United States
Antarctic Activities 2001-2002

This site fulfills the annual obligation of the United States of America as an Antarctic Treaty signatory to report its activities taking place in Antarctica. This portion details planned activities for July 2001 through June 2002. Modifications to these plans will be published elsewhere on this site upon conclusion of the 2001-2002 season.

National Science Foundation
Arlington, Virginia 22230
November 30, 2001

Introduction

Organization and content of this site respond to articles III(1) and VII(5) of the Antarctic Treaty. Format is as prescribed in the Annex to Antarctic Treaty Recommendation VIII-6, as amended by Recommendation XIII-3.

The National Science Foundation, an agency of the U.S. Government, manages and funds the United States Antarctic Program. This program comprises almost the totality of publicly supported U.S. antarctic activities—performed mainly by scientists (often in collaboration with scientists from other Antarctic Treaty nations) based at U.S. universities and other Federal agencies; operations performed by firms under contract to the Foundation; and military logistics by units of the Department of Defense.

Activities such as tourism sponsored by private U.S. groups or individuals are included. In the past, some private U.S. groups have arranged their activities with groups in another Treaty nation; to the extent that these activities are known to NSF, they are included. Visits to U.S. Antarctic stations by non-governmental groups are described in Section XVI.

This document is intended primarily for use as a Web-based file, but can be printed using the PDF option. Its internal cross links and links to other sites present more information than in the print publications of past years. These links also are intended to facilitate easy use of the site.

Contents

I. Ships and Aircraft

Section I of the 2001-2002 season plans lists the names, types, numbers, descriptions, and armament of ships, aircraft, and other vehicles introduced to the Antarctic Treaty area and information on military equipment, if any, and its location in the area.

Ships

- **Icebreakers**

Ship: USCGC POLAR STAR (WAGB-10)
Aircraft: 2 each HH-65A helicopters
Armament: Small arms only

- **Supply/Tankers**

Ship: M/V GREEN WAVE - dry cargo
Armament: None

Ship: TBA - Champion Class T-5 Tanker
Armament: None

- **Research Vessels**

Ship: R/V LAURANCE M. GOULD
Armament: None

Ship: R/V NATHANIEL B. PALMER
Armament: None

Aircraft

Five LC-130 transport aircraft operated by the 109th Air Wing.

Two Bell 212 helicopter based at McMurdo Station.

Two Aerospatiale AS-350B-2 helicopters based at McMurdo Station

Note: No armament

Air Mobility Command

Between October and November 2001, C-141B and C-17 aircraft of the U.S. Air Force Air Mobility Command (AMC) will transport cargo and personnel to and from Christchurch, New Zealand, and McMurdo Station, Antarctica. During December 2001 and January 2002, C-130 aircraft of the U.S. Air Force Air Mobility Command (AMC) will transport cargo and personnel to and from Christchurch, New Zealand and McMurdo Station, Antarctica. Additionally, during January and February 2002, C-141 aircraft of the U.S. Air Force Air Mobility Command (AMC) will transport cargo and personnel to and from Christchurch, New Zealand and McMurdo Station, Antarctica.

Note: No armament

Other Aircraft

Royal New Zealand Air Force C-130 aircraft will transport cargo and personnel on intercontinental flights between Christchurch, New Zealand, and McMurdo Station, Antarctica, during November and December 2001 and January 2002 in support of the U.S. and New Zealand Antarctic Programs.

Note: Two DeHavilland DHC-6/300 Twin Otters will be used; both aircraft will arrive at McMurdo in early November 2001, and depart early February 2002.

Note: No armament

II. Expedition Dates

Section II of the 2001-2002 season plan includes information concerning vessel and aircraft operations along with estimated dates of expeditions and other significant events.

Winfly Activities

Annual augmentation of the U.S. Antarctic Program (USAP) begins with austral winter flights (WINFLY), departing Christchurch, New Zealand, and arriving McMurdo Station, Antarctica, about 20 August 2001. The aircraft will carry scientists and support personnel to start early pre-summer projects, to augment maintenance personnel, and to prepare skiways and ice runways at McMurdo Station. This will involve 5 U.S. Air Force C-141B flights and will increase station population from the winter-over level of about 154 to a transition level of about 426.

