishing the temporal relationships of glacier and sea-level advances. They will work at three island locations, where they will map deposits left by ancient glaciers and seas and collect samples for later radiocarbon dating. They hope to establish a detailed chronology of the alternating periods of heavy glaciation and submergence of the South Shetland Islands, which in turn they will test for correlation with other aspects of global climate change.

The first two research sites will be on King George Island—first on the Fildes Peninsula and then at Potter Cove on the Barton Peninsula, some 8 miles away. The third site will be on the Byers Peninsula of Livingston Island, nearly 100 ship miles away. The Fildes Peninsula site is in the proximity of the Chilean Base, Presidente Frei. This base is operated by the Chilean Air Force, who will provide helicopter support for the team members to move from the Fildes Peninsula to the Potter Cove site. Other than this, the team members will travel on board the R/V *Laurence M. Gould* and use Zodiac inflatable boats for travel between ship and shore. The team members will establish a small tent camp at each site.

The team members will travel on board the R/V *Laurence M. Gould* (cruise LMG01-3), which is scheduled to leave Punta Arenas in mid-March 2001. Before beginning their work at Base Frei, the research vessel will make a brief stop at the Potter Cove site to cache fuel, food, and equipment for the later work there.

After about three weeks at the Fildes Peninsula site, the team will be transported by Chilean Air Force helicopter to Potter Cove. After about two weeks at Potter Cove, the team will be picked up by the R/V *Laurence M. Gould* (cruise LMG01-4) and transported to the Byers Peninsula site for their final five weeks of field work. They will then be picked up by the R/V *Laurence M. Gould* in early June 2001 on the northbound leg of cruise LMG01-4 and transported to Punta Arenas, Chile.

# **Deglacial Chronology of the Northern Scott Coast from Relative Sea-Level Curves IO-196-M**

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## **Research Objectives**

A key unresolved question concerns the stability (instability) of the West Antarctic Ice Sheet. One way to gain insight into present and future WAIS stability is to examine its past behavior. In particular, the timing of deglaciation is critical for isolating the mechanisms (sea level, climate, ocean temperatures, internal ice processes) that control WAIS dynamics. New relative sea-level curves from the southern Scott Coast indicate a Holocene age for deglaciation of the Ross Sea Embayment. However, those data do not bear on the initial timing of deglaciation, since they are located 450 km south of the last glacial maximum grounding line. This project is designed to develop relative sea-level curves (and hence to determine the timing of deglaciation) farther north along the Scott Coast in areas closer to the former grounding line.

This season, we will be working along the Scott Coast in an area extending from Granite Harbor to Terra Nova Bay. We will map flights of raised beaches and collect organic remains for radiocarbon dating. We also will study the morphology, sedimentology, and stratigraphy of raised beaches to determine 1) how the beaches formed, 2) any temporal variations in beach formation, and 3) the mechanism(s) by which organic material was incorporated into the beaches.

## **Field Research Plan**

### **Logistics**

Dates in Antarctica: late December 2000 to mid-February 2001  
Research Locations: Cape Ross, Gregory Island, Cape Roberts, Depot Island, Cape Hickey, Inexpressible Island, Tripp Island

### **Team Members**

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Peter Marcotte Nate Gardner

### **Field-Season Operations**

The researchers plan to map the raised beaches of the northern Scott Coast, determine their elevations, and collect organic samples for radiocarbon dating. Using this data, the researchers will determine the relative sea-level history of the northern Scott Coast and from that deduce the timing of grounded ice recession from the Ross Embayment.

In early January 2001, team members will travel via helicopter to Cape Ross, where they will set up the first of several field camps. From the Cape Ross camp, the team members will make day trips via helicopter to study sites at Gregory Island, Tripp Island, Depot Island, Marble Point, and Granite Harbor. At Cape Ross and the other study sites, team members will investigate the terrain on foot. They will use GPS equipment to map the locations and elevations of raised beaches, and they will collect samples of organic matter from the beach soil for radiocarbon dating.

In mid-January 2001, the team members will split into two groups and move their camp via helicopter from Cape Ross to two smaller camps—one on Inexpressible Island and the other on Tripp Island. In early February 2001, the Inexpressible Island camp will be moved by helicopter to Cape Hickey and the Tripp Island camp will be moved by helicopter to Depot Island. At each camp, the team members will continue GPS mapping and data collection. In mid-February 2001, both camps will be pulled out and all the team members, equipment, and samples will travel by helicopter to McMurdo Station.

Samples will be returned to the home institution for analysis.

**United States Component of the  
International Trans-Antarctic Expedition  
(U.S. ITASE)**

**IU-133-O,153-A,153-B,155-O,158-O,178-O,  
185-O,193-O, 311-O**

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## **Research Objectives**

The following information contains the U.S. ITASE projects' research objectives:

### **Radar Studies of Internal Stratigraphy and Bedrock Topography along the U.S. ITASE Traverse (IU-133-O)**

The U.S. component of the International Trans-Antarctic Scientific Expedition (U.S. ITASE) conducts radar studies to determine the internal stratigraphy and bedrock topography of the terrain along the traverses. To help in the selection of core sites as the traverse proceeds, the radar provides information on ice thickness and internal layer structure that is immediately available to those working in the field. These data can also be used to site deeper millennial scale cores (planned at less frequent intervals along the traverse) and to provide a context for selecting the location of the deep inland core (planned for the future). In addition to mapping the traverse route, radar is used to examine a grid surrounding each of the core locations, to better characterize the accumulation and bedrock topography in each area.

This radar system works as a complement to that operated by the Cold Regions Research and Engineering Laboratory (CRREL). Theirs is a high-frequency radar, most suited to the shallower portion of the record down to approximately 60 meters; it can detect near-surface crevasses. Our radar system is most sensitive at depths below 60 meters, able to depict deep bedrock and internal geological layers deep within the ice.

### **Science Management for U.S. ITASE (IU-153-A)**

The Science Management Office (SMO) coordinates the efforts of the United States component of the International Trans-Antarctic Scientific Expedition (U.S. ITASE). The broad aim of U.S. ITASE is to develop an understanding of the last 200 years of west Antarctic climate and environmental change. ITASE is a multidisciplinary program that integrates remote sensing, meteorology, ice coring, surface glaciology and geophysics. To marshal this effort, SMO runs a series of annual workshops to coordinate the science projects that will be involved in ITASE. SMO also establishes and operates the logistics base that supports ground-based sampling in West Antarctica.

### **U.S. ITASE Glaciochemistry (IU-153-B)**

Among the research targets for scientists in the U.S. component of the International Trans-Antarctic Scientific Expedition (U.S. ITASE) are the impact of anthropogenic activity on the climate and atmospheric chemistry of West Antarctica and variations in the biogeochemical cycling of sulfur and nitrogen compounds over the last 200 years. This 5-year project is conducting glaciochemical analyses of the major anions and cations to be found in shallow and intermediate depth ice cores collected on the U.S. ITASE traverses. The ionic composition of polar ice cores provides one of the basic stratigraphic tools for relative dating. Also, these data can be used to document changes in chemical-species source emissions, which in turn facilitate mapping and characterization of the major atmospheric circulation systems affecting the West Antarctic Ice Sheet.

### **Snow and Firn Microstructure and Transport Properties: U. S. ITASE (IU-155-O)**

Not all valuable data are buried deep within the ice. The microstructure and bulk properties of snow and firn near and at the surface control the air/snow/firn transport processes; i.e., how heat, vapor, and chemical species in air are incorporated into snow and polar firn. Since many of the snow and firn properties also affect the interaction of radiation in different parts of the electromagnetic spectrum, field measurements provide a valuable ground truth “check” for complementary efforts using remote sensing to map the spatial variations of snow, firn, and ice properties.

This project does the field and lab work to characterize snow and firn properties along the U.S. International Trans-Antarctic Scientific Expedition (U.S. ITASE) traverses in West Antarctica. Our objective is to obtain field measurements of near-surface (down to 2 meters) snow and firn properties, including surface roughness, permeability, density, grain size, surface-to-volume ratio, and tortuosity. In the laboratory, firn cores from as deep as 20 meters will be analyzed for these properties and for their microstructure. Ultimately, we will develop a transport model to elucidate the nature of the air/snow/firn exchange and firnification process at the various sites along the U.S. ITASE traverse.

**Hydrogen Peroxide (H<sub>2</sub>O<sub>2</sub>), Formaldehyde (HCHO), and Sub-annual Snow Accumulation in West Antarctica: Participation in West Antarctic Traverse (IU-158-O)**

Atmospheric photochemistry leaves valuable traces in snow, firn and ice, and it has been verified that the efficiency of atmosphere-to-snow transfer and the preservation of H<sub>2</sub>O<sub>2</sub> and HCHO is strongly related to temperature and to the rate and timing of snow accumulation. Thus measurements of these components in the firn and atmosphere will provide data needed to study changes in tropospheric chemistry of the boundary layer over West Antarctica.

This project will collect samples and take atmospheric measurements along the U.S. International Trans-Antarctic Scientific Expedition (ITASE) traverses. The wide-ranging extent of these traverses will train the scientific lens upon a variety of locations covering much of the West Antarctic region and reflecting a range of different depositional environments.

Measurements of the concentration of seasonally dependent species (such as hydrogen peroxide, nitric acid, formaldehyde and stable isotopes of oxygen) will be made on these samples and fed into a recently developed, physically based atmosphere-to-snow transfer model in order to elucidate the photochemistry that led to the depositions. In addition, current atmospheric levels of H<sub>2</sub>O<sub>2</sub>, higher peroxides such as methylhydroperoxide (MHP), and HCHO will constrain model boundary conditions and the state of photochemistry in the austral summer.

**Mass Balance and Accumulation Rate along U.S. ITASE Routes (IU-178-O)**

The polar ice sheets and the snow falling on them are important components of the global hydrological cycle. Yet, because of their very large size and remote locations, we have only a limited understanding of their mass balance (rate of thickness change) or the spatial distribution of snow accumulation. Work conducted as part of the US component of the International Transantarctic Scientific Expedition (ITASE) seeks to improve this understanding.

This 5-year project involves measuring the rate of ice sheet thickening or thinning at selected sites along flow lines, on ice divides, and along elevation contours. The measurements entail comparing the vertical velocity of ice, obtained from very precise global positioning system (GPS) surveys of markers buried 5-20 meters deep in the surface firn, with the local, long-term average snow accumulation rate derived from ice-core stratigraphy. Prior work demonstrates that very precise rates of thickness change can be measured using this technique.

Another aspect of this project is a study of spatial variations in accumulation rates. This work involves studying the link between snow accumulation and surface topography. Continuously operating, autonomous instruments will be deployed at several closely-spaced sites, but in places of very different slope gradient. The instruments will record snow accumulation, wind speed and direction, firn compaction, and firn temperature. Results will be used to test hypotheses concerning the physical processes of snow deposition and erosion.

We shall also investigate the ice flow effects on accumulation rates derived from U.S. ITASE ice core records. At sites along flow lines, ice cores record the

integrated accumulation rate history for a distance up-glacier of the core site corresponding to the time period covered by the core. Changes in surface topography along this flow line length will lead to apparent accumulation rate variations in the ice-core record. By studying local ice dynamics (horizontal velocities, surface slope) around each ice-core site we will be better able to understand the cause of accumulation rate variations in core records.

### **The Physical Properties of the U.S. ITASE Ice Cores (IU-185-O)**

This four-year project will examine the visual stratigraphy and the physical and structural properties of the U.S. ITASE ice cores, which span the last 200 years of snow accumulation in Antarctica. A first priority will be to examine visual stratigraphy to delineate annual layer structure for dating purposes and to determine, to as great a depth as possible, accumulation variability over the full length of a stratigraphically dated core. A second objective will be to measure and analyze depth-density profiles. The rate of snow and firn densification depends upon both the rate at which the snow is deposited and the *in situ* snow temperature. These data can and will be used to derive average snow accumulation rates for the sites where annual layer structure is difficult to decipher or where stratigraphic analysis fails altogether.

A third objective will entail measurements of mean crystal size over the full length of a core. Crystal growth is a strongly temperature-dependent process, and measurements to be made on ITASE cores will help to bridge a significant data gap that exists in the mean annual temperature range,  $-31^{\circ}$  to  $-50^{\circ}\text{C}$ . Additionally, crystal size data can also be used, in conjunction with ice loads based on density profile measurements, to extract mean accumulation rates for these sites where stratigraphic dating of cores proves difficult or impossible to accomplish. This is likely to occur at the lowest accumulation/lowest temperature sites along the ITASE traverse routes.

### **Stable Isotope Studies at West Antarctic ITASE Sites (IU-193-O)**

As participants in the International Trans-Antarctic Scientific Expedition (ITASE), we will perform stable isotope analyses of samples collected during the traverses in West Antarctica. Using instrumental and remote-sensing temperature histories, we will focus on the spatial and temporal distribution of oxygen-18 and deuterium in West Antarctica (where data are particularly sparse), and we will calibrate the isotope-climate relationship on a site-by-site basis. Our objectives are:

- to obtain detailed oxygen-18, deuterium and deuterium excess, and stratigraphic histories in snow pits at most or all of the ITASE coring sites;
- to provide direct calibration of the isotope-climate relationship at each site through a combination of direct (AWS) and indirect (passive microwave satellite) temperature measurements;
- to obtain isotope profiles covering the last 200 years; and
- to use the results to provide 200-year-long climate histories at high temporal and broad spatial resolution across West Antarctica.

These climate histories will allow testing of proposed relationships among isotopes, moisture source conditions, synoptic scale climatology, and site-specific meteorological parameters, while enhancing our ability to interpret isotope records from older and deeper Antarctic ice cores.

**High Resolution Radar Profiling of the Snow and Ice Stratigraphy Beneath the ITASE Traverses, West Antarctic Ice Sheet (IU-311-0)**

Ice core measurements provide historical profiles of snow accumulation and chemistry at only point locations. Along the ITASE traverses, core measurements are spaced about 100 km apart. Subsurface radar provides reflection profiles of continuous horizons generally related to density and chemistry contrasts, but their continuity strongly suggests that they are isochronal. Thus they can be used to track particular years between core sites, and to provide a broad and more meaningful average of year-to-year accumulation rates given the time versus depth calibrations from the cores.

This project is tracking these reflection horizons between core sites using high resolution ground-penetrating, short-pulse radar. Our main antenna system uses a pulse centered near 400 MHz, which provides vertical resolution of about 35 cm and records reflections from a depth in firn of about 60 m. During the first year of ITASE, we tracked some horizons over 190 km distance and found many to vary as much as 22 m in depth over 5 kilometers. The variations are caused by surface topography, which affects local accumulation rates, and ice movement. We are also using frequencies as high as 10 GHz and as low as 100 MHz to distinguish between conductivity and density as a cause of the reflections. The horizon tracking will be used to find spatially averaged, historical accumulation rates, and correlations with GPS data will be used to find the effects of topography upon local accumulation rates. In addition, the radar is also being used for advanced crevasse detection.

The following list contains the U.S. ITASE projects' Principal Investigator contact information:

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**IU-158-O: Hydrogen Peroxide (H<sub>2</sub>O<sub>2</sub>), Formaldehyde (HCHO), and Sub-annual Snow Accumulation in West Antarctica: Participation in West Antarctic Traverse**

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**IU-178-O: Mass Balance and Accumulation Rate along U.S. ITASE Routes**

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**IU-185-O: The Physical Properties of the U.S. ITASE Ice Cores**

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**IU-193-O: Stable Isotope Studies at West Antarctic ITASE Sites**

Drs. Eric Steig, James White, and Christopher Shuman

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**IU-311-0: High Resolution Radar Profiling of the Snow and Ice Stratigraphy beneath the ITASE Traverses, West Antarctic Ice Sheet**

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## **Field Research Plan**

### **Logistics (For all U.S. ITASE Projects)**

Dates in Antarctica: late October 2000 to early January 2001  
Research Locations: Byrd Surface Camp, Marie Byrd Land

### **Team Members (For all U.S. ITASE Projects)**

Paul Mayewski	Gordon Hamilton	Steve Arcone
Chris Shuman	Norbert Yankielun	Benjamin Cavallari
Zachary Smith	Michael Gerasimoff	Markus Frey
Brian Welch	Leigh Stearns	David Schneider
TBD (2)		

### **Field-Season Operations**

### **ITASE Traverse Overview**

The broad aim of the United States component of the International Trans-Antarctic Scientific Expedition (U.S. ITASE) is to develop an understanding of the last 200 years of West Antarctic climate and environmental change. ITASE, part of the West Antarctic Ice Sheet Initiative (WAIS), is a multidisciplinary program that integrates remote sensing, meteorology, ice coring, surface glaciology, and geophysics. The U.S. component of the ITASE is coordinated through the science management office located at the University of Maine at Orono.

The projects funded as part of the U.S. ITASE are:

IU-133-O Dr. Jacobel  
IU-153-B Dr. Mayewski  
IU-155-O Dr. Albert  
IU-158-O Dr. Bales  
IU-178-O Dr. Hamilton  
IU-185-O Dr. Meese  
IU-193-O Drs. Steig, White, and Shuman  
IU-311-O Dr. Arcone

The U.S. ITASE team will conduct a 1200-kilometer, triangular traverse in West Antarctica during the 2000-2001 field season. In early November 2000, the ITASE team members and support contractor personnel will fly via LC-130 aircraft from McMurdo Station to Byrd Surface Camp (BSC). The traverse, which will consist of team members traveling on snowmobiles and tracked vehicles pulling sleds, will begin at BSC and extend 150 kilometers grid west on the West Antarctic Ice Sheet. At that point, the traverse will head grid south-southeast for approximately 500 kilometers, then grid north for another 500 kilometers, returning to BSC in mid-December 2000.

The traverse team members will camp in tents along the route. During the traverse, they will take ice cores, collect surface snow and ice samples, take meteorological readings, and collect radar profiles of the ice sheet. Periodically, Twin Otter aircraft will resupply the traverse team and transport ice cores and other samples back to BSC.

Some traverse members will conduct ground studies from a series of tent camps along the route while other team members travel ahead via snowmobile to conduct additional radar and surface studies. The two teams will rejoin before returning to BSC in mid-December 2000. All U.S. ITASE team members and their samples will be transported to McMurdo Station on an LC-130 aircraft "cold deck" flight in late December 2000. Ice and snow samples will be returned to the home institutions for analysis.

### **IU-133-O: Radar studies of Internal Stratigraphy and Bedrock Topography along the U.S. ITASE Traverse**

The team members plan to use a snowmobile and a Komatik sled to tow a low-frequency, ice-penetrating radar system along the U.S. ITASE traverse routes. The radar data will depict bedrock topography and internal layers along 1200 kilometers of the West Antarctic Ice Sheet (WAIS). In addition, the researchers will conduct more detailed studies on grids surrounding each of the ITASE 200-year ice-core sites to characterize accumulation and bedrock topography in these areas. The grids will require 60 to 80 kilometers of radar profiles each, depending on ice thickness and bed topography. The grid surrounding the site of the deep inland WAIS core may require up to 100 kilometers of profiling.

In addition to the radar surveys around ice core sites, the team members plan to conduct a radar survey beginning at the location of the most distant 200-year

core (in the catchment of ice stream C) and continuing across crevasse-free regions toward ridge B/C for approximately 100 kilometers.

**IU-153-A: Science Management for U.S. ITASE**

Researchers in this component of the U.S. ITASE plan to continue their overall management of the U.S. ITASE program. This will include coordinating logistics and sample collection, assisting in sample collection, and maintaining a science management office. Team members will also organize a series of annual workshops to coordinate the science projects involved in ITASE.

**IU-153-B: U.S. ITASE Glaciochemistry**

The researchers plan to continue their studies of atmospheric chemistry, as a means of elucidating climate variations over seasonal, inter-annual, decadal, and centennial scales. They will also examine the impact of anthropogenic activity on the climate and atmospheric chemistry of West Antarctica, as well as variations in the biogeochemical cycling of sulfur and nitrogen compounds over the last 200 years.

Traverse team members will collect ice-core samples for ultra-high resolution analysis and interpretation of soluble ion content. The ions of interest comprise more than 95% of the soluble chemistry in the atmosphere, and researchers plan to examine 200 years of deposition along the U.S. ITASE traverse routes. The 6-10 cores collected this season will provide information that contributes to the understanding of changes in atmospheric chemistry and associated climatic variation. The cores will be packed in boxes and flown via Twin Otter aircraft from drill sites on the traverse route to Byrd Surface Camp. From there, they will be transported on an LC-130 aircraft “cold deck” flight to McMurdo Station and sent on to the home institution for soluble ion analyses.

**IU-155-O: Snow and Firn Microstructure and Transport Properties: U. S. ITASE**

The researchers plan to continue their investigation into snow and firn bulk properties and microstructures along the project’s traverse route in West Antarctica. They will measure near-surface snow and firn parameters, including stratigraphy, permeability, density, grain size, surface-to-volume ratio, and porosity. These measurements will provide valuable ground truth for remote sensing efforts to map the spatial variations of snow, firn, and ice properties.

Since no members of this project will participate in the 2000-2001 ITASE traverse, other members of the U.S. ITASE traverse team will conduct field measurements and collect samples in support of this project. Team members will drill 15-meter firn cores and send them to CRREL for analysis. The data will be used in a finite-element process model to elucidate the nature of the air-snow-firn exchange and firnification processes at the coring sites.

Traverse team members will also measure the permeability of 10-centimeter samples in snow pits at the ITASE coring sites. The snow samples will be preserved in dimethyl phthalate and shipped to CRREL for thick section analysis of their microstructure.

**IU-158-O: Hydrogen Peroxide (H<sub>2</sub>O<sub>2</sub>), Formaldehyde (HCHO), and Sub-annual Snow Accumulation in West Antarctica: Participation in West Antarctic Traverse**

The researchers plan to continue their studies of atmospheric photochemistry over West Antarctica, as recorded in snow, firn, and ice. They will use an atmosphere-to-snow transfer model to correlate estimates of atmospheric hydrogen peroxide and formaldehyde concentrations to concentrations measured in surface and near-surface snow, snow pits, and shallow cores.

Since no members of this project will participate in the 2000-2001 ITASE traverse, other members of the U.S. ITASE traverse team will collect snow pit, firn, and ice core samples in support of this project. The team members will use plexiglas scrapers to collect snow-surface samples during and after fresh snow events, and they will record the time elapsed since precipitation. The samples will be melted, aliquoted, and refrozen immediately, then packed for return to the home institution. ITASE team members will take separate snow pit samples for formaldehyde analysis and store them in SCHOTT bottles. At each core site, team members will take continuous measurements of hydrogen peroxide in the air above the snow. Atmospheric hydrogen peroxide will be collected using the cartridge method. Team members will also record vertical profiles of snow temperature in each pit.

This project's researchers will analyze the samples at the home institution to measure hydrogen peroxide and formaldehyde concentrations in surface, near surface, snow pit, and shallow ice core samples.

**IU-178-O: Mass Balance and Accumulation Rate along U.S. ITASE Routes**

The researchers in this component of the U.S. ITASE plan to study the mass balance and accumulation rate of ice along the traverse routes. Team members will use markers and GPS to record the horizontal and vertical velocities of subsurface ice, thereby measuring the rate of ice-sheet thickening or thinning along flow lines, ice divides, and elevation contours in West Antarctica. The findings are expected to improve scientists' ability to deduce true past climatic variations from the U.S. ITASE ice-core records.

Team members will install a series of recording instruments to provide continuous records of firn densification and changes in snow-surface elevation. These instruments will be deployed at selected sites to link transient changes in snow-surface elevation, as measured by altimeters, to long-term rates of ice-thickness change. Other recording instruments will measure wind-speed and direction as well as snow accumulation. The data will be returned to the home institution for analysis.

**IU-185-O: The Physical Properties of the U.S. ITASE Ice Cores**

The researchers plan to examine the visual stratigraphy and the physical and structural properties of the U.S. ITASE ice cores, which span the last 200 years of snow accumulation in Antarctica.

Since no members of this project will participate in the 2000-2001 ITASE traverse, other members of the U.S. ITASE traverse team will conduct on-site weighing of samples for this project for snow/firn/ice density calculations. Ice cores drilled by the drilling team (approximately 1 meter in length) and smaller samples from snow pits will be carefully weighed. It is necessary to do this in the field, as the exterior portion of snow and firn cores may deteriorate during transport. Therefore, field measurements will be the most accurate.

Collected samples will be returned to the home institution for additional studies.

### **IU-193-O: Stable Isotope Studies at West Antarctic ITASE Sites**

The researchers plan to examine the spatial and temporal distribution of oxygen-18 and deuterium along the U.S. ITASE traverse routes in West Antarctica. The data will be used to calibrate the isotope-climate relationship at each collection site through a combination of direct (automatic weather station) and indirect (passive microwave satellite) temperature measurements. The results will be used to provide 200-year climate histories at high-temporal and broad-spatial resolution across West Antarctica. The data are also expected to enhance scientists' ability to interpret isotope records from older and deeper antarctic ice cores.

One member of this project will deploy with the U.S. ITASE team to collect snow-pit and ice-core samples along the traverse routes. The samples will be returned to the home institution where the researchers will perform oxygen-18 and deuterium analyses.

### **IU-311-0: High Resolution Radar Profiling of the Snow and Ice Stratigraphy beneath the ITASE Traverses, West Antarctic Ice Sheet**

The researchers plan to use high-resolution, ground-penetrating radar to profile the snow and ice stratigraphy beneath the ITASE traverse routes. The data will be used to choose coring sites with horizontal and unique stratigraphy, interpolate the areal extent that a core represents, reconstruct snow deposition records between core sites, determine the influence of topography and ice movement on local accumulation rates, and provide advance crevasse detection along the ITASE traverse routes.

Team members will both push and drag 400-megahertz radar along the traverse. The pushed antenna will extend six meters in front of the lead Tucker Sno-Cat tracked vehicle to detect crevasses. The dragged radar antenna and a GPS antenna will be used to profile the top 60 meters of firn. The instruments will be operated from inside the vehicle. The radar team will also use pulse center frequencies of 100 and 200 megahertz to obtain profiles of stratigraphy through the firn-ice transition near the core site camps. The researchers will compile and process data enroute and electronically enter GPS positions on the radar data.

**NSF/OPP Program Manager**  
Dr. Julie Palais

**RPS Point-of-Contact**  
Mr. Andy Young



## Overview of the Antarctic Oceans and Climate Systems Program

Antarctic oceanic and tropospheric studies focus on the structure and processes of the ocean-atmosphere environment and their relationships with the global ocean, the atmosphere, and the marine biosphere. As part of the global heat engine, the Antarctic has a major role in the world's transfer of energy. Its ocean/atmosphere system is both an indicator and a component of climate change. The ocean and climate systems program sponsors research that will improve understanding of high-latitude oceanic environment, including the global exchange of heat, salt, water, and trace elements, sea-ice dynamics, and tropospheric chemistry and dynamics.

Major program elements include the following:

- Physical oceanography: the dynamics and kinematics of the polar oceans; the interaction of such forces as wind, solar radiation, and heat exchange; water-mass production and modification processes; ocean dynamics at the pack-ice edge; and the effect of polynyas on ventilation.
- Chemical oceanography: the chemical composition of seawater and its global differentiation, reactions among chemical elements and compounds in the ocean, fluxes of material within ocean basins and at their boundaries, and the use of chemical tracers to study time and space scales of oceanic processes.
- Sea-ice dynamics: the material characteristics of sea ice from the individual crystal level to the large-scale patterns of freezing, deformation, and melting.
- Meteorology: atmospheric circulation systems and dynamics, including the energy budget; atmospheric chemistry; transport of atmospheric contaminants to the Antarctic; and the role of large and mesoscale systems in global exchange of heat, momentum, and trace constituents.

## **Longwave Radiation Processes on the Antarctic Plateau**

**OO-201-O**

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### **Research Objectives**

Thermal infrared (“longwave”) radiation is an important component in the energy balance of the atmosphere and the Earth’s surface. On the Antarctic continent, radiation processes dominate the surface energy budget. In summer the balance is made up of four components: incoming solar radiation, reflected solar radiation, longwave radiation emitted by the atmosphere, and longwave radiation emitted by the snow surface. In winter, after the sun sets, the short-wave components fall to zero. The emitted long-wave radiation increases with temperature, so the surface temperature is determined by the balance of radiation fluxes.

This project entails an experimental study of long-wave radiation processes near the surface at South Pole station. We will deploy instrumentation capable of high-resolution spectral measurements of the longwave radiation at the snow surface. A Fourier-transform Interferometer will be installed in late 2000 and operated through a full year. Supporting observations will also be made of the variation of temperature and humidity with height in the lower atmosphere, and of ice crystals in the atmospheric boundary layer. The research also includes experiments designed to elucidate the emission characteristics of snow, of ice crystals in the atmosphere, of clouds, and of greenhouse gases near the surface. Determining the concurrent environmental conditions (such as cloud-base altitude, temperature and humidity-structure) and the sizes and concentrations of ice crystals will contribute to the newly developing climatology of cloud properties, and the data should improve the representation of radiation processes in climate models.

## **Field Research Plan**

### **Logistics**

Dates in Antarctica: mid-November 2000 to mid-February 2001 AND the 2001 austral-winter season

Research Locations: Boundary of the Clean Air Sector, Atmospheric Research Observatory (ARO)

### **Team Members**

Vol Walden	Sergei Dolgy	Penny Rowe
Michael Town	Stephen Warren	Jessica Dempsey
Jim Spinhirne	Richard Brandt	

### **Field-Season Operations**

The project team members plan to work at South Pole Station for most of the 2000-2001 austral summer season, and two team members will remain at the South Pole for the 2001 austral-winter season. The team members will operate the South Pole Transmissometer (SPT) and the Polar Atmospheric Emitted Radiance Interferometer (PAERI). They will also operate a Tethered Balloon System (TBS) and the NASA Micropulse Lidar.

The support contractor will provide three heated research buildings at ground level at the boundary of the Clean Air Sector from which the SPT and PAERI experiments will be conducted. Two of these buildings will be used during the summer season and the third building will be used for winter-over research efforts.

In an effort to measure the near-surface humidity profile, as well as the properties of low clouds and diamond-dust ice crystal, the team members will operate the TBS from a research building upwind of the station. Support contractor personnel will construct a ramped trench below the snow surface to store the inflated balloon when it is not deployed.

In an effort to measure the heights of clouds, team members will continue to operate the NASA micropulse lidar from its present location in the ARO building.

## **A Study of Atmospheric Oxygen Variability in Relation to Annual to Decadal Variations in Terrestrial and Marine Ecosystems**

**OO-204-O**

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### **Research Objectives**

Oxygen is the most abundant element on the Earth. Airborne, it comprises about a fifth of the atmosphere. But much of the Earth's oxygen exists in water, rocks and minerals, and of course in flora and fauna who recycle it both directly and as carbon dioxide through the processes of photosynthesis and respiration. Thus scientists are interested in measuring the concentration of molecular oxygen and carbon dioxide in air samples. This project is part of sample collections being made at a series of baseline sites around the world. The data should help to improve estimates of the processes whereby oxygen is cycled throughout the global ecosystem, specifically:

- net exchange rates of carbon dioxide with biota on land and in the oceans;
- photosynthesis rates; and
- atmospheric mixing rates.

An important part of the measurement program entails developing absolute standards for oxygen-in-air, to ensure stable long-term calibration. We also are conducting surveys of the oxidative oxygen/carbon ratios of both terrestrial- and marine-based organic carbon, hoping to improve the quantitative basis for linking the oxygen and carbon dioxide geochemical cycles.

These results are needed to enhance our understanding of the processes that regulate the buildup of carbon dioxide in the atmosphere. They should also contribute to our understanding of the change processes – especially climate change – that regulate ecological functions on land and in the sea.

## **Field Research Plan**

### **Logistics**

Research Location:                    behind the T-5 building at Palmer Station

### **Team Members**

No deploying project personnel

### **Field-Season Operations**

The researchers plan to continue measuring the concentration of molecular oxygen and carbon dioxide in air samples from Palmer Station, Antarctica. The Palmer Station physician will continue to collect air samples from behind the T-5 building for this project on a semi-weekly basis. The samples will be returned in airtight flasks to the home institution for oxygen and carbon dioxide content analysis.