Mainbody Activities

Austral summer activities will be initiated early October 2001 with wheeled aircraft operations between Christchurch, New Zealand and the sea-ice runways at McMurdo Station, Antarctica. This will involve approximately 18 C-141B flights and 7 C-17 flights of transport aircraft of the U.S. Air Force Air Mobility Command (AMC), and 12 flights by C-130 transport aircraft of the Royal New Zealand Air Force. The sea-ice runway operations will cease about early December 2001. Williams Field will open for the ski-equipped LC-130 aircrafts and at the same time approximately 4 days pass the Ice Runway closure, Pegasus Blue Ice Runway will be open for wheeled C-130 aircraft from Christchurch to McMurdo. From approximately mid-January to the end of the season 10 USAF C-141B and 3 RNZAF C-130 flights will finish out the airlift movement. The

109th ANG Airlift Wing will fly north from McMurdo to Christchurch on Saturdays and south from Christchurch to McMurdo on Sundays from 27 Oct through 10 February.

The 109th Air Wing of the Air National Guard in Schenectady, New York will provide five LC-130 aircraft and five crews for intra-continental flights from late October 2001 through mid-February 2002 when McMurdo Station closes.

Significant Dates

Other significant dates for the summer season include:

1. 02 October 2001 - McMurdo Station-Summer Operations Commence
2. 26 September 2001 - Palmer Station – Summer Operations Commence
3. 05 October 2001 - Marble Point opens
4. 22 October 2001 - South Pole Station – Summer Operations Commence
5. 26 October 2001 - Siple Dome Camp opens
6. 02 November 2001 - Onset D Camp opens
7. 01 November 2001 - Byrd Surface Camp opens
8. 12 October 2001 - Pieter J. Lenie Field Station ("Copacabana") opens
9. 13 November 2001 - Cape Shirreff Field Station opens
10. 15 November 2001 - TAM Camp opens
11. 21 November 2001 - Vostok opens

Ship Movements

M/V GREEN WAVE

The cargo ship, M/V GREEN WAVE, is scheduled to complete one trip to McMurdo this season. The ship will depart Port Hueneme, California, in late December 2001 after onloading cargo and transit directly to Port Lyttelton, New Zealand. The GREEN WAVE will again onload additional cargo and depart New Zealand for McMurdo Station, Antarctica. Cargo will be off-loaded between 03-10 February, after which the ship will depart McMurdo and proceed to Lyttelton, New Zealand to offload cargo destined for the States. It will depart on approximately 18 February for Port Hueneme, CA to off-load waste and recyclable materials from McMurdo Station, approximately 07 March 2002 arrival at Port Hueneme, CA..

R/V NATHANIEL B. PALMER

The R/V NATHANIEL B. PALMER will conduct 6 scientific research cruises, totaling an estimated 215 days at sea, during the 2001-2002 season. The vessel will provide support throughout the season for biological, chemical, physical oceanographic, and marine geology & geophysics investigations in the Weddell and Bellingshausen Seas, station work at Seymour Island and Livingston Island—Cape Shirreff Field Station put in, and station support at Palmer Station. Ports of call include: Punta Arenas and Talcahuano, Chile; Port Fourchon, Louisiana.

R/V LAURENCE M. GOULD

The R/V LAURENCE M. GOULD will conduct 6 scientific research cruises, totaling an estimated 188 days at sea, during the 2001-2002 season. The research supported will include at sea biological, chemical, and physical oceanographic research, station work at King George Island—Pieter J. Lenie Field Station (Copacabana) put in, and station support at Palmer Station. Ports of call include Talchauano and Punta Arenas, Chile.

III. Stations

Section III of the 2001-2002 season plans lists the names, locations, and opening dates of the Party's bases and subsidiary stations established in the Antarctic Treaty Area, and whether they are for summer and/or winter operations.

Year Round Stations

McMurdo Station

Location:	Hut Point Peninsula on Ross Island in McMurdo Sound
	77° 55'S Latitude
	166° 39'E Longitude
Annual Relief:	2 October 2001

Amundsen-Scott South Pole Station

Location:	90° 00'S Latitude
Annual Relief:	22 October 2001

Palmer Station

Location:	Anvers Island near Bonaparte Point
	64° 46'S Latitude
	64° 05'W Longitude
Annual Relief:	26 September 2001

Austral Summer Camps

Siple Dome Camp

Location:	81° 39'S Latitude 149° 04'W Longitude
Open:	26 October 2001
Close:	25 January 2002