## Shelf and Bottom Water Formation Near East Antarctic Polynyas and Glaciers

OO-225-O

**Dr. Richard G. Fairbanks, Principal Investigator**

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### Research Objectives

We are interested in how the formation of dense water masses on the Antarctic continental shelves is affected by the periodic flushing of relatively warm circumpolar deep water and whether the intrusion of warm water can enhance the formation rate of dense Antarctic water. Our investigation involves the observation of water-mass modification processes on the continental shelf off the Adelie Coast in East Antarctica, near a quasi-permanent area of open water near the Mertz and Ninnis Glacier Tongues — the so-called Mertz Polynya.

Antarctic coastal polynyas, formed by strong offshore winds, are often referred to as major sea ice and salt “factories” because the newly formed ice is blown seaward, allowing more ice to form along the coast, and because the freezing process increases the salinity of the continental shelf water. The open water, or even thin ice, implies significant heat loss from the ocean to the atmosphere, and it also increases the density of the shelf water. The shelf water sinks, fills any depressions in the bottom, and is gravitationally driven down the continental slope. We also believe that an additional process—the intrusion of relatively warm water onto the continental shelf that overrides the shelf water and essentially shuts down the densification processes—is expected to be at work in this area.

Using the USAP icebreaking research ship *Nathaniel B. Palmer*, we will obtain data at a closely spaced array of hydrographic stations over the continental shelf and slope along the George V Coast in the austral summer. The data will complement a similar winter study by the Australian National Antarctic Program.

## Cruise Research Plan

### Logistics

Cruise NBP00-08

Departs: Hobart, Australia, 20 December 2000

Arrives: Hobart, Australia, 25 January 2001

Research Location: Mertz Glacier Polynya, near the Adelie Coast

### Team Members

Richard Fairbanks

Stanley Jacobs

TBD (4)

### Cruise Operations

The team members plan to travel aboard the R/V *Nathaniel B. Palmer* (cruise NBP00-08) to perform hydrographic sampling of the Mertz Glacier Polynya, near the Adelie Coast, Antarctica. Team members will use the conductivity, temperature, and depth (CTD) rosette to collect water samples and CTD profiles. The water will be tested in the research vessel laboratory for nutrient load, oxygen, and salinity. Bottom contours in the study area will be taken with the SeaBeam Swath Mapping Sonar. Team members will also use a Zodiac inflatable boat and the SeaCat CTD to collect high-resolution conductivity, temperature, and depth data in the surface layer, away from the vessel.

The team members also plan to use the Multiple Opening and Closing Net and Environmental Sampling System (MOCNESS) to collect CTD profiles while the vessel is underway. If researchers from the Australian National Antarctic Research Expedition (ANARE) accompany this project, as planned, both USAP and ANARE team members will recover two ANARE moorings in the polynya. The researchers will collect data from the moored instruments, service the moorings, and redeploy them.

Some samples will be returned to the home institution for further analysis.

## **Measurements of the Size, Shape, Scattering Phase Function, and Extinction Coefficient of Ice Crystals at South Pole Station**

**OO-226-O**

**Dr. Paul Lawson, Principal Investigator**

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### **Research Objectives**

A number of theoretical and experimental studies have demonstrated that particle size and shape strongly affect the radiative effects of cloud particles, and specifically ice crystals. Using a high-resolution digital cloud-particle imager, we will automatically classify cloud particles by size and shape during this 3-year investigation of cirrus clouds and the light-scattering properties of ice crystals in the atmosphere at South Pole Station. In cooperation with an ongoing radiation transfer program, we will operate two cloud-particle imagers at the South Pole during the 2000-01 and 2001-02 austral summer seasons. Particle images, concentrations, and size distributions will be processed on site and preliminary analyses will be conducted to assure data quality. Current software capabilities of the system allow the rejection of artifacts, as well as the computation of various size and shape parameters, scattering characteristics, and the ice/water fraction.

The individual observations, as well as the collective statistics, will significantly add to several concurrent experiments investigating the emission characteristics of snow, ice crystals in the atmosphere, and greenhouse gases near the surface. These data, together with measurements of such environmental conditions as cloud-base altitude, temperature, and humidity structure, will allow us to develop a climatology of cloud and cloud-particle properties and new algorithms to substantially improve representations of radiation processes in general circulation models.

## **Field Research Plan**

### **Logistics**

Dates in Antarctica: late January 2001 to mid-February 2001  
Research Location: inside and outside the Atmospheric Research Observatory (ARO)

### **Team Members**

Paul Lawson                      Pat Zmarzly                      Brad Baker

### **Field-Season Operations**

The project team members will work at South Pole Station from late January 2001 to mid-February 2001 to install and operate an optical instrument that measures the size, shape, and scattering phase function of ice crystals.

Support contractor personnel will design and build a 2-meter platform for this instrument. This platform will be located about 10 meters outside the ARO building.

The team members will work within lab space inside the ARO building to process and analyze their data.

## **Chlorine- and Bromine-Containing Trace Gases in the Antarctic**

**OO-254-O**

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### **Research Objectives**

Airborne trace constituents in atmospheric gases come from both biogenic and anthropogenic sources. Scientists monitor them closely, as they have been implicated in depletion of the ozone layer over Antarctica as well as in other alterations of the Earth's climate.

This study will investigate the seasonal trend of trace gas concentrations by collecting a year-long suite of air samples at Palmer Station. Samples will subsequently be analyzed at the Oregon Graduate Center for a number of trace components, especially chlorine- and bromine-containing species.

This work should contribute to a better understanding of the buildup of trace constituents, particularly those of high-latitude marine origin.

## **Field Research Plan**

### **Logistics**

Research Location:                    behind the T-5 building at Palmer Station

### **Team Members**

No deploying project personnel

### **Field-Season Operations**

The researchers plan to continue analyzing Antarctic air samples for seasonal trends in trace gas concentrations. Throughout the year, the Palmer Station physician will continue to collect as many as three air samples per week—depending on weather conditions—from behind the T-5 Building and send the air samples to the home institution. Researchers will analyze the air samples for a number of trace gases, including chlorine- and bromine-containing species, from both biogenic and anthropogenic sources.

**South Pole Monitoring for Climatic Change -  
U.S. Department of Commerce, NOAA, Climate  
Monitoring and Diagnostic Laboratory**

**OO-257-O**

**Dr. Dave Hofmann, Principal Investigator**

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## **Research Objectives**

The National Oceanic and Atmospheric Administration (NOAA) has been engaged in studies to determine and assess the long-term buildup of global pollutants in the atmosphere. The NOAA Climate Monitoring and Diagnostic Laboratory team will continue long-term measurements of trace atmospheric constituents that influence climate and the ozone layer. These measurements will enable time-series analyses of multiyear data records. Phenomena of particular interest are:

- seasonal and temporal variations in greenhouse gases;
- stratospheric ozone depletion;
- transantarctic transport and deposition;
- the interplay of trace gases and aerosols with solar and terrestrial radiation fluxes on the polar plateau; and
- the development of polar stratospheric clouds over Antarctica.

Four scientists will work from the Amundsen-Scott South Pole Station observatory during the austral summer, and two NOAA personnel will stay over the winter (working in the Atmospheric Research Observatory) to measure carbon dioxide, methane, carbon monoxide, aerosols, chlorofluorocarbons, and other trace constituents. Concurrent measurements will be made of water vapor, surface and stratospheric ozone, wind, pressure, air and snow temperatures, and atmospheric moisture. Other personnel at Palmer Station will collect carbon dioxide samples in support of this project.

These measurements will allow us to determine the rates at which concentrations of these atmospheric constituents change. The measurements will also suggest likely sources, sinks, and budgets. Our work includes collaborating with climate modelers and diagnosticians to determine how the rates of change of these parameters affect climate.

## Field Research Plan

### Logistics

Dates in Antarctica: early November 2000 to mid-February 2001 AND the 2001 austral-winter season

Research Locations: Atmospheric Research Observatory (ARO), Balloon Inflation Facility (BIF)

### Team Members

Paulene Roberts (winter-over)	Russ Schnell	Ed Dlugokencky
Eric Sandberg (winter-over)	Andy Clarke	James Butler
James Elkins	Mark Clark	Bob Evans

### Field-Season Operations

The project team members plan to continue their long-term measurements of trace atmospheric constituents that influence climate. The team members will work at South Pole Station from early November 2000 to mid-February 2001. In early November, the team members will relieve the 2000 winter-over team members and continue the atmospheric monitoring program, which includes monitoring surface and stratospheric ozone, carbon dioxide, water vapor, ozone-depleting compounds, and other trace constituents of the atmosphere.

At various times during the season, the team members will conduct the following experimental procedures:

- Sampling air upwind of the station, in the Clean Air Sector, using machines that suck air through chemical analyzers through the roof of the ARO;
- Measuring ozone in the atmosphere optically, using a Dobson UV spectrometer operating through a window in the ARO;
- Sampling ozone in the upper air (from the surface to over 30 kilometers), using ozonesondes connected to high-altitude balloons launched from the BIF; and
- Collecting air samples in the Clean Air Sector, near the snow surface upwind of the ARO.

Samples and data will be returned to the home institution for analysis. Two of the team members will remain at the station during the 2001 austral winter to operate and maintain the equipment and continue the research.

## Drake Passage XBT/XCTD Program

OO-260-O

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### Research Objectives

The Antarctic Circumpolar Current (ACC) is a powerful force that drives waters in the Southern Ocean four times as fast as the Gulf Stream. Wherever the distance between Antarctica and other continents is narrowed – so-called chokepoints such as the Drake Passage off the tip of South America and the sea regions between Antarctica and the Cape of Good Hope and Tasmania, respectively – the current is even stronger. Scientists deploy bottom pressure gauges and similar instruments to determine the fluctuations in the transport of the ACC, and to relate it to those in the subtropical and subpolar gyres and to the wind field over the southern oceans.

Specifically, since 1996 scientists in this research project have collected data to characterize the water mass variability in the Drake Passage, to describe temperature and circulation variability in the Southern Ocean, and to define the role of the Southern Ocean in the global climate system. This season, using high-density expendable bathythermographs (XBT), we will make expendable current/temperature/depth observations to measure the seasonal and year-to-year temperature fluctuations in the upper ocean within the Drake Passage.

To clearly describe inter-annual and seasonal changes in upper-ocean temperature, we need closely-spaced, underway XBT measurements to be made on every R/V *Laurence M. Gould* cruise throughout the year. As the ship crosses the Drake Passage, approximately 60 XBT profiles are made, beginning and ending at the 200-meter bathymetric contour on either side of the passage. XBT casts are spaced approximately 1 hour apart, although sampling is more frequent across the Subantarctic, Polar, and ACC fronts, as the water temperature changes more rapidly in these regions.

## Cruise Research Plan

### Logistics

XBT sampling is planned on selected R/V *Laurence M. Gould* cruises during the 2000-2001 season.

### Team Members

No deploying project personnel

### Cruise Operations

In this on-going project, the researchers plan to measure the seasonal and year-to-year variability in upper-ocean temperature within the Drake Passage. In doing so, the researchers plan to document time-series shifts in the Subantarctic, Polar, and Antarctic Circumpolar Current Fronts.

Shipboard contractor personnel will use a permanently installed autolauncher to deploy expendable bathythermographs (XBTs) while the vessel is underway. The Sippican MK-12 Oceanographic Data Acquisition system will be used to record the data. Approximately 60 XBT casts will be made on each selected R/V *Laurence M. Gould* crossing of the Drake Passage, as weather conditions allow.

The casts will be made on the southbound leg of the crossing, from the 200-meter bathymetric contour off Isla de la Estados (in Argentine territorial waters) to the 200-meter contour off Antarctica. Along the cruise track, XBT casts will take place half-hourly between 54°50' S and 58°30' S, hourly between 58°30' S and 61°30' S, and every 45 minutes between 61°30' S and 62°50' S.

Data from the casts will be sent via FTP over the internet or via original data disks to the home institution for analysis and archiving.

## **Katabatic Winds in Eastern Antarctica and Their Interaction with Sea Ice**

**OO-263-O**

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### **Research Objectives**

Katabatic winds are driven by the flow of cold, dense air down a mountain or glacier slope, especially in regions subject to radiational cooling of the Earth's surface. These winds can drive the sea ice offshore any time of the year, forming coastal polynyas - areas of open ocean within sea ice. In winter, these coastal polynyas experience extremely high heat fluxes from the ocean to the atmosphere, making them areas in which large amounts of sea ice and Antarctic Bottom Water are formed. To obtain more detailed information on these fluxes, the USCG ice breakers are instrumented to measure the heat fluxes as function of ice concentration, ice thickness, and ice type. Further, this project continues the international collaboration (France, Australia, and the United States) to study katabatic winds and the interaction with sea ice along the coast of Adelie- and King George-Lands.

A number of weather stations collect meteorological data: One array stretches from the interior (Dome D at 3280 m) to the coast (D 10) near the French station Dumont d'Urville; the other array runs along the coast, including stations at Cape Denison and Port Martin, an area where the highest average surface wind speeds on Earth have been recorded - a monthly average of 27.8 meters per second.

We are producing a numerical model of the structure of the region's atmosphere, which will incorporate a more detailed terrain map as well as a new mesoscale model developed by French scientists. This model will not only predict average mean winter conditions (previously done), but also extreme events. Wind speeds in excess of 50 meters per second occur even as hourly means. The effect of these winds on the formation, persistence and size of coastal polynyas will be analyzed; data from satellite-based active microwave imagery (synthetic aperture radar) will be combined with the observed meteorological data in this investigation. Another application of this work will be to enlarge the body of information by including data collected by Australian, French, and Japanese station networks (to the west of our stations) to assess the influence of cyclonic storm systems on the drainage flow along the coast.

## Cruise Research Plan

### Logistics

Cruise on board the Icebreaker *Polar Sea*

Departs: Hobart, Australia, mid-December 2000

Arrives: McMurdo Station, late January 2001

Research Locations: Dumont d'Urville; D-10; Sutton; Port Martin;  
Cape Dennison; Penguin Point; Cape Webb

### Team Members

Gerd Wendler

Adrienne Tivy

TBD

### Cruise Operations

The researchers plan to continue an international (U.S.-French-Australian) katabatic wind study presently underway in Adelie and King George Lands, where the katabatic winds are extraordinarily strong. Katabatic winds can drive ice away from shore and create polynyas, which are areas of open water in normally ice-covered regions. Since open water releases about two orders of magnitude more energy in winter than ice-covered ocean, katabatic wind-generated polynyas affect heat transfer from the ocean to the atmosphere, as well as sea-ice formation and the production of Antarctic Bottom Water. There are two arrays of Automatic Weather Stations (AWS) in Eastern Antarctica, one stretching from Dome C to the coast close to Dumont d'Urville, the other along the coast from Dumont d'Urville to Cape Webb.

In mid-December 2000, the project team members plan to board the U.S. Coast Guard Icebreaker *Polar Sea* in Hobart, Australia. The vessel will sail south toward the Adelie Coast, on its way to McMurdo Station. Working in conjunction with project OO-283-M (Dr. Stearns), team members will travel via USCG helicopters from the icebreaker to the AWS stations along the Antarctic coast to inspect, maintain, and repair the units. In addition, team members plan to transport spare parts via helicopter to inland AWS sites serviced by the French field team.

The team members will install instrumentation aboard the USCG Icebreaker *Polar Sea* to measure the radiative and turbulent energy transfer between the ocean and the atmosphere as a function of sea-ice conditions. The measurements will run continuously from Hobart, Australia, to McMurdo Station. Team members will also conduct direct radiative energy transfer measurements on the sea ice as conditions allow during the cruise. The research team will disembark the *Polar Sea* at McMurdo Station in late January 2001 and then return to the U.S.

## **Collection of Atmospheric Air for the NOAA/ CMDL Worldwide Flask Sampling Network**

**OO-264-O**

### **Dr. Dave Hofmann, Principal Investigator**

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### **Research Objectives**

The National Oceanic and Atmospheric Administration (NOAA) has been engaged in studies to determine and assess the long-term buildup of global pollutants in the atmosphere. The NOAA Climate Monitoring and Diagnostic Laboratory team will continue long-term measurements of trace atmospheric constituents that influence climate and the ozone layer. These measurements will enable time-series analyses of multiyear data records. Phenomena of particular interest are:

- seasonal and temporal variations in greenhouse gases;
- stratospheric ozone depletion;
- transantarctic transport and deposition;
- the interplay of trace gases and aerosols with solar and terrestrial radiation fluxes on the polar plateau; and
- the development of polar stratospheric clouds over Antarctica.