Byrd Camp

Location:	80° 05'S Latitude 119° 32'W Longitude
Open:	01 November 2001
Close:	10 January 2002

Onset D Camp

Location:	80° 75' S Latitude 125° 75' W Longitude
Open:	2 November 2001
Close:	12 January 2002

Tamesis Camp

Location:	81° 69' S Latitude 122° 44' E Longitude
Open:	15 November 2001
Close:	19 December 2001

Pieter J. Lenie Field Station ("Copacabana"), King George Island

Location:	62° 10'S Latitude 58° 28'W Longitude
Open:	12 October 2001
Close:	28 February 2002

Cape Shirreff Field Station, Livingston Island

Location:	62° 28'S Latitude 60° 47'W Longitude
Open:	13 November 2001
Close:	01 March 2002

IV. Personnel

Section IV gives the names of the officers in charge of each of these bases, subsidiary stations, ships and aircraft; the number, occupation and specialization of personnel (including any designated by other Governments), who are or will be stationed at each of these bases and subsidiary stations and onboard these ships and aircraft, including the number of personnel who are members of the military services, together with the rank of any officers and the names and professional affiliations of personnel engaged in scientific activities:

Oversight

The United States Antarctic Program is managed by the National Science Foundation (NSF). The NSF designates a Senior U.S. Representative in Antarctica, and designates an NSF Representative, Antarctica, to coordinate all field activities. Unless otherwise specified, the Senior U.S. Representative in Antarctica is the Director, Office of Polar Programs (OPP), located at the National Science Foundation.

NSF Representatives in Antarctica (TBA) will be stationed at McMurdo, Palmer, and South Pole Stations during the austral summer operating season. Additionally, Raytheon Polar Services Company (RPSC), under contract to the National Science Foundation, will provide station management year round.

Officers in Charge of Bases

Each U.S. station has a station manager for operations/logistics support and a station science leader. Station managers for the 2001-2002 season will be:

McMurdo Station

William Coughran	(Oct 2001 – Feb 2002)
Tom Vinson	(Feb 2002 – Oct 2002)

Amundsen-Scott South Pole Station

Katherine Jensen	(Oct 2001 - Feb 2002)
Katrin Hafner	(Feb 2002 - Nov 2002)

Palmer Station

Robert Farrell	(Sep 2001 - Mar 2002)
Joseph Pettit	(Mar 2002 - Sep 2002)

Officers in Charge of Ships

USCG POLAR STAR (WAGB-10)	CDR David Mackenzie
Champion Class T-5 Tanker (fuel tanker)	TBA
M/V GREEN WAVE (cargo ship)	Captain Peter Stalkus
R/V NATHANIEL B. PALMER	Captain Joe Bokowski
R/V LAURENCE M. GOULD	Captain Warren Sanamo

Numbers, Occupations and Specialization of Personnel

McMurdo

	Summer		Winter	
	Military	*Civilian*	*Military*	*Civilian*
Headquarters	38	38	0	9
Science Support	0	58	0	4
Operations	68	291	0	90
Logistics	375	108	0	30
SPSE	0	29	0	2
Engineering /Construction	0	139	0	92
Information Systems	5	72	0	15
Aviation	199	18	0	0
Scientists	0	258	0	3
Working Visitors	2	144	0	0

South Pole

	Summer		Winter	
	Military	*Civilian*	*Military*	*Civilian*
Headquarters	0	5	0	1
Science Support	0	9	0	5
Operations, EH&S	0	30	0	9
Logistics	0	11	0	3
SPSE/SM	0	85	0	27
Engineering/Construction	0	14	0	4
Information Systems	0	11	0	4
Aviation	0	0	0	0
Scientists	0	50	0	9
Working Visitors	0	5	0	0

Palmer Station

	Summer		Winter	
	Military	*Civilian*	*Military*	*Civilian*
Headquarters	0	1	0	1
Science Support	0	4	0	1
Operations	0	6	0	4
Logistics	0	2	0	3
Engineering/Construction	0	7	0	19
Information Systems	0	3	0	2
Scientist	0	13	0	0
Working Visitors	0	13	0	7

Siple Dome Field Camp

	Summer Only	
	Military	*Civilian*
Camp Manager	0	1
General Asst	0	1
Cook	0	1
Mechanic	0	1
Scientists	0	15
Carpenters	0	4

Byrd Camp

	Summer Only	
	Military	*Civilian*
Camp Manager	0	1
Mechanic	0	1
Mountaineer	0	1
Scientists	0	11

Onset D

	Summer Only	
	Military	*Civilian*
Camp Manager	0	1
Cook	0	1
General Asst.	0	1
Mechanic	0	1
Fuels Operator	0	1
Construction	0	6
Equipment Operator	0	1
Scientists	0	15
Meteorologist	0	1

Tamesis Camp

	Summer Only	
	Military	*Civilian*
Camp Manager	0	1
Fuels Operator	0	1
Mechanic	0	1
Construction	0	3
Cook	0	1
Scientists	0	14

Odell Glacier

	Summer Only	
	Military	*Civilian*
Camp Manager	0	1
Equipment Operator	0	1
Carpenters	0	2
Scientists	0	11

SHIPS

USCGC POLAR STAR

	Number of Personnel
Crew	160

Champion Class T-5 Tanker

	Number of Personnel
Crew	24

M/V GREEN WAVE

	Number of Personnel
Crew	21

R/V NATHANIAL B. PALMER

	Number of Personnel
Crew	21
Scientists	37

R/V LAURENCE M. GOULD

	Number of Personnel
Crew	21
Scientists	37

Names and Professional Affiliation of Personnel Engaged in Scientific Activities

Further details are found in Section VI (Appendix II), and are cross-referenced here according to the project identification code (AO-XXX-X, BM-XXX-X, etc.). The numbers in parentheses besides the principal investigator's name represent the anticipated number of additional field party members. Projects are listed by scientific discipline under each major field location or platform.

MCMURDO STATION - ONLY (341 Scientists)

Aeronomy & Astrophysics (73 Scientists)

	I.D. No.	Institution
Adriani (+1)	AO-107-O	Instituto De Fisica Dell'Atmosfera
Bieber (+1)	AO-120-M	University of Delaware
Binns (+13)	AB-149-O	Washington University
Deshler (+4)	AO-131-O	University of Wyoming
Engebretson (+0)	AO-102-M	Augsburg College
Hernandez (+3)	AO-110-M	University of Washington
Lanzerotti (+0)	AO-101-M	Lucent Technologies
NSBF/LDB (+21)	AB-145-O	National Scientific Balloon Facility
Rosenberg (+1)	AO-111-M	University of Maryland
Rosenberg (+0)	AO-112-O	University of Maryland
Ruhl (+18)	AB-148-O	University of California Santa Barbara

Biology & Medical Research (86 Scientists)

	I.D. No.	Institution
Blanchette (+2)	BO-038-O	University of Minnesota
Davis (+7)	BO-017-O	Texas A & M University
DeVries (+6)	BO-005-M	University of Illinois Urbana

Doran (+1)	BM-042-D	Department of Earth and Environmental Sciences
Dudley (+5)	BO-030-O	University of Texas Austin
Fountain (+4)	BM-042-F	Portland State University
Hofmann (+4)	BO-134-O	National Oceanic and Atmospheric Administration
Lisle (+2)	BO-024-O	Lockheed Martin
Lyons (+3)	BM-042-L	Ohio State University
Madigan (+3)	BO-174-O	Southern Illinois University
McKnight (+3)	BM-042-M	University of Colorado Boulder
Ponganis (+7)	BO-197-O	Scripps Institution of Oceanography
Priscu (+4)	BM-042-P	Montana State University Bozeman
Raymond (+2)	BO-001-O	University of Nevada Las Vegas
Siniff (+9)	BO-009-O	University of Minnesota
Virginia (+1)	BM-042-V	Dartmouth College
Wall (+6)	BM-042-W	Colorado State University

Environmental Research (6 Scientists)

	I.D. No.	*Institution*
Kennicutt, II (+5)	EO-318-O	Texas A & M University

Geology & Geophysics (107 Scientists)

	I.D. No.	*Institution*
Anandakrishnan (+2)	GO-180-O	University of Alabama Tuscaloosa
Dalziel (+6)	GO-087-O	University of Texas Austin
Dougherty (+5)	GO-078-O	Science Applications International Corp.
Elliot (+1)	GO-290-O	Ohio State University
Fitzgerald (+4)	GO-059-O	(Other)
Hallet (+2)	GO-053-O	University of Washington
Harvey (+7)	GO-058-O	Case Western Reserve University
Isbell (+4)	GO-094-O	University of Wisconsin Milwaukee
Johns (+3)	GO-295-O	UNAVCO/UCAR