Four scientists will work from the Amundsen-Scott South Pole Station observatory during the austral summer, and two NOAA personnel will stay over the winter (working in the Atmospheric Research Observatory) to measure carbon dioxide, methane, carbon monoxide, aerosols, chlorofluorocarbons, and other trace constituents. Concurrent measurements will be made of water vapor, surface and stratospheric ozone, wind, pressure, air and snow temperatures, and atmospheric moisture. Other personnel at Palmer Station will collect carbon dioxide samples in support of this project.

These measurements will allow us to determine the rates at which concentrations of these atmospheric constituents change. The measurements will also suggest likely sources, sinks, and budgets. Our work includes collaborating with climate modelers and diagnosticians to determine how the rates of change of these parameters affect climate.

## **Field Research Plan**

### **Logistics**

Research Location:                    behind the T-5 building at Palmer Station

### **Team Members**

No deploying project personnel

### **Field-Season Operations**

The researchers plan to continue long-term measurements of trace atmospheric constituents that influence climate and the ozone layer. The Palmer Station physician will collect weekly air samples year-round from behind the T-5 building, using a flushing and pressurizing apparatus. One or two samples will be collected each week, and environmental conditions at the time of collection will be logged. Sampling may occasionally be deferred until certain meteorological criteria are met.

All samples will be returned to the NOAA laboratory on a regular schedule for analysis of carbon dioxide and trace constituents

## **An Investigation of Sulfur Chemistry in the Antarctic Troposphere (ISCAT)**

**OO-270-O**

**Dr. Douglas Davis, Principal Investigator**

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### **Research Objectives**

During this four-year study at Amundsen–Scott South Pole Station, we will examine the sulfur chemistry of the Antarctic atmosphere. The study involves two field seasons, the first of which was completed in 1998–1999. This field season (2000–2001) will be the second and last for this project. The study, which includes 10 principal and senior investigators at five institutions, with seven additional contributing investigators, has two broad-based goals: to improve substantially our current understanding of the oxidation chemistry of biogenic sulfur in the polar environment, and to improve the climatic interpretation of sulfur-based signals in Antarctic ice-core records.

The South Pole was selected because the atmospheric boundary layer at this site presents a homogeneous and relatively simple environment from which to unravel the photochemically driven oxidation chemistry of dimethyl sulfide. Atmospheric sulfur chemistry is an important component in climate change issues because both naturally (i.e., from volcanic emissions and oceanic phytoplankton production) and anthropogenically emitted sulfur compounds form minute particles in the atmosphere—the so-called aerosols—that reflect solar radiation, produce atmospheric haze and acid rain, and affect ozone depletion. Sulfate particles in the atmosphere may also act as condensation nuclei for water vapor and enhance global cloudiness. On the millennial time scale, the variability and natural background level of atmospheric aerosols can be reconstructed from the preserved paleorecords of sulfur oxidation products in ice cores. It is necessary, however, to understand how the physical and chemical environment of the oxidation process affects the relative concentrations of the oxidation products that become buried in the ice. This study requires simultaneous observations of a wide-ranging suite of sulfur species, such as DMS and its oxidation products, sulfur dioxide, dimethyl sulfoxide, dimethyl sulfone, methane sulfonic acid, and sulfuric acid, as well as photochemically important compounds such as carbon monoxide,

nitrous oxide, water vapor, and non-methane hydrocarbons.

Secondary objectives will be:

- to examine interior Antarctic air samples for other significant DMS oxidation products, such as sulfurous acid and methane sulfonic acid; and
- to assess the local variation in hydroxyl and perhydroxyl radicals, a measure of the oxidizing power of the atmosphere.

This study will provide, for the first time, a quantitative picture of exactly which atmospheric sulfur compounds are advected into the Antarctic interior and a detailed picture of the sulfur chemistry that is active in the Antarctic atmosphere.

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## Field Research Plan

### Logistics

Dates in Antarctica: early November 2000 to early January 2001  
Research Location: Atmospheric Research Observatory (ARO)

### Team Members

Greg Huey	David Tanner	Martin Buhr
Doug Davis	Jack Dibb	Fred Eisele
Roy Mauldin III	Edward J. Kosciuch	Barry Lefer
Don Thornton	Fang-Huang Tu	Steve Semmer

### Field-Season Operations

The project team members plan to work on the second floor of the ARO facility from mid-November 2000 to early January 2001 to reinstall their research equipment and then operate the equipment in an effort to study atmospheric chemistry (sulfur chemistry) at South Pole Station. (*Note:* This equipment was installed at this site during the 1998-1999 season.)

The support contractor will supply a crane and operator for lifting the equipment up to the second floor of the ARO building. Support contractor personnel will also make modifications as needed on the HVAC system on the second floor in order to maintain ambient temperature, given the operation of this additional equipment.

Once the research equipment is set up, the researchers will begin taking measurements of H<sub>2</sub>SO<sub>4</sub>, MSA, OH, NH<sub>3</sub>, and DMSO with two chemical ionization mass spectrometers, and of SO<sub>2</sub> and DMS with an atmospheric pressure ionization mass spectrometer. A gas chromatograph/ mass spectrometer will be used for backup and ancillary measurements.

When the team members have completed their measurements, support contractor personnel will use the crane to remove the instruments from the second floor of the ARO and pack them up for shipment to the home institution.

**NSF/OPP Program Manager**  
Dr. Bernhard Lettau

**RPS Point-of-Contact**  
Mr. Eivind Jensen

**University of Miami/Department of Energy-  
Environmental Measurements Laboratory  
Remote Atmospheric Measurements Program  
(RAMP)**

**OO-275-O**

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### **Research Objectives**

The Environmental Measurements Laboratory (EML), a New York City-based unit of the U.S. Department of Energy, installed an array of instruments at Palmer Station in 1990. These were a high-volume aerosol sampler, a gamma-ray spectrometer, and a link to the National Oceanic and Atmospheric Administration's ARGOS satellite system. Sampling data from Antarctica contributes to EML's Remote Atmospheric Measurements Program, part of its worldwide surface-air sampling program.

## **Field Research Plan**

### **Logistics**

Research Location:                    behind the T-5 building at Palmer Station

### **Team Members**

No deploying project personnel

### **Field-Season Operations**

As part of the U.S. Department of Energy/Environmental Measurements Laboratory's Remote Atmospheric Measurements Program (RAMP), the researchers plan to continue sampling air at Palmer Station for anthropogenic radionuclides. Throughout the year, the support contractor's science technician will operate the RAMP high-volume aerosol sampler, gamma-ray spectrometer, and satellite data transmission system in the T-5 building at Palmer Station. Each week, the technician will count one sample (i.e., filter) and one background, and perform one calibration.

The filters will be sent back to the Environmental Measurements Laboratory for analysis and archiving.

## POC Production and Export in the Indian Sector of the Southern Ocean

OO-278-O

**Dr. Cynthia Pilskaln, Principal Investigator**

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### Research Objectives

The Polar Front Zone, where the cold, dense waters of the Antarctic meet the warmer waters of the northern oceans, is subject to major currents and water displacements. Each austral spring, phytoplankton bloom in this region. Scientists believe the blooms are driven by nutrient transport brought to the surface, as intermediate and deep water masses are ventilated. Each year, the theory goes, such blooms are the primary source of particulate organic carbon (POC) and biogenic silica flux to the ocean bottom. But the theory remains to be tested, as no data exist on the amount of particulate organic matter that is sinking through the water column. Without such quantitative measurements in this region, the hypothesized relationships between biomass production and the currents must remain undefined.

As part of a collaboration between the University of Maine and the Chinese Antarctic Research Expedition (CINARE), we will study the biological production and export flux of biogenic matter in response to ventilation of intermediate and deep water masses within the Polar Front Zone. The initial phase of our work consisted of setting out a time-series sediment-trap mooring at approximately 64°S, 73°E. The biweekly-to-monthly trap samples were analyzed for their organic constituents and, in conjunction with primary productivity observations, will provide the basic data from which export values can be derived. Data gathered in this effort will be enhanced by the historical data set that CINARE has obtained in this area over the past decade.

Initial sediment trap placement and recovery was carried out in collaboration with the State Oceanic Administration (SOA) of the People's Republic of China and the Chinese Antarctic Research Expedition. However one trap in Prydz Bay was not recovered. This season, we will recover that sediment trap from aboard the R/V *Nathaniel B. Palmer*. All samples and data will continue to be shared between the U.S. and Chinese investigators, and the data analysis will be carried out jointly.

## Field Research Plan

### Logistics

Cruise NBP01-01

Departs:

Hobart, Australia, 29 January 2001

Arrives:

Capetown, South Africa, 29 March 2001

Research Location:

Prydz Bay

### Team Members

Cynthia Pilskaln

Matthew Cadwallader

### Field-Season Operations

The team members plan to travel on board the *R/V Nathaniel B. Palmer* during cruise NBP01-01, primarily to recover a sediment trap moored in Prydz Bay at 63° 27.69' S; 76° 09.45' E. While at the mooring site, the team members will also take sediment cores; collect conductivity, temperature, and depth (CTD) profiles; collect transmissometer profiles; and collect suspended particulate matter (SPM) data.

The contractor's ship-board personnel will assist the team members in releasing the mooring and recovering the sediment trap. Once this is accomplished, both contractor personnel and researchers from project GO-073-O (Dr. Leventer) will assist in sediment core and hydrographic data collection at the mooring site. Team members from this project will also collect sediment cores and hydrographic data along the cruise track, in collaboration with members of project GO-073-O. Instruments used may include the Jumbo Piston Core, the Kasten Core, the Gravity Core, the Mega-core, and the SeaBird 911 Plus and Rosette with twenty-four 10-liter Niskin bottles. The researchers will collect SPM data by filtering large volumes of seawater at selected sites along the cruise track.

Sediment and other samples will be returned to the home institution for further analysis.

## **Antarctic Automatic Weather Stations**

**OO-283-M**

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### **Research Objectives**

A network of nearly 50 automatic weather stations (AWS) has been established on the Antarctic continent and several surrounding islands. These facilities were built to measure surface wind, pressure, temperature and humidity. Some of them also track other atmospheric variables, such as snow accumulation and incident solar radiation.

Their data are transmitted via satellite to a number of ground stations, where they are put to several uses, including operational weather forecasting, accumulation of climatological records, general research purposes, and specific support of the U.S. Antarctic Program. The AWS network has grown from a small-scale program in 1980 into a significant data retrieval system that is now extremely reliable, and it has proven indispensable for both forecasting and research purposes. This project maintains and augments the AWS, as necessary.

## Field Research Plan

### Logistics

Dates in Antarctica:  
Research Locations:

late December 2000 to early February 2001  
Ross Ice Shelf region (Marilyn, Schwerdtfeger, Gill, Elaine, Lettau, Ross Ice Shelf); Ross Island Region (Marble Point, Ferrell, Pegasus North & South, Minna Bluff, Linda, Willie Field, White Out, White Island, Windless Bight, Cape Bird, Cape Crozier); West Antarctic Region (Byrd Station, Brianna, Elizabeth, J.C., Erin, Harry, Theresa, Doug, Mount Siple, Siple Dome, Swithinbank, ITASE-Noel, ITASE-Site 1, ITASE-Site 2)

### Team Members

George Weidner                      Robert Holmes                      TBD (2)

### Field-Season Operations

Team members based at McMurdo Station will travel via Twin Otter aircraft to service six automatic weather stations (AWS) sites on the Ross Ice Shelf, and via helicopter and snowmobile to service 12 AWS sites around the Ross Island region. The team members will also travel via Twin Otter aircraft to the Siple Dome field camp and to Byrd Station to service AWS stations at those locations.

In December 2000, one team member will travel with the U.S. Coast Guard icebreaker to service selected AWS along the Adelie Coast, at Terra Nova Bay, and on Franklin Island. This team member will transit to shore from the icebreaker via helicopter or small boat.

In mid-January 2001, the team members plan to travel via LC-130 aircraft from McMurdo Station to South Pole Station. There they plan to move the AWS at the South Pole away from the dome toward the Clean Air Sector in preparation for construction of the new facilities. In addition, team members plan to travel via Twin Otter aircraft from the South Pole Station to service the two AWS sites that are approximately 100 km from the station.

The data collected by the weather stations support the Long-Term Ecological Research (LTER) program at McMurdo and Palmer Stations, aircraft operations, and other Antarctic research projects that request meteorological information.

## **Antarctic Automatic Weather Stations**

**OO-283-P**

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### **Research Objectives**

A network of nearly 50 automatic weather stations (AWS) has been established on the Antarctic continent and several surrounding islands. These facilities were built to measure surface wind, pressure, temperature and humidity. Some of them also track other atmospheric variables, such as snow accumulation and incident solar radiation.

Their data are transmitted via satellite to a number of ground stations, where they are put to several uses, including operational weather forecasting, accumulation of climatological records, general research purposes, and specific support of the U.S. Antarctic Program. The AWS network has grown from a small-scale program in 1980 into a significant data retrieval system that is now extremely reliable, and it has proven indispensable for both forecasting and research purposes. This project maintains and augments the AWS, as necessary.

## Field Research Plan

### Logistics

Research Locations: three Automatic Weather Stations (Bonaparte Point, Hugo Island, and Racer Rock) in the Palmer Station vicinity

### Team Members

No deploying project personnel

### Field-Season Operations

Support contractor personnel and/or several members of the Palmer Long-Term Ecological Research (LTER) program will maintain and service the Automatic Weather Stations (AWSs) on Racer Rock, Bonaparte Point, and Hugo Island throughout the 2000-2001 austral summer season, and in January 2001 during the annual LTER cruise on the R/V *Laurence M. Gould* (LMG01-1). From Palmer Station, they will travel on foot to the Bonaparte Point AWS. To reach the Hugo Island and the Racer Rock AWSs, they will travel on the R/V *Laurence M. Gould* to the islands where the AWSs are located, then take Zodiac inflatable boats from the research vessel to the shore. In each case, they will perform preventative maintenance and diagnose, troubleshoot, and repair (if necessary) the stations.

## **Antarctic Automatic Weather Stations**

**OO-283-S**

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### **Research Objectives**

A network of nearly 50 automatic weather stations (AWS) has been established on the Antarctic continent and several surrounding islands. These facilities were built to measure surface wind, pressure, temperature and humidity. Some of them also track other atmospheric variables, such as snow accumulation and incident solar radiation.

Their data are transmitted via satellite to a number of ground stations, where they are put to several uses, including operational weather forecasting, accumulation of climatological records, general research purposes, and specific support of the U.S. Antarctic Program. The AWS network has grown from a small-scale program in 1980 into a significant data retrieval system that is now extremely reliable, and it has proven indispensable for both forecasting and research purposes. This project maintains and augments the AWS, as necessary.

## **Field Research Plan**

### **Logistics**

Dates in Antarctica: mid-January 2001 to late January 2001  
Research Locations: Clean Air, Henry, and Nico AWS Sites

### **Team Members**

George Weidner TBD

### **Field-Season Operations**

The project team members plan to work from South Pole Station between mid-January 2001 and late January 2001 to move one automatic weather station (AWS) and raise two other AWSs.

The AWS currently located near the station between the Atmospheric Research Observatory (ARO) facility and the fuel arch will be moved toward the Clean Air Sector.

In late January 2001, the team members will receive close support from a Twin Otter aircraft to travel to the two other AWS sites (the Nico AWS site and the Henry AWS site), which are located approximately 100 kilometers from South Pole Station. Once they are at these sites, the team members will raise the sensors because of snow accumulation.

**Measurement of Combustion Effluent  
Carbonaceous Aerosols  
in the McMurdo Dry Valleys**

**OO-314-O**

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**Research Objectives**

To assess the impact of operations of the U.S. Antarctic Program on the environment, we will install an instrument to measure carbonaceous aerosol in the McMurdo Dry Valleys and generate a database. The McMurdo Dry Valleys, a Long-Term Ecological Research (LTER) study site, supports a fragile, nutrient-limited ecosystem that may be significantly affected by human activities. One aspect of these activities is the generation and deposition of carbonaceous aerosols particles (“black carbon”) from the exhaust of diesel power generators and helicopter operations within the McMurdo Dry Valleys, as well as the possible long-distance transport of combustion products from McMurdo Station about 100 kilometers away. A real-time optical analyzer will be deployed at the LTER site for three austral summer seasons to measure the concentration of black carbon, polycyclic aromatic hydrocarbons, and other filterable organic compounds useful in fingerprinting combustion products.