	I.D. No.	Institution
Kyle (+6)	GO-081-O	New Mexico Institute of Mining and Technology
Lancaster (+2)	GO-183-O	Desert Research Institute
Luyendyk (+5)	GF-121-O	University of California Santa Barbara
Morse (+5)	GO-167-O	University of Texas Austin
Mullins (+13)	GO-052-L	United States Geological Survey
Mullins (+5)	GO-052-M	United States Geological Survey
Paulson / Wilson (+3)	GO-099-O	University of Wisconsin Oshkosh
Wiens (+17)	GO-089-O	Washington University

Glaciology (38 Scientists)

	I.D. No.	Institution
Anandakrishnan (+8)	IO-205-O	University of Alabama Tuscaloosa
Hall (+3)	IO-196-M	The University of Maine
Mayewski (+14)	IU-153-A	The University of Maine
McConnell (+0)	IO-323-O	Desert Research Institute
Raymond (+4)	II-163-O	University of Nevada Las Vegas
Waddington (+3)	II-171-O	University of Washington

*PI non-deploying; experiments may be supported on-site by contract personnel.

Ocean & Climate Systems (7 Scientists)

	I.D. No.	Institution
Dempsey (+3)	OO-316-O	Clarkson University
Hansen (+1)	OO-314-O	Magee Scientific Company
Stearns (+0)	OO-202-O	University of Wisconsin Madison

Technical Projects (24 Personnel)

	I.D. No.	Institution
Bentley (+1)	TO-150-M	University of Wisconsin Madison
Blaisdell (+0)	TO-13-O	US Army Cold Regions Research & Engineering Lab

Borek/Penikett (+7)	RO-500-O	Ken Borek Air Ltd.
Comberiate (+2)	TO-10-O	National Aeronautics and Space Administration
Griffin (+3)	TO-308-O	Honeywell Technical Solutions Inc. NASA Wallops Flight Facility
Hawkins (+0)	TO-450-O	Petroleum Helicopters, Inc.
Kippenhan (+1)	TO-007-O	Raytheon Polar Services Company
Osborne (+2)	TO-396-O	University of Alaska Fairbanks

MCMURDO AND SOUTH POLE STATIONS (17 Scientists)

Writers & Artists Program (6 Personnel)

	I.D. No.	*Institution*
Fox (+0)	WO-218-O	(Other)
Kaiser (+0)	WO-220-O	(Other)
Miller (+3)	WO-222-O	The Exploratorium

Technical Programs (11 Personnel)

	I.D. No.	*Institution*
Kolden (+0)	TO-00	USAP Calibration Laboratory
Johnson (+8)	TO-296-O	Raytheon Polar Services Company
Booth (+0)	TO-513-O	Biospherical Instruments Inc.

MCMURDO STATION AND USCGC (45 Scientists)

Ocean & Climate Sciences (4 Scientists)

	I.D. No.	*Institution*
Stearns (+3)	OO-283-M	University of Wisconsin Madison
Buessler (+0)	OO-288-O	Woods Hole Oceanographic Institution

Biology & Medicine Program (30 Scientists)

	I.D. No.	*Institution*
Pitman (+1)	BO-289-O	National Oceanic and Atmospheric Administration
Ainley (+9)	BO-031-O	H.T. Harvey & Associates
Bowser (+9)	BO-043-O	New York State Department of Health
Smith (+7)	BO-047-O	University of California Santa Barbara

Geology & Geophysics (5 Scientists)

	I.D. No.	*Institution*
Powell (+4)	GO-170-O	Northern Illinois University

Glaciology (6 Scientists)

	I.D. No.	*Institution*
MacAyeal (+5)	IO-190-O	University of Chicago

OTHER ANTARCTIC LOCATIONS

(10 Scientists)

Biology and Medicine (7 Scientists)

	I.D. No.	*Institution*
Trivelpiece (+3)	BO-040-O	Montana State University Bozeman
Emslie (+0)	BO-034-O	University of North Carolina
Kvitek (+1)	BO-320-O	California State University Monterey Bay

Geology and Geophysics (3 Scientists)

	I.D. No.	*Institution*
Case (+2)	GO-206-O	Saint Mary's College of California

PALMER STATION - ONLY (41 Scientist)

Aeronomy and Astrophysics (1 Scientist)

	I.D. No.	Institution
Inan (+0)	AO-106-P	Stanford University

Biology and Medicine (30 Scientists)

	I.D. No.	Institution
Amsler/McClintock (+6)	BO-022-O	University of Alabama Birmingham
Ducklow (+4)	BP-045-P	College of William and Mary
Fraser (+5)	BP-013-P	Polar Oceans Research Group
Murray (+1)	BO-179-O	Desert Research Institute
Quetin/Ross (+3)	BP-028-P	University of California Santa Barbara
Smith (+1)	BP-032-P	University of California Santa Barbara
Vernet (+3)	BP-016-P	Scripps Institution of Oceanography

Geology and Geophysics (4 Scientists)

	I.D. No.	Institution
Butler (+2)	GO-090-P	Incorporated Research Institutions for Seismology
Mullins (+0)	GO-052-P	United States Geological Survey

Polar Climate and Ocean Systems (5 Scientists)

	I.D. No.	Institution
Hofmann (+0)	OO-264-O	National Oceanic and Atmospheric Administration
Keeling (+0)	OO-204-O	University of California San Diego
Rasmussen (+0)	OO-254-O	Oregon Graduate Institute of Science & Technology
Sanderson (+0)	OO-275-O	United States Department of Energy
Stearns (+0)	OO-283-P	University of Wisconsin Madison

Writers and Artists (1 Personnel)

	I.D. No.	*Institution*
Hooper (+0)	WO-219-O	

R/V LAURENCE M. GOULD - ONLY (40 Scientists)

Biology and Medicine Program (39 Scientists)

	I.D. No.	*Institution*
Costa (+0)	BG-232-O	University of California Santa Cruz
Fraser (+0)	BG-234-O	Polar Oceans Research Group
Harvey (+0)	BG-237-O	Case Western Reserve University
Martinson (+0)	OG-241-O	Columbia University
Veit (+1)	BO-023-O	City University of New York/College of Staten Isl.
Scheltema (+9)	BO-281-O	Woods Hole Oceanographic Institution
Fraser (+1)	BP-013-L	Polar Oceans Research Group
Vernet (+4)	BP-016-L	Scripps Institution of Oceanography
Quetin/Ross (+6)	BP-028-L	University of California Santa Barbara
Smith (+1)	BP-032-L	University of California Santa Barbara
Karl (+5)	BP-046-L	University of Hawaii Manoa

Ocean and Climate Systems (1 Scientist)

	I.D. No.	*Institution*
Martinson (+0)	OG-241-O	Columbia University

R/V NATHANIEL B. PALMER - ONLY (80 Scientists)

Biology and Medicine Program (38 Scientists)

	I.D. No.	*Institution*
Ribic (+0)	BG-243-O	University of Wisconsin Madison
Ross (+0)	BG-244-O	University of California Santa Barbara

Vernet (+0)	BG-246-O	Scripps Institution of Oceanography
Wiebe (+0)	BG-247-O	Woods Hole Oceanographic Institution
Fraser (+1)	BP-013-N	Polar Oceans Research Group
Vernet (+5)	BP-016-N	Scripps Institution of Oceanography
Martinson (+0)	BP-021-N	Columbia University
Quetin/Ross (+10)	BP-028-N	University of California Santa Barbara
Smith (+4)	BP-032-N	University of California Santa Barbara
Ducklow (+3)	BP-045-N	College of William and Mary
Karl (+3)	BP-046-N	University of Hawaii Manoa

Geology and Geophysics (33 Scientists)

	I.D. No.	*Institution*
Aronson (+4)	GO-065-O	Dauphin Island Sea Lab
Berger (+13)	GO-092-O	Desert Research Institute
Anderson (+8)	GO-083-O	Rice University
Bart (+4)	GO-154-O	Louisiana State University Baton Rouge

Ocean and Climate Systems (9 Scientists)

	I.D. No.	*Institution*
Fanning (+0)	OG-233-O	University of South Florida
Hofmann (+0)	OG-240-O	National Oceanic and Atmospheric Administration
Powell (+0)	OG-242-O	University of California, Berkley
Visbeck / Huber (+4)	OO-124-O	Columbia University

R/V NATHANIEL B. PALMER and R/V LAURENCE M. GOULD (7 Scientists)

Biology and Medicine Program (5 Scientists)

	I.D. No.	*Institution*
Fritsen (+0)	BG-235-O	Desert Research Institute
Daly (+0)	BG-236-O	National Science Foundation