## **Field Research Plan**

### **Logistics**

Dates in Antarctica: early November 2000 to late November 2000  
Research Location: Lake Hoare Camp, Taylor Valley

### **Team Members**

Tony Hansen

### **Field-Season Operations**

The researcher plans to study the long-term environmental impacts of human activities on the pristine and fragile ecosystem of the Antarctic Dry Valleys. With the assistance of support contractor personnel from the Mechanical Equipment Center (MEC), the Principal Investigator (PI) will deploy a real-time optical particle analyzer in Taylor Valley. The instrument will collect and identify carbonaceous particles produced by diesel generators, furnaces, helicopters, motors, and other anthropogenic sources of combustion.

In early November 2000, the PI and an MEC technician will travel via helicopter to Taylor Valley, where they will place the instrument between one-quarter and one-half mile downwind of the Lake Hoare Camp. Once the instrument is established, the PI will return by helicopter to McMurdo Station, then redeploy to the United States. The instrument will run automatically for the duration of the season. Data from the instrument will be collected throughout the 2000-2001 austral summer season by the Lake Hoare Camp manager, who will replace the data disks once a week. The camp manager will also check the status of the instrument at this time. Full data disks will be returned to the Crary Science and Engineering Center (CSEC) at McMurdo Station, where the data will be e-mailed to the home institution.

The Lake Hoare Camp Manager and an MEC technician will remove the instrument at the end of the season and return it by vessel if possible, or by air the following WINFLY, to the home institution.

**Shipboard Acoustic Doppler Current Profiling  
on *R/V Nathaniel B. Palmer* and  
*R/V Laurence M. Gould***

**OO-315-O**

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## **Research Objectives**

Currents in the Southern Ocean have a profound influence on the world's oceans – and therefore upon global temperature and the planet's ecosystem – yet some remote regions receive little scientific attention. Using doppler (sound wave transmission and reflection) technology, this project is exploring upper ocean current velocities and will try to generate a quality-controlled data set in one such sparsely sampled and remote region – a region which nonetheless appears to play a significant role in global ocean circulation. We will develop and maintain a shipboard Acoustic Doppler Current Profiler (ADCP) program on board the *R/V Nathaniel B. Palmer* and the *R/V Laurence M. Gould*, two research ships operated by the United States Antarctic Program.

This work is part of a long-term science goal to characterize the temporal and spatial velocity structure in the Southern Ocean. This will entail measuring the seasonal and annual changes in upper ocean currents within the Drake Passage, combining this information with similar temperature observations, and exploring how the heat exchange varies and how it drives upper ocean currents.

## **Cruise Research Plan**

### **Logistics**

Measurements will be taken on all cruise tracks of both USAP research vessels during the 2000-2001 season.

### **Team Members**

No deploying project personnel

### **Cruise Operations**

Shipboard contractor electronics technicians will operate the on-board Acoustic Doppler Current Profilers (ADCP), on-board thermosalinographs, and on-board weather instruments for this project while the USAP research vessels (i.e., *R/V Laurence M. Gould* and *R/V Nathaniel B. Palmer*) are underway during the 2000-2001 season. These instruments will measure ocean currents, backscatter, surface temperature, surface salinity, and weather information. The electronics technicians will download and process data from these instruments and send the data to the home institution.

The researchers will analyze the data in an effort to characterize upper ocean current and thermohaline variability in the Southern Ocean. In the course of this investigation, the researchers expect to increase their understanding of the Circumpolar Current and its effect on global weather and climate.

## **Field Experiments and Modeling of the Breakup of Antarctic Sea Ice**

**OO-316-O**

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### **Research Objectives**

We are interested in how the Antarctic sea-ice cover responds to stresses applied by wind and ocean waves and how the temperature distribution within the sea ice affects these responses. In McMurdo Sound, we will conduct experiments on the deformation and fracture of sea ice by applying a series of controlled stresses and observing their effects. Large ice floes do not fracture in the same way as small ones do; consequently, experiments must be carried out on the scale of tens of meters to validly extrapolate the fracture process to the larger scales that have applications to engineering problems of breaking ice. Obtaining detailed information on the microstructure of the ice (such as crystal structure, brine channels, and other flaws in the ice fabric) and having a sound theoretical framework to guide the experimental work and subsequent model development are the crucial elements of this study. A key effect is the initiation and growth of microcracks within the ice. One component of this project, carried out jointly with the New Zealand Antarctic Program, concerns the fracture mechanics of fatigue crack propagation, the use of microstructural observations to verify magnetic resonance measurements of the structure of inclusions in the ice, and the acoustic emissions of fracture zones.

## Field Research Plan

### Logistics

Dates in Antarctica: early October 2000 to early November 2000  
Research Locations: sea ice camp on McMurdo Sound, Crary Science and Engineering Center (CSEC)

### Team Members

John Dempsey	David Cole	Lewis Shapiro
Guro Kjestveit	TBD	

### Field-Season Operations

The researchers plan to conduct *in situ* experiments designed to thoroughly characterize the physical properties of first-year Antarctic sea ice. Using data from these experiments, the researchers will develop physically based models of the breakup of the ice.

The team members will travel from McMurdo Station via tracked vehicle to establish both a camp site and a work site on the sea ice of McMurdo Sound. If possible, the work site will be set up on sea ice no thicker than one meter, and it will be as close as possible to the camp. The camp will be established on thicker ice. Team members will make day trips to the work site by tracked vehicle, towing a heated, portable instrumentation shelter on skis. At the work site, the team members will use a special ice-cutting machine to cut away a free floating block of sea ice. After creating a “starter crack” in this block, team members will place a loading device in the mouth of the crack and deformation gauges on the surface along the crack. The crack will then be subjected to a series of carefully measured load pressures until the crack propagates through the block.

The team members will also take a series of ice-core samples, which will be returned to the CSEC for a detailed microstructural examination of the ice. Other core samples will be returned to the Cold Regions Research and Engineering Labs (CRREL) in New Hampshire for laboratory experiments.

## **Record of Atmospheric Photochemistry in Firn at South Pole**

**OO-324-O**

**Dr. Joseph McConnell, Principal Investigator**

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### **Research Objectives**

Scientists are eager to develop models that will extend their knowledge of current and active dynamic processes into the past. One such process vital to the Earth is photochemistry, how the sun's radiant energy affects conversion of oxygen in the atmosphere. By measuring and interpreting the hydrogen peroxide, formaldehyde, and nitric acid concentrations in the snow and firn at Amundsen-Scott South Pole Station, we hope to develop a credible history of the oxidation capacity of the atmosphere over the last two centuries. We also hope to evaluate methods that will confirm statistically significant changes in the concentration of these species over that time.

South Pole Station is ideal for this work: The extreme cold makes the chemistry relatively simple, the NOAA Climate Modeling and Diagnostics Laboratory provides a supply of high quality meteorological and chemical data, and the station is staffed continuously so that samples can be taken year-round.

We will sample air and near-surface snow throughout the year. During the summer, we will sample and analyze snow pits and firn cores, and will model the air/snow chemistry to try to explain the observed concentrations in the firn. Also in summer, we will intensively sample two snow pits around the perimeter of the snow stake field (for accumulation observations), a process that will establish markers to maintain time control for stratigraphic and chemical horizons.

During earlier work at South Pole and in central Greenland, we have developed and tested physically-based models of air-snow exchange of hydrogen peroxide. This project extends that work.

## Field Research Plan

### Logistics

Dates in Antarctica: mid-November 2000 to late December 2000  
Research Locations: Clean Air Sector and Atmospheric Research  
Observatory (ARO)

### Team Members

Joseph McConnell                      Manuel Hutterli

### Field-Season Operations

The project team members will work at South Pole Station from mid-November 2000 to late December 2000. They will collect and process surface snow samples, and they will install equipment in the ARO facility to collect and process air samples, all in an effort to characterize the impact of the recent stratospheric ozone depletion on atmospheric photochemistry. This project is an extension of the work that has been done under a cooperative agreement with NOAA/CMDL for the past few years.

The snow samples will be collected by hand-drilling shallow, 1-2 meter deep cores just inside the Clean Air Sector, around the ARO facility, on a weekly to semi-weekly basis throughout the austral summer. The samples will be melted, aliquoted, and refrozen for shipment back to the home institution for analysis.

The team members will install atmospheric hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) and formaldehyde (HCHO) detectors in the ARO facility. When the  $\text{H}_2\text{O}_2$  detector is up and running, data from this detector will be sent to the home institution via FTP every few days for quality control.

The team members will also dig and sample snow pits around the perimeter of the snow stake accumulation array, which is located near the Clean Air Sector. These samples will also be melted, aliquoted, and refrozen for shipment to the home institution.

## Appendix A

### 2000-2001 USAP Field Season Alphabetical List of Deploying Research Team Members

Last Name, First Name .....	SEN #	PI Name
Abrams, Daniel .....	IO-157-O	Kamb
Adams, James .....	AB-149-O	Wefel
Adaros, Rodrigo .....	GO-097-O	Wiens
Aguirre, James .....	AB-147-O	Meyer
Ahrens, Michael .....	AO-138-O	deZafra
Ainley, David .....	BO-031-O	Ainley
Alsup, Dianna .....	EO-318-O	Kennicutt
Anandakrishnan, Sridhar .....	GO-089-O	Wiens
	and GO-180-O	Anandakrishnan
Anderson, Don .....	GO-090-S	Butler
Arcone, Steve .....	IU-133-311-O	ITASE PIs
Armand, Leanne .....	GO-073-O	Leventer
Aronson, Richard .....	GO-065-O	Aronson
Ashley, Michael .....	AC-372-O	Storey
Askin, Rosemary .....	GO-094-O	Isbell
Aster, Richard .....	GO-081-O	Kyle
Austin, James .....	GO-306-O	Austin
Avery, James .....	AO-284-O	Avery
Avery, Susan .....	AO-284-O	Avery
Bachmann, Matt .....	IO-157-O	Kamb
Bai, Xinhua .....	AO-109-O	Gaisser
Baker, Brad .....	OO-226-O	Lawson
Balco, Gregory .....	IO-175-O	Stone
Baldwin, Suzanne .....	GO-059-O	Fitzgerald
Baldwin, Donald .....	BO-050-O	Smith
Baldwin, Roberta .....	BO-050-O	Smith
Ballance, Lisa .....	BO-031-O	Ainley
Ballard, Grant .....	BO-031-O	Ainley
Banks, Alison .....	BO-267-O	Costa
Barker, Daniel .....	GO-306-O	Austin
Barouch, Giles .....	AA-130-O	Morse
Barrett, John .....	BM-042-V	Virginia
Bartee, Justin .....	AO-129-O	Sivjee
Barwick, Steven .....	AA-130-O	Morse
Bastide, Jesse .....	IO-162-O	Bender
Batten, Kate .....	IO-157-O	Kamb
Battle, Mark .....	IO-162-O	Bender

Bawcom, Dwight .....	AB-145-O	Peterzen
Bay, Ryan .....	II-171-O	Waddington
Behar, Alberto .....	IO-157-O	Kamb
Besson, David .....	AA-130-O	Morse
Bevin, Tony .....	GO-052-M	Mullins
Bezaire, Jeff .....	AB-147-O	Meyer
Bezanilla, Francisco .....	BO-030-O	Dudley
Bier, Alex .....	AB-147-O	Meyer
Blake, Daniel .....	GO-065-O	Aronson
Blanchette, Robert .....	BO-038-O	Blanchette
Blankenship, Donald .....	GS-098-O	Blankenship
Blecker, Steve .....	BM-042-W	Wall
Bliss, Andrew .....	IO-190-O	MacAyeal
Bogel, Stefan .....	IO-157-O	Kamb
Bolsey, Robin .....	IO-157-O	Kamb
Bowles, Julie .....	GO-071-O	Cande
Bowling, Jerry .....	GO-089-O	Wiens
	and GO-180-O	Anandakrishnan
Boyce, Michael .....	AA-130-O	Morse
Brachfeld, Stefanie .....	GO-073-O	Leventer
Braddock, Peter .....	GO-099-O	Wilson
Brandt, Richard .....	OO-201-O	Warren
Bratina, Bonnie .....	BO-041-O	Green
Buhr, Martin .....	OO-270-O	Davis
Burton, Michael .....	AC-372-O	Storey
Bustamante, Monica .....	BO-197-O	Ponganis
Butler, James .....	IO-162-O	Bender
Butler, James .....	OO-257-O	Hofmann
Byrd, Don .....	GO-078-O	Oliver
Byrnes, Jeff .....	GO-058-O	Harvey
Cadwallader, Matthew .....	OO-278-O	Pilskaln
Cairo, Francesco .....	AO-107-O	Adriani
Calisse, Paolo .....	AC-372-O	Storey
Cameron, Michael .....	BO-009-O	Siniff
Campbell, Walt .....	BO-197-O	Ponganis
Candelaria, Frank .....	AB-145-O	Peterzen
Cantalupo, Chris .....	AC-375-O	Peterson
Capara, Jeff .....	AC-371-O	Stark
Carlstrom, John .....	AC-373-O	Carlstrom
Carrillo, Christopher .....	BP-046-O	Karl
Casciotti, Karen .....	BO-310-O	Ward
Case, Gary .....	AB-149-O	Wefel
Catania, Ginny .....	II-163-O	Raymond
Catapano, Katie .....	BM-042-V	Virginia
Cavallari, Benjamin .....	IU-133-311-O	ITASE PIs
Cavanaugh, John .....	AO-126-O	Rall
Chamberlin, Richard .....	AC-371-O	Stark
Chapman, Eric .....	BP-013-O	Fraser
Cheng, Edward .....	AB-147-O	Meyer
Cheng-DeVries, Chris .....	BO-005-M	DeVries

Childress, Steve .....	BO-030-O	Dudley
Christenson, Gail .....	GO-306-O	Austin
Christl, Mark .....	AB-149-O	Wefel
Chu, Xinzhao .....	AO-127-O	Papen
Church, Matthew .....	BP-046-O	Karl
Chuss, David .....	AC-376-O	Novac
Clark, Mark .....	OO-257-O	Hofmann
Clarke, Andy .....	IO-162-O	Bender
Clarke, Andy .....	OO-257-O	Hofmann
Clow, Gary .....	II-171-O	Waddington
Coats, Larry .....	BO-034-O	Emslie
Cobble, Mark .....	AB-145-O	Peterzen
Coble, Kim .....	AC-378-O	Ruhl
Cole, David .....	OO-316-O	Dempsey
Conidi, Alessandro .....	AO-107-O	Adriani
Conovitz, Peter .....	BM-042-M	McKnight
Conrad, Jan .....	AA-130-O	Morse
Conway, Howard .....	GO-053-O	Hallet
Conway, Howard .....	II-163-O	Raymond
Conway, Maurice .....	II-163-O	Raymond
Cordone, Sean .....	AB-147-O	Meyer
Costello, Richard .....	BM-042-D	Doran
Cottingham, David .....	AB-147-O	Meyer
Counard, Cory .....	BO-009-O	Siniff
Cox, Charles .....	AO-106-P	Inan
Crabil, Marty .....	AB-145-O	Peterzen
Crain, Jessie .....	GO-081-O	Kyle
Crawford, Thomas .....	AB-147-O	Meyer
Cullen, Mary Fran .....	BO-050-O	Smith
Culley, Tim .....	GO-094-O	Isbell
Dahle, Shawn .....	BO-009-O	Siniff
Dana, Gayle .....	BM-042-L	Lyons
Das, Sarah .....	II-168-O	Alley
Daub, Mike .....	AC-378-O	Ruhl
Davis, Doug .....	OO-270-O	Davis
Davison, Victor .....	AB-145-O	Peterzen
DeLong, Ed .....	BO-301-O	Manahan
Dempsey, Jessica .....	OO-201-O	Warren
Dempsey, John .....	OO-316-O	Dempsey
Denker, Christopher .....	BP-013-O	Fraser
Denoux, Guy .....	EO-318-O	Kennicutt
Deshler, Terry .....	AO-131-O	Deshler
Desiati, Paolo .....	AA-130-O	Morse
Detrich, William .....	BO-037-O	Detrich
DeVries, Arthur .....	BO-005-M	DeVries
Dewult, Jean-Paul .....	AA-130-O	Morse
DeYoung, Tyce .....	AA-130-O	Morse
Dibb, Jack .....	OO-270-O	Davis
Dietzman, Gregg .....	BO-282-O	Dietzman
Dingle, Graeme .....	GO-059-O	Fitzgerald

DiTullio, Giacomo .....	BO-025-O	Priscu
Dlugokencky, Ed .....	OO-257-O	Hofmann
Dolan, Jim .....	GO-306-O	Austin
Dolbey, Derek .....	AB-145-O	Peterzen
Dolgy, Sergei .....	AO-126-O	Rall
Dolgy, Sergei .....	OO-201-O	Warren
Dolittle, John .....	AO-104-O	Mende
Domack, Gene .....	GO-073-O	Leventer
Donnellan, Andrea .....	GF-121-O	Luyendyk
Doran, Peter .....	BM-042-D	Doran
Drazen, Helene .....	BO-050-O	Smith
Drazen, Jeffrey .....	BO-050-O	Smith
Dudley, Robert .....	BO-030-O	Dudley
Duerksen, Gary .....	AO-126-O	Rall
Dunbar, Nelia .....	GO-081-O	Kyle
Dunbar, Rob .....	GO-073-O	Leventer
Dykes, Kathleen .....	BO-050-O	Smith
Edwards, Steven .....	AB-147-O	Meyer
Edwards, Diane .....	BO-024-O	Lisle
Eisele, Fred .....	OO-270-O	Davis
Elkins, James .....	OO-257-O	Hofmann
Emslie, Steven .....	BO-034-O	Emslie
Encarnacion, John .....	GO-066-O	House/Farley
Engelhardt, Hermann .....	IO-157-O	Kamb
Evans, Bob .....	OO-257-O	Hofmann
Evans, Rhodri .....	AC-370-O	Pernic
Everett, Jon .....	AC-372-O	Storey
Fairbanks, Richard .....	OO-225-O	Fairbanks
Farley, Kenneth .....	GO-066-O	House/Farley
Farrow, Ben .....	GS-098-O	Blankenship
Feldmann, Rodney .....	GO-093-O	Feldmann
Felus, Yaron .....	GO-099-O	Wilson
Ferrero, Timothy .....	BO-303-O	Smith
Feser, Thomas .....	AA-130-O	Morse
Fisher, Jesse .....	GO-089-O	Wiens
Fitzgerald, Paul .....	GO-059-O	Fitzgerald
Fixsen, Dale .....	AB-147-O	Meyer
Foreman, Christine .....	BM-042-P	Priscu
Forte, Greg .....	AO-109-O	Gaisser
Fraser, William .....	BP-013-O	Fraser
Frey, Markus .....	IU-133-311-O	ITASE PIs
Gades, Tony .....	GO-053-O	Hallet
Gades, Tony .....	II-163-O	Raymond
Galer, Chad .....	BO-041-O	Green
Galley, Elizabeth .....	BO-303-O	Smith
Ganel, Opher .....	AB-149-O	Wefel
Gann, Whitney .....	BM-042-L	Lyons
Gardner, Chester .....	AO-127-O	Papen
Gardner, Nate .....	IO-196-M	Hall
Gaug, Markus .....	AA-130-O	Morse

Geisz, Heidi .....	BP-013-O	Fraser
Gelatt, Thomas .....	BO-009-O	Siniff
Gerasimoff, Michael .....	IU-133-311-O	ITASE PIs
Gerboc, John .....	GS-098-O	Blankenship
Gill, Swarndeep .....	AO-131-O	Deshler
Glass, Alexander .....	GO-065-O	Aronson
Glover, Adrian .....	BO-303-O	Smith
Goff, Lynda .....	BO-301-O	Manahan
Goldschmidt, Azreil .....	AA-130-O	Morse
Goldstein, John .....	AC-378-O	Ruhl
Goodwin, Ian .....	GO-073-O	Leventer
Gootee, Brian .....	GO-116-O	Stump
Gordon, Shulamit .....	IO-157-O	Kamb
Gould, Randy .....	AB-149-O	Wefel
Govoni, John .....	IO-192-O	Taylor
Graf, Urs .....	AC-371-O	Stark
Granger, Doug .....	AB-149-O	Wefel
Granger, Julie .....	BO-310-O	Ward
Gray, Sarah .....	BO-050-O	Smith
Green, Adrian .....	BM-042-L	Lyons
Green, William .....	BO-041-O	Green
Gregg, Gerald .....	AB-145-O	Peterzen
Griffith, Edgor .....	AC-375-O	Peterson
Groppi, Chris .....	AC-371-O	Stark
Grove, Theresa .....	BO-036-O	Sidell
Guzik, T. Gregory .....	AB-149-O	Wefel
Hadley, Scott .....	AB-145-O	Peterzen
Hall, Brenda .....	IO-196-L	Hall
	and IO-196-M	Hall
Hall, Aaron .....	BM-042-P	Priscu
Halverson, Nils .....	AC-373-O	Carlstrom
Hamilton, Gordon .....	IU-133-311-O	ITASE PIs
Han, YeonJu .....	AB-149-O	Wefel
Hann, Steve .....	BO-037-O	Detrich
Hansen, Kael .....	AA-130-O	Morse
Hansen, Tony .....	OO-314-O	Hansen
Harris, Peter .....	GO-073-O	Leventer
Harvey, Ralph .....	GO-058-O	Harvey
Hasskamp, Bill .....	GO-058-O	Harvey
Hawley, Robert .....	II-171-O	Waddington
Heath, Sacha .....	BO-031-O	Ainley
Held, Benjamin .....	BO-038-O	Blanchette
Hello, Yann .....	GO-306-O	Austin
Hellwig, Marc .....	AA-130-O	Morse
Henderson, Randal .....	AB-145-O	Peterzen
Hernandez, Gonzalo .....	AO-110-O	Hernandez
Herr, Susan .....	GO-306-O	Austin
Hervig, Mark .....	AO-131-O	Deshler
Hester, Michelle .....	BO-031-O	Ainley
Himmelsbach, Clay .....	GO-078-O	Oliver

Hoefling, Kevin .....	BO-005-M	DeVries
Hofmann, Gretchen .....	BO-301-O	Manahan
Holmes, Robert .....	OO-283-M	Stearns
Holt, Jack .....	GS-098-O	Blankenship
Holzapfel, Bill .....	AC-378-O	Ruhl
Hothem, Larry .....	GO-052-M	Mullins
	and GO-052-S	Mullins
Houlihan, Terrence .....	BP-046-O	Karl
House, Martha .....	GO-066-O	House/Farley
Hubbard, Erin .....	BO-050-O	Smith
Huey, Greg .....	OO-270-O	Davis
Hulth, Per Olof .....	AA-130-O	Morse
Hunt, Benjamin .....	BO-005-M	DeVries
Hutterli, Manuel .....	OO-324-O	McConnell
Idol, Jeff .....	GO-090-P	Butler
Ireson, Kirk .....	BP-032-O	Smith
Irinaga, Matt .....	BP-013-O	Fraser
Isbell, John .....	GO-094-O	Isbell
Isbert, Joachim .....	AB-149-O	Wefel
Ivany, Linda .....	GO-065-O	Aronson
Jackson, Shannon .....	GF-121-O	Luyendyk
Jacobs, Karl .....	AC-371-O	Stark
Jacobs, Stanley .....	OO-225-O	Fairbanks
Jacobsen, John .....	AA-130-O	Morse
Janacek, Tom .....	GO-073-O	Leventer
Jaros, Chris .....	BM-042-M	McKnight
Jarrett, Effie .....	GS-098-O	Blankenship
Jeffrey, Wade .....	BO-301-O	Manahan
Johns, Bjorn .....	GO-295-O	Johns
Johnson, Brad .....	GO-052-M	Mullins
	and GO-052-S	Mullins
Johnston, Robin .....	BM-042-F	Fountain
Jurgens, Joel .....	BO-038-O	Blanchette
Kamb, Barclay .....	IO-157-O	Kamb
Kaminski, Charles .....	AC-370-O	Pernic
Karentz, Deneb .....	BO-301-O	Manahan
Karl, David .....	BP-046-O	Karl
Karle, Albrecht .....	AA-130-O	Morse
Karstens, Richard .....	GO-081-O	Kyle
Kaspari, Susan .....	BM-042-F	Fountain
Keller, William .....	GO-071-O	Cande
Kempf, Scott .....	GS-098-O	Blankenship
Kenney, Peter .....	AB-147-O	Meyer
Kennicutt II, Mahlon .....	EO-318-O	Kennicutt
Keough, John .....	GO-082-O	Raymond
Kerman, Benjamin .....	IO-190-O	MacAyeal
Kjestveit, Guro .....	OO-316-O	Dempsey
Klein, Erich .....	AB-145-O	Peterzen
Klein, Andrew .....	EO-318-O	Kennicutt
Koci, Bruce .....	AA-130-O	Morse

Koepke, Lutz .....	AA-130-O	Morse
Kooi, Jacob .....	AC-371-O	Stark
Kooyman, Gerald .....	BO-197-O	Ponganis
Koppes, Michele .....	IO-157-O	Kamb
Kosciuch, Edward J. ....	OO-270-O	Davis
Kouznetsov, Evgueni .....	AB-149-O	Wefel
Kovac, John .....	AC-373-O	Carlstrom
Kowalski, Marek .....	AA-130-O	Morse
Kozlowski, Wendy .....	BP-016-O	Vernet
Kravchenko, Ilya .....	AA-130-O	Morse
Kristensen, Rene .....	AB-147-O	Meyer
Krutikov, Lena .....	GS-098-O	Blankenship
Krysl, Kolene .....	BO-009-O	Siniff
Kuo, Chaolin .....	AC-378-O	Ruhl
Kurnik, Charles .....	GO-295-O	Johns
Kurtz, Andrew .....	II-168-O	Alley
Kyle, Phil .....	GO-081-O	Kyle
Lamoureux, Jodi .....	AA-130-O	Morse
Landsberg, Randy .....	AC-370-O	Pernic
Laubacher, Matthew .....	BO-050-O	Smith
Lavigne, Kevin .....	BM-042-V	Virginia
Lawson, Paul .....	OO-226-O	Lawson
Lawson, Jennifer .....	BM-042-D	Doran
Leach, Eric .....	AC-373-O	Carlstrom
Leaker, Martin .....	AC-378-O	Ruhl
Lee, Peter .....	BO-025-O	Priscu
Lee, Wonchoel .....	EO-318-O	Kennicutt
Lefer, Barry .....	OO-270-O	Davis
Lemczyk, Tom .....	AB-149-O	Wefel
Leppik, Karina .....	AC-371-O	Stark
Leuthold, Matthias .....	AA-130-O	Morse
Levenson, David .....	BO-197-O	Ponganis
Leventer, Amy .....	GO-073-O	Leventer
Lever, James .....	IO-192-O	Taylor
Lewis, Adam .....	GO-054-O	Marchant
Linnehan, Rick .....	GO-058-O	Harvey
Lisle, John .....	BO-024-O	Lisle
	and BO-025-O	Priscu
Loewenstein, Robert .....	AC-370-O	Pernic
Lovell, Lawrence .....	BO-050-O	Smith
Lui, Alan .....	AO-127-O	Papen
Lurton, Charlie .....	GO-078-O	Oliver
Luyendyk, Bruce .....	GF-121-O	Luyendyk
Lyons, W. Berry .....	BM-042-L	Lyons
MacAyeal, Douglas .....	IO-190-O	MacAyeal
Macdonald, Francis .....	GO-071-O	Cande
MacNulty, Daniel .....	BO-009-O	Siniff
Madsen, James .....	AA-130-O	Morse
Magnoni, Leonardo .....	BO-036-O	Sidell
Makarov, Nikolai .....	AO-284-O	Avery

Maldanodo, Maria .....	BO-310-O	Ward
Manahan, Donal .....	BO-301-O	Manahan
Manley, Pat .....	GO-073-O	Leventer
Marchant, David .....	GO-054-O	Marchant
Marchant, Gary .....	AB-145-O	Peterzen
Marciniewski, Pavel .....	AA-130-O	Morse
Marcotte, Peter .....	IO-196-M	Hall
Marsh, Adam .....	BO-301-O	Manahan
Marshall, Chad .....	BM-042-P	Priscu
Marshall, Craig .....	BO-301-O	Manahan
Marshall, Greg .....	BO-197-O	Ponganis
Martin, Chris .....	AC-371-O	Stark
Martin, Dan .....	BP-028-O	Quetin/Ross
Masterman, Michael .....	GO-082-O	Raymond
Mauldin III, Roy .....	OO-270-O	Davis
Maxson, Robert .....	BO-301-O	Manahan
Mayewski, Paul .....	IU-133-311-O	ITASE PIs
McClennen, Charlie .....	GO-073-O	Leventer
McConnell, Joseph .....	OO-324-O	McConnell
McConnell, Martha .....	GS-098-O	Blankenship
McIntosh, William .....	GO-081-O	Kyle
McKnight, Diane .....	BM-042-M	McKnight
McLain, Teri .....	BO-005-M	DeVries
McLean, Donald Archie .....	BO-050-O	Smith
McParland, Charles .....	AA-130-O	Morse
Metzger, Mark .....	AB-145-O	Peterzen
Meyer, Stephan .....	AB-147-O	Meyer
Minaeva, Yulia .....	AA-130-O	Morse
Mincks, Sarah .....	BO-303-O	Smith
Mitani, Yoko .....	BO-009-O	Siniff
Mitchell, Nicola .....	BO-303-O	Smith
Mock, Leslie .....	AB-149-O	Wefel
Montagna, Paul .....	EO-318-O	Kennicutt
Moorhead, Daryl .....	BM-042-L	Lyons
Morack, John .....	IO-164-O	Harrison
Morehead, Sally .....	EO-318-O	Kennicutt
Morse, David .....	GS-098-O	Blankenship
Morse, Robert .....	AA-130-O	Morse
Motyka, Jason .....	GO-078-O	Oliver
Mucciarone, Dave .....	GO-073-O	Leventer
Mueller, Derek .....	BM-042-D	Doran
Mullenax, Robert .....	AB-145-O	Peterzen
Mullins, Jerry .....	GO-052-M	Mullins
Murray, Alison .....	BO-301-O	Manahan
Muscari, Giovanni .....	AO-138-O	deZafra
Nakamura, Yosio .....	GO-306-O	Austin
Nevins, Hannah .....	BO-031-O	Ainley
Newcomb, Matt .....	AC-375-O	Peterson
Nittler, Larry .....	GO-058-O	Harvey
Novac, Giles .....	AC-376-O	Novac

Nylen, Thomas .....	BM-042-F	Fountain
Oakes, Stephanie .....	BP-028-O	Quetin/Ross
Oh, Eun .....	AB-147-O	Meyer
Okada, Masaki .....	AO-117-O	Ejiri
Olano, Donny .....	AB-149-O	Wefel
Oliver, Kenneth .....	GO-078-O	Oliver
Olsen, Carrie .....	GO-306-O	Austin
Owczarek, Magdalena .....	BO-040-O	Trivelpiece
Parker, Sandra .....	BO-037-O	Detrich
Parsons, Andy .....	BM-042-W	Wall
Patterson, Donna .....	BP-013-O	Fraser
Paulos, Bob .....	AA-130-O	Morse
Paulsen, Timothy .....	GO-099-O	Wilson
Pernic, Robert .....	AC-370-O	Pernic
Perry, Ethan .....	IO-196-L	Hall
Persefield, Kyle .....	GO-090-S	Butler
Pescue, Jonathan .....	AO-129-O	Sivjee
Peters, Matthew .....	GS-098-O	Blankenship
Peterson, Jeff .....	AC-375-O	Peterson
Peterzen, Francie .....	AB-145-O	Peterzen
Peterzen, Steven .....	AB-145-O	Peterzen
Pettinga, Jarg .....	GO-059-O	Fitzgerald
Phillips, Andre .....	AC-372-O	Storey
Phillips, William .....	GO-054-O	Marchant
Pickering, Chuck .....	BO-301-O	Manahan
Pilskaln, Cynthia .....	OO-278-O	Pilskaln
Poirier, Gerald .....	AO-109-O	Gaisser
Ponganis, Katherine .....	BO-197-O	Ponganis
Ponganis, Paul .....	BO-197-O	Ponganis
Porazinska, Dorota .....	BM-042-W	Wall
Praebel, Kim .....	BO-005-M	DeVries
Price, Brad .....	AB-149-O	Wefel
Price, Steven .....	IO-173-O	Bindschadler
Priscu, John .....	BO-025-O	Priscu
Pyle, Roger .....	AO-120-O	Bieber
Quetin, Langdon .....	BP-028-O	Quetin/Ross
Rall, Jonathan .....	AO-126-O	Rall
Rawlins, Katherine .....	AA-130-O	Morse
Raymond, Carol .....	GO-082-O	Raymond
Rebold, Tom .....	GF-121-O	Luyendyk
Redell, Benjamin .....	AC-373-O	Carlstrom
Rehmann, Kenneth .....	AB-147-O	Meyer
Rektoris, Ladislav .....	BO-040-O	Trivelpiece
Richter, Steffen .....	AA-130-O	Morse
Richter, Thomas .....	GS-098-O	Blankenship
Riseman, Sarah .....	BO-025-O	Priscu
Ritchie, John .....	GO-052-M	Mullins
Roberts, Jeffery .....	GO-078-O	Oliver
Roberts, John .....	GO-116-O	Stump
Roberts, Mike .....	IO-175-O	Stone

Roberts, Paulene .....	OO-257-O	Hofmann
Robertson, Stacey .....	GO-097-O	Wiens
Rodman, Bill .....	AB-149-O	Wefel
Rodriguez, Silvia .....	BP-016-O	Vernet
Rosenthal, Josh .....	BO-030-O	Dudley
Ross, Robin .....	BP-028-O	Quetin/Ross
Roth, James .....	AO-120-O	Bieber
Rottman, Joseph .....	AC-370-O	Pernic
Rowe, Penny .....	OO-201-O	Warren
Ruhl, John .....	AC-378-O	Ruhl
Runyan, Marcus .....	AC-378-O	Ruhl
Russell, Sara .....	GO-058-O	Harvey
Rutishauser, Matthew .....	BO-267-O	Costa
Sadler, Wil .....	BM-042-M	McKnight
Sandberg, Eric .....	OO-257-O	Hofmann
Sato, Katsufumi .....	BO-009-O	Siniff
Sattler, Birgit .....	BM-042-P	Priscu
Saustrup, Steffen .....	GO-306-O	Austin
Scambos, Ted .....	II-163-O	Raymond
Scheider, Thomas .....	AA-130-O	Morse
Schmidt, Torsten .....	AA-130-O	Morse
Schmitz, David .....	AA-130-O	Morse
Schneider, Darryn .....	AA-130-O	Morse
Schneider, David .....	IU-133-311-O	ITASE PIs
Schnell, Russ .....	OO-257-O	Hofmann
Schutt, John .....	GO-058-O	Harvey
Schweitzer, Carrie .....	GO-093-O	Feldmann
Searson, Sara .....	BP-032-O	Smith
Sedwick, Peter .....	GO-073-O	Leventer
Seibel, Brad .....	BO-030-O	Dudley
Semmer, Steve .....	OO-270-O	Davis
Shapiro, Lewis .....	OO-316-O	Dempsey
Sharp, Elmer .....	AB-147-O	Meyer
Shill, Laina .....	BO-040-O	Trivelpiece
Shore, Patrick .....	GO-089-O	Wiens
Shu, Takeshita .....	AO-117-O	Ejiri
Shulman, Leonard .....	AO-120-O	Bieber
Shuman, Chris .....	IU-133-311-O	ITASE PIs
Sidell, Bruce .....	BO-036-O	Sidell
Siebertz, Oliver .....	AC-371-O	Stark
Silverberg, Robert .....	AB-147-O	Meyer
Sines, Karie .....	BP-016-O	Vernet
Sivjee, G.G. .....	AO-129-O	Sivjee
Sletten, Ronald .....	GO-053-O	Hallet
Slijjk, Wendy .....	GO-073-O	Leventer
Smith, Colby .....	IO-196-M	Hall
Smith, Doug .....	AB-149-O	Wefel
Smith, Gideon .....	GO-097-O	Wiens
Smith, Margaret .....	GO-053-O	Hallet
Smith, Roger .....	AO-110-O	Hernandez

Smith, Zachary .....	IU-133-311-O	ITASE PIs
Smith, Craig .....	BO-303-O	Smith
Smith, Jim .....	BO-024-O	Lisle
Smith, Kenneth .....	BO-050-O	Smith
Smith, Ray .....	BP-032-O	Smith
Smith, Stanley .....	BO-303-O	Smith
Somero, George .....	BO-301-O	Manahan
Soto, Nelyn .....	BO-005-M	DeVries
Spiczak, Glenn .....	AO-109-O	Gaisser
Spinhirne, Jim .....	OO-201-O	Warren
Spotz, Robert .....	AC-370-O	Pernic
Stark, Tony .....	AC-371-O	Stark
Staude, Craig .....	BO-282-O	Dietzman
Stearns, Leigh .....	IU-133-311-O	ITASE PIs
Stegemoeller, Anna .....	GO-078-O	Oliver
Stewart, Michael .....	AB-149-O	Wefel
Stewart, Brent .....	BO-009-O	Siniff
Stone, John .....	IO-175-O	Stone
Storey, John .....	AC-372-O	Storey
Stracner, Bill .....	AB-145-O	Peterzen
Strait, Melissa .....	GO-058-O	Harvey
Stump, Edmund .....	GO-116-O	Stump
Suhr, Stephanie .....	BO-303-O	Smith
Sullivan, David .....	AB-145-O	Peterzen
Swanson, William .....	BP-032-O	Smith
Sweet, Stephen .....	EO-318-O	Kennicutt
Swenson, Gary .....	AO-127-O	Papen
Talarico, Franco .....	GO-116-O	Stump
Tanner, David .....	OO-270-O	Davis
Taylor, Fiona .....	GO-073-O	Leventer
Taylor, Susan .....	IO-192-O	Taylor
Thiessen, Conrad .....	BO-040-O	Trivelpiece
Thimgan, Michael .....	BP-016-O	Vernet
Thoma, Mark .....	AC-375-O	Peterson
Thomas, W. Thomas .....	AB-145-O	Peterzen
Thornton, Don .....	OO-270-O	Davis
Tivy, Adrienne .....	OO-263-O	Wendler
Toptygin, Alexey .....	AB-149-O	Wefel
Torbet, Eric .....	AC-378-O	Ruhl
Town, Michael .....	OO-201-O	Warren
Tremblay, Rolf .....	II-171-O	Waddington
Trivelpiece, Susan .....	BO-040-O	Trivelpiece
Trussoni, Vincente .....	BO-041-O	Green
Tu, Fang-Huang .....	OO-270-O	Davis
Tulaczyk, Slawek .....	IO-157-O	Kamb
Uhlman, Alfred .....	BO-050-O	Smith
Uhlman, Jan .....	BO-050-O	Smith
van Dam, Robert .....	BO-197-O	Ponganis
Van Dijken, Gert .....	GO-073-A	Arrigo
Vandenheuvel, Brett .....	GO-054-O	Marchant

Vera, Emilio .....	GO-097-O	Wiens
Vernet, Maria .....	BP-016-O	Vernet
Virginia, Ross .....	BM-042-V	Virginia
Voight, Don .....	GO-089-O	Wiens
Voigt, Donald .....	GO-180-O	Anandakrishnan
Volna, Bill .....	AC-370-O	Pernic
Vornberger, Patricia .....	IO-173-O	Bindschadler
Walden, Vol .....	OO-201-O	Warren
Walker, Chris .....	AC-371-O	Stark
Wall, Diana .....	BM-042-W	Wall
Ward, Bess .....	BO-310-O	Ward
Wardell, Lois Jean .....	GO-081-O	Kyle
Warren, Stephen .....	OO-201-O	Warren
Weatherwax, Alan .....	AO-111-O	Rosenberg
Wefel, John .....	AB-149-O	Wefel
Wefel, Mark .....	AB-149-O	Wefel
Weidner, George .....	OO-283-M	Stearns
	and OO-283-S	Stearns
Welch, Brian .....	IU-133-311-O	ITASE PIs
Welch, Kathleen .....	BM-042-L	Lyons
Welch, Timothy .....	BO-197-O	Ponganis
Wells, Mark .....	BO-310-O	Ward
Wendler, Gerd .....	OO-263-O	Wendler
Wheeler, Kevin .....	BM-042-M	McKnight
Whiteside, Robin .....	AB-145-O	Peterzen
Wiens, Douglas .....	GO-089-O	Wiens
Willenbring, Jane .....	GO-054-O	Marchant
Williams, Carlen .....	AO-131-O	Deshler
Willis, Mike .....	GO-052-M	Mullins
Wilson, Grant .....	AB-147-O	Meyer
Wilson, Terry .....	GO-099-O	Wilson
Wilson, RJ .....	EO-318-O	Kennicutt
Wirth, Caesar (Jesse) .....	AC-370-O	Pernic
Wolf, Craig .....	BM-042-P	Priscu
Wolff, Gary .....	EO-318-O	Kennicutt
Womack, Lyle .....	AO-131-O	Deshler
Wright, Greg .....	AC-371-O	Stark
Yankielun, Norbert .....	IU-133-311-O	ITASE PIs
Yates, Ben .....	GO-306-O	Austin
Yergeau, Donald .....	BO-037-O	Detrich
Yochem, Pamela .....	BO-009-O	Siniff
Zmarzly, Pat .....	OO-226-O	Lawson
Zumberge, Mark .....	IO-164-O	Harrison

Several Team members are yet to be determined. Listed below are the TBDs with their associated Event # and PI Name.

TBD .....	AC-370-O	Pernic
TBD .....	AC-373-O	Carlstrom
TBD .....	AC-375-O	Peterson
TBD .....	AO-110-O	Hernandez
TBD .....	AO-111-O	Rosenberg
TBD .....	AO-127-O	Papen
TBD .....	BO-025-O	Priscu
TBD .....	BO-034-O	Emslie
TBD .....	BO-303-O	Smith
TBD .....	BP-016-O	Vernet
TBD .....	GO-052-M	Mullins
TBD .....	GO-053-O	Hallet
TBD .....	GO-082-O	Raymond
TBD .....	IO-175-O	Stone
TBD .....	OO-263-O	Wendler
TBD .....	OO-283-S	Stearns
TBD .....	OO-316-O	Dempsey
TBD (1 or 2) .....	GO-071-O	Cande
TBD (10) .....	GS-098-O	Blankenship
TBD (14) .....	GO-073-O	Leventer
TBD (2) .....	AC-371-O	Stark
TBD (2) .....	BO-036-O	Sidell
TBD (2) .....	BO-037-O	Detrich
TBD (2) .....	BP-046-O	Karl
TBD (2) .....	GO-094-O	Isbell
TBD (2) .....	IO-162-O	Bender
TBD (2) .....	IU-133-311-O	ITASE PIs
TBD (2) .....	OO-283-M	Stearns
TBD (28) .....	BO-301-O	Manahan
TBD (3) .....	BO-041-O	Green
TBD (4) .....	BO-031-O	Ainley
TBD (4) .....	OO-225-O	Fairbanks
TBD (5) .....	BP-028-O	Quetin/Ross

**Appendix B**  
**2000-2001 USAP Field Season**  
**Alphabetical List of**  
**Principal Investigators' Names**  
**and Associated Science Event Numbers (SENs)**

<b>PI Name .....</b>	<b>SEN #</b>
Adriani, Alberto .....	AO-107-O
Ainley, David .....	BO-031-O
Albert, Mary .....	IU-155-O
Alley, Richard .....	II-168-O
Anandakrishnan, Sridhar .....	GO-180-O
Arcone, Steven .....	IU-311-O
Aronson, Richard .....	GO-065-O
Arrigo, Kevin .....	GO-073-A
Austin, James .....	GO-306-O
Avery, Susan .....	AO-284-O
Bales, Roger .....	IU-158-O
Bender, Michael .....	IO-162-O
Bieber, John .....	AO-120-O
Bindschadler, Robert .....	IO-173-O
Blanchette, Robert .....	BO-038-O
Blankenship, Donald .....	GS-098-0
Butler, Rhett .....	GO-090-P
	and GO-090-S
Cande, Steven .....	GO-071-O
Carlstrom, John .....	AC-373-O
Chereskin, Teresa .....	OO-315-O
Costa, Daniel .....	BO-267-O
Davis, Douglas .....	OO-270-O
Dempsey, John .....	OO-316-O
Deshler, Terry .....	AO-131-O
Detrich, William .....	BO-037-O
DeVries, Arthur .....	BO-005-M
deZafra, Robert .....	AO-138-O
Dietzman, Gregg .....	BO-282-O
Doran, Peter .....	BM-042-D
Dudley, Robert .....	BO-030-O
Ejiri, Masaki .....	AO-117-O
Emslie, Steven .....	BO-034-O
Engebretson, Mark .....	AO-102-O
Fairbanks, Richard .....	OO-225-O





**Appendix C**

**2000-2001 USAP Field Season**

**Alphabetical List of Principal Investigators'**

**Home Institutions / Affiliations**

Home Institution / Affiliation .....	SEN #	PI Name
Arizona State University .....	GO-116-O	Stump
Augsburg College .....	AO-102-O	Engebretson
Boston University .....	GO-054-O	Marchant
California Institute of Technology .....	GO-066-O	House
California Institute of Technology .....	GO-082-O	Raymond
California Institute of Technology .....	IO-157-O	Kamb
Carnegie-Mellon University .....	AC-375-O	Peterson
Case Western Reserve University .....	GO-058-O	Harvey
Clarkson University .....	OO-316-O	Dempsey
Cold Regions Research & Engineering Lab (CRREL) .....	IO-192-O	Taylor
Cold Regions Research & Engineering Lab (CRREL) .....	IU-155-O	Albert
Cold Regions Research & Engineering Lab (CRREL) .....	IU-185-O	Meese
Cold Regions Research & Engineering Lab (CRREL) .....	IU-311-O	Arcone
Colgate University .....	GO-073-O	Leventer
Colorado State University .....	BM-042-W	Wall
Columbia University .....	BP-021-O	Martinson
Columbia University .....	OO-225-O	Fairbanks
Consiglio Nazionale delle Ricerche .....	AO-107-O	Adriani
Dartmouth College .....	AO-128-O	LaBelle
Dartmouth College .....	BM-042-V	Virginia
Dauphin Island Sea Lab .....	GO-065-O	Aronson
Desert Research Institute .....	OO-324-O	McConnell
Embry-Riddle University .....	AO-129-O	Sivjee
Georgia Institute of Technology .....	OO-270-O	Davis
GSP Technical Operations .....	GO-078-O	Oliver
H.T. Harvey & Associates .....	BO-031-O	Ainley
Incorporated Research Institutions for Seismology .....	GO-090-P	Butler
and GO-090-S .....		Butler
Kent State University .....	GO-093-O	Feldman
Lockheed Martin .....	BO-024-O	Lisle
Louisiana State University .....	AB-149-O	Wefel
Lucent Technologies .....	AO-101-O	Lanzerotti
Magee Scientific Co. ....	OO-314-O	Hansen

Miami University .....	BO-041-O	Green
Montana State University .....	BM-042-P	Priscu
	and BO-025-O	Priscu
Montana State University .....	BO-040-O	Trivelpiece
Montana State University .....	BP-013-O	Fraser
National Aeronautics and Space Administration (NASA), Goddard Space Flight Center .....	AO-126-O	Rall
National Aeronautics and Space Administration (NASA), Goddard Space Flight Center .....	IO-173-O	Bindschadler
National Institute of Polar Research (Japan) .....	AO-117-O	Ejiri
National Oceanic and Atmospheric Administration (NOAA) / Climate Monitoring and Diagnostics Laboratory (CMDL) .....	OO-257-O	Hofmann
	and OO-264-O	Hofmann
National Scientific Balloon Facility .....	AB-145-O	Peterzen
New Mexico Institute of Mining and Technology ...	GO-081-O	Kyle
Northeastern University .....	BO-037-O	Detrich
Northwestern University .....	AC-376-O	Novac
Ohio State University .....	BM-042-L	Lyons
Ohio State University .....	GO-099-O	Wilson
Oregon Graduate Inst. of Science & Technology ....	OO-254-O	Rasmussen
Pennsylvania State University .....	II-168-O	Alley
Portland State University .....	BM-042-F	Fountain
Princeton University .....	BO-310-O	Ward
Princeton University .....	IO-162-O	Bender
Smithsonian Astrophysical Observatory .....	AC-371-O	Stark
SPEC Inc. ....	OO-226-O	Lawson
St. Olaf College .....	IU-133-O	Jacobel
Stanford University .....	AO-106-P	Inan
	and AO-106-S	Inan
Stanford University .....	GO-073-A	Arrigo
State University of New York .....	AO-138-O	deZafra
Syracuse University .....	GO-059-O	Fitzgerald
Texas A&M University .....	EO-318-O	Kennicutt
U.S. Geological Survey .....	GO-052-M	Mullins
	and GO-052-P	Mullins
	and GO-052-S	Mullins
UNAVCO .....	GO-295-O	Johns
United States Department of Energy .....	OO-275-O	Sanderson
University of Alabama .....	GO-180-O	Anandakrishnan
University of Alaska .....	IO-164-O	Harrison
University of Alaska .....	OO-263-O	Wendler
University of Arizona .....	IU-158-O	Bales
University of California — Berkeley .....	AO-104-O	Mende
University of California — San Diego, Scripps Institution of Oceanography .....	BO-050-O	Smith
University of California — San Diego, Scripps Institution of Oceanography .....	BO-197-O	Ponganis
University of California — San Diego, Scripps Institution of Oceanography .....	BP-016-O	Vernet

University of California — San Diego, Scripps Institution of Oceanography .....	GO-071-O	Cande
University of California — San Diego, Scripps Institution of Oceanography .....	OO-204-O	Keeling
University of California — San Diego, Scripps Institution of Oceanography .....	OO-260-O	Peterson
University of California — San Diego, Scripps Institution of Oceanography .....	OO-315-O	Chereskin
University of California — Santa Barbara .....	AC-378-O	Ruhl
University of California — Santa Barbara .....	BP-028-O	Ross
University of California — Santa Barbara .....	BP-032-O	Smith
University of California — Santa Barbara .....	GF-121-O	Luyendyk
University of California — Santa Cruz .....	BO-267-O	Costa
University of Chicago .....	AB-147-O	Meyer
University of Chicago .....	AC-373-O	Carlstrom
University of Chicago .....	IO-190-O	MacAyeal
University of Colorado .....	AO-284-O	Avery
University of Colorado .....	BM-042-M	McKnight
University of Colorado .....	II-163-O	Scambos
University of Colorado .....	IU-193-O	White
University of Delaware .....	AO-109-O	Gaisser
University of Delaware .....	AO-120-O	Bieber
University of Hawaii .....	BO-303-O	Smith
University of Hawaii .....	BP-046-O	Karl
University of Illinois — Urbana .....	AO-127-O	Papen
University of Illinois — Urbana .....	BO-005-M	DeVries
University of Illinois — Chicago .....	BM-042-D	Doran
University of Maine .....	BO-036-O	Sidell
University of Maine .....	IO-196-L	Hall
	and IO-196-M	Hall
University of Maine .....	IU-153-A	Mayewski
	and IU-153-B	Mayewski
University of Maine .....	IU-178-O	Hamilton
University of Maine .....	OO-278-O	Pilskaln
University of Maryland .....	AO-111-O	Rosenberg
	and AO-112-O	Rosenberg
University of Maryland .....	IU-193-O	Shuman
University of Minnesota .....	BO-009-O	Siniff
University of Minnesota .....	BO-038-O	Blanchette
University of New South Wales .....	AC-372-O	Storey
University of North Carolina .....	BO-034-O	Emslie
University of Pennsylvania .....	IU-193-O	Steig
University of Southern California .....	BO-301-O	Manahan
University of Texas .....	BO-030-O	Dudley
University of Texas .....	GO-306-O	Austin
University of Texas .....	GS-098-0	Blankenship
University of Washington .....	AO-110-O	Hernandez
University of Washington .....	GO-053-O	Hallet
University of Washington .....	II-163-O	Raymond
University of Washington .....	II-171-O	Waddington

University of Washington .....	IO-175-O	Stone
University of Washington .....	OO-201-O	Warren
University of Wisconsin — Madison .....	AA-130-O	Morse
University of Wisconsin — Madison .....	OO-283-M	Stearns
	and OO-283-P	Stearns
	and OO-283-S	Stearns
University of Wisconsin — Milwaukee .....	GO-094-O	Isbell
University of Wyoming .....	AO-131-O	Deshler
Washington University .....	GO-089-O	Wiens
	and GO-097-O	Wiens
White Point Systems, Inc. ....	BO-282-O	Dietzman
Yerkes Observatory .....	AC-370-O	Pernic
Yerkes Observatory .....	AC-374-O	Loewenstein

## Appendix D

### List of Research Projects by Location (Then in alphabetical order of Science Event Numbers (SENs) with Principal Investigator (PI) Last Names )

#### McMurdo Station Based Research Projects

<i>SEN</i>	<i>PI Last Name</i>
AB-145-O	Peterzen
AB-147-O	Meyer
AB-149-O	Wefel
AO-107-O	Adriani
AO-112-O	Rosenberg
AO-131-O	Deshler
BM-042-D	Doran
BM-042-F	Fountain
BM-042-L	Lyons
BM-042-M	McKnight
BM-042-P	Priscu
BM-042-V	Virginia
BM-042-W	Wall
BO-005-M	DeVries
BO-009-O	Siniff
BO-024-O	Lisle
BO-025-O	Priscu
BO-030-O	Dudley
BO-031-O	Ainley
BO-034-O	Emslie
BO-038-O	Blanchette
BO-041-O	Green
BO-197-O	Ponganis
BO-301-O	Manahan
BO-310-O	Ward
EO-318-O	Kennicutt
GF-121-O	Luyendyk
GO-052-M	Mullins
GO-053-O	Hallet
GO-054-O	Marchant
GO-058-O	Harvey
GO-059-O	Fitzgerald
GO-066-O	House
GO-078-O	Oliver

GO-082-O .....	Raymond
GO-089-O .....	Wiens
GO-094-O .....	Isbell
GO-099-O .....	Wilson
GO-116-O .....	Stump
GO-180-O .....	Anandakrishnan
GO-295-O .....	Johns
GS-098-O .....	Blankenship
II-163-O .....	Raymond & Scambos
II-168-O .....	Alley
II-171-O .....	Waddington
IO-157-O .....	Kamb
IO-164-O .....	Harrison
IO-173-O .....	Bindschadler
IO-175-O .....	Stone
IO-190-O .....	MacAye
IO-196-M .....	Hall
IU-133-O .....	Jacobel
IU-153-A .....	Mayewski
IU-153-B .....	Mayewski
IU-155-O .....	Albert
IU-158-O .....	Bales
IU-178-O .....	Hamilton
IU-185-O .....	Meese
IU-193-O .....	Stein, White, & Shuman
IU-311-O .....	Arcone
OO-263-O .....	Wendler
OO-283-M .....	Stearns
OO-314-O .....	Hansen
OO-316-O .....	Dempsey

**Palmer Station Based Research Projects**

<i>SEN</i> .....	<i>PI Last Name</i>
AO-106-P .....	Inan
GO-052-P .....	Mullins
GO-090-P .....	Butler
OO-204-O .....	Keeling
OO-254-O .....	Rasmussen
OO-264-O .....	Hofmann
OO-275-O .....	Sanderson
OO-283-P .....	Stearns

**Palmer Station & R/V *Laurence M. Gould* Based Research Projects**

<i>SEN</i> .....	<i>PI Last Name</i>
BO-036-O .....	Sidell
BO-037-O .....	Detrich
BP-013-O .....	Fraser
BP-016-O .....	Vernet

BP-028-O ..... Ross  
BP-032-O ..... Smith

**R/V Laurence M. Gould Based Research Projects**

*SEN* ..... *PI Last Name*  
BO-050-O ..... Smith  
BO-282-O ..... Dietzman  
BO-303-O ..... Smith  
BP-021-O ..... Martinson  
BP-046-O ..... Karl  
IO-196-L ..... Hall  
OO-260-O ..... Peterson

**R/V Nathaniel B. Palmer Based Research Projects**

*SEN* ..... *PI Last Name*  
GO-071-O ..... Cande  
GO-073-A ..... Arrigo  
GO-073-O ..... Leventer  
GO-306-O ..... Austin  
OO-225-O ..... Fairbanks  
OO-278-O ..... Pilskaln

**R/V Nathaniel B. Palmer & R/V Laurence M. Gould  
Based Research Project**

*SEN* ..... *PI Last Name*  
OO-315-O ..... Chereskin

**South Pole Based Research Projects**

*SEN* ..... *PI Last Name*  
AA-130-O ..... Morse  
AC-370-O ..... Pernic  
AC-371-O ..... Stark  
AC-372-O ..... Storey  
AC-373-O ..... Carlstrom  
AC-374-O ..... Loewenstein  
AC-375-O ..... Peterson  
AC-376-O ..... Novac  
AC-378-O ..... Ruhl  
AO-104-O ..... Mende  
AO-106-S ..... Inan  
AO-109-O ..... Gaisser  
AO-110-O ..... Hernandez  
AO-117-O ..... Ejiri  
AO-127-0 ..... Papen  
AO-128-O ..... LaBelle  
AO-129-O ..... Sivjee

AO-138-O ..... deZafra  
 AO-284-O ..... Avery  
 GO-052-S ..... Mullins  
 GO-090-S ..... Butler  
 IO-162-O ..... Bender  
 IO-192-O ..... Taylor  
 OO-201-O ..... Warren  
 OO-226-O ..... Lawson  
 OO-257-O ..... Hofmann  
 OO-270-O ..... Davis  
 OO-283-S ..... Stearns  
 OO-324-O ..... McConnell

**South Pole Station & McMurdo Station Based Research Projects**

*SEN* ..... *PI Last Name*  
 AO-101-O ..... Lanzerotti  
 AO-102-O ..... Engebretson  
 AO-111-O ..... Rosenberg  
 AO-126-O ..... Rall  
 GO-081-O ..... Kyle

**South Pole Station & McMurdo Station & Icebreaker Based Research Project**

*SEN* ..... *PI Last Name*  
 AO-120-O ..... Bieber

**Research Projects Not Based at any of the Above Locations**

*Unique Location* ..... *SEN* ..... *PI Last Name*  
 Copacabana Field Station  
 on King George Island ..... BO-040-O ..... Trivelpiece  
 Cape Shirreff on Livingston Island ..... BO-267-O ..... Costa  
 Seymour Island and adjacent islands ..... GO-065-O ..... Aronson  
 Seymour Island ..... GO-093-O ..... Feldman  
 Chilean Bases (Frei, Prat, and O'Higgins) ... GO-097-O ..... Wiens

**Index of  
Science Project Write-Ups  
In Ascending Numerical Order  
of the Science Event Number (SEN)**

<b>SEN #</b>	<b>PI Name .....</b>	<b>Page #</b>
BO-005-M	DeVries .....	66
BO-009-O	Siniff .....	68
BP-013-O	Fraser .....	104
BP-016-O	Vernet .....	104
BP-021-O	Martinson .....	104
BO-024-O	Lisle .....	70
BO-025-O	Priscu .....	72
BP-028-O	Quetin & Ross .....	104
BO-030-O	Dudley .....	74
BO-031-O	Ainley .....	76
BP-032-O	Smith .....	104
BO-034-O	Emslie .....	78
BO-036-O	Sidell .....	80
BO-037-O	Detrich, III .....	82
BO-038-O	Blanchette .....	84
BO-040-O	Trivelpiece .....	86
BO-041-O	Green .....	88
BM-042-D	Doran .....	58
BM-042-F	Fountain .....	58
BM-042-L	Lyons .....	58
BM-042-M	McKnight .....	58
BM-042-P	Priscu .....	58
BM-042-V	Virginia .....	58
BM-042-W	Wall .....	58
BP-046-O	Karl .....	104
BO-050-O	Smith .....	90
GO-052-M	Mullins .....	122
GO-052-P	Mullins .....	124
GO-052-S	Mullins .....	126
GO-053-O	Hallet .....	128
GO-054-O	Marchant .....	130
GO-058-O	Harvey .....	132
GO-059-O	Fitzgerald .....	134
GO-065-O	Aronson .....	136
GO-066-O	House .....	138
GO-071-O	Cande .....	140
GO-073-A	Arrigo .....	142
GO-073-O	Leventer .....	144
GO-078-O	Oliver .....	146

GO-081-O	Kyle .....	148
GO-082-O	Raymond .....	150
GO-089-O	Wiens .....	152
GO-090-P	Butler .....	154
GO-090-S	Butler .....	156
GO-093-O	Feldman .....	158
GO-094-O	Isbell .....	160
GO-097-O	Wiens .....	162
GS-098-O	Blankenship .....	174
GO-099-O	Wilson .....	164
AO-101-O	Lanzerotti .....	18
AO-102-O	Engebretson .....	20
AO-104-O	Mende .....	22
AO-106-P	Inan .....	24
AO-106-S	Inan .....	26
AO-107-O	Adriani .....	28
AO-109-O	Gaisser .....	30
AO-110-O	Hernandez .....	32
AO-111-O	Rosenberg .....	34
AO-112-O	Rosenberg .....	36
GO-116-O	Stump .....	166
AO-117-O	Ejiri .....	38
AO-120-O	Bieber .....	40
GF-121-O	Luyendyk .....	120
AO-126-O	Rall .....	42
AO-127-0	Papen .....	44
AO-128-O	LaBelle .....	46
AO-129-O	Sivjee .....	48
AA-130-O	Morse .....	2
AO-131-O	Deshler .....	50
IU-133-O	Jacobel .....	204
AO-138-O	deZafra .....	52
AB-145-O	Peterzen .....	4
AB-147-O	Meyer .....	6
AB-149-O	Wefel .....	8
IU-153-A	Mayewski .....	204
IU-153-B	Mayweski .....	204
IU-155-O	Albert .....	204
IO-157-O	Kamb .....	186
IU-158-O	Bales .....	204
IO-162-O	Bender .....	188
II-163-O	Raymond & Scambos .....	180
IO-164-O	Harrison .....	190
II-168-O	Alley .....	182
II-171-O	Waddington .....	184
IO-173-O	Bindschadler .....	192
IO-175-O	Stone .....	194
IU-178-O	Hamilton .....	204
GO-180-O	Anandakrishnan .....	168
IU-185-O	Meese .....	204

IO-190-O	MacAyeal .....	196
IO-192-O	Taylor .....	198
IU-193-O	Steig,White, & Shuman .....	204
IO-196-L	Hall .....	200
IO-196-M	Hall .....	202
BO-197-O	Ponganis .....	92
OO-201-O	Warren .....	218
OO-204-O	Keeling .....	220
OO-225-O	Fairbanks .....	222
OO-226-O	Lawson .....	224
OO-254-O	Rassmussen .....	226
OO-257-O	Hofmann .....	228
OO-260-O	Peterson .....	230
OO-263-O	Wendler .....	232
OO-264-O	Hofmann .....	234
BO-267-O	Costa .....	94
OO-270-O	Davis .....	236
OO-275-O	Sanderson .....	238
OO-278-O	Pilskaln .....	240
BO-282-O	Dietzman .....	96
OO-283-M	Stearns .....	242
OO-283-P	Stearns .....	244
OO-283-S	Stearns .....	246
AO-284-O	Avery .....	54
GO-295-O	Johns .....	170
BO-301-O	Manahan .....	98
BO-303-O	Smith .....	100
GO-306-O	Austin .....	172
BO-310-O	Ward .....	102
IU-311-O	Arcone .....	204
OO-314-O	Hansen .....	248
OO-315-O	Chereskin .....	250
OO-316-O	Dempsey .....	252
EO-318-O	Kennicutt .....	116
OO-324-O	McConnell .....	254
AC-370-O	Pernic .....	10
AC-371-O	Stark .....	10
AC-372-O	Storey .....	10
AC-373-O	Carlstrom .....	10
AC-374-O	Loewenstein .....	10
AC-375-O	Peterson .....	10
AC-376-O	Novac .....	10
AC-378-O	Ruhl .....	10