Hildebrand (+0)	BG-239-O	Scriptts Institution of Oceanography
Torres (+0)	BG-245-O	University of South Florida
Zhou (+0)	BG-248-O	University of Minnesota

Ocean & Climate Systems (2 Scientists)

	I.D. No.	*Institution*
Beardsley (+0)	OG-231-O	Woods Hole Oceanographic Institution
Padman (+0)	OG-238-O	Earth and Space Research

Other Vessels (13 Scientists)

Biology and Medicine Program (7 Scientists)

	I.D. No.	*Institution*
Pearce (+2)	BO-069-O	University of California Santa Cruz
Blake (+3)	BO-292-O	University of Massachusetts

Geology & Geophysics (3 Scientists)

	I.D. No.	*Institution*
Wiens (+2)	GO-097-O	Washington University

Ocean & Climate Sciences(3 Scientists)

	I.D. No.	*Institution*
Peterson (+0)	OO-260-O	Carnegie-Mellon University
Chereskin (+1)	OO-315-O	University of California San Diego

SOUTH POLE STATION - ONLY (172 Scientists)

Aeronomy & Astrophysics (139 Scientists)

	I.D. No.	*Institution*
Avery (+2)	AO-284-O	University of Colorado Boulder
Bieber (+0)	AO-120-S	University of Delaware

Carlstrom (+5)	AC-373-O	University of Chicago
Ejiri (+2)	AO-117-O	National Institute of Polar Research
Engebretson	AO-102-S	Augsburg College
Gaisser (+4)	AO-109-O	University of Delaware
Hernandez (+3)	AO-110-S	University of Washington
Holzapfel (+5)	AC-378-O	Univeristy of California Berkeley
Inan (+0)	AO-106-S	Stanford University
Inan (+1)	AO-108-O	Stanford University
Jackson (+1)	AC-374-O	Boston University
Lanzerotti	AO-101-S	Lucent Technologies
Morse (+46)	AA-130-O	University of Texas Austin
Novak (+3)	AC-376-O	Northwestern University
Pernic (+15)	AC-370-O	University of Chicago
Peterson (+3)	AC-375-O	Carnegie-Mellon University
Rosenberg (+0)	AO-111-S	University of Maryland
Sivjee (+2)	AO-129-O	Embry Riddle Aeronautical University
Stacey (+0)	AC-377-O	Cornell University
Stark (+15)	AC-371-O	Smithsonian Institution
Storey (+5)	AC-372-O	University of New South Wales
Swenson (+5)	AO-127-O	University of Illinois Urbana

Geology & Geophysics (8 Scientists)

	I.D. No.	*Institution*
Butler (+4)	GO-090-S	Incorporated Research Institutions for Seismology
Mullins (+2)	GO-052-S	United States Geological Survey

Technical Programs (4 Scientists)

	I.D. No.	*Institution*
Bentley (+3)	TO-150-S	University of Wisconsin Madison

Ocean & Climate Systems (21 Scientists)

	I.D. No.	*Institution*
Hofmann (+7)	OO-257-O	National Oceanic and Atmospheric Administration
Lawson (+4)	OO-226-O	SPEC, Inc.
McConnell (+0)	OO-324-O	Desert Research Institute
Stearns (+0)	OO-283-S	University of Wisconsin Madison
Warren (+5)	OO-201-O	University of Washington

V. Armaments

Section V details the number and type of armaments possessed by personnel at the main Antarctic stations and on research vessels. Signaling devices such as flare pistols are not included.

McMurdo Station

No armaments are currently stored or in use at McMurdo Station.

Palmer Station

- 2 pistols, 38-caliber, Smith and Wesson [SN: 2D09672; SN: 2D06268]
- 1 shotgun, 12-gauge, Magnum, pump action, Remington [SN: S346543M]
- 1 shotgun, 12-gauge, double barrel, Centrure Liege [SN: 6633]
- 1 shotgun, 12-gauge, over and under, Fabrica Haliana [SN: 77978]
- 1 mini ranch rifle, 223-calibre, Ruger [SN: 188-32652]

Note: SN = Serial Number

South Pole Station

No armaments are currently stored or in use at South Pole Station.

R/V NATHANIEL B. PALMER

No armaments are currently onboard the R/V NATHANIEL B. PALMER.

R/V LAURENCE M. GOULD

No armaments are currently onboard the R/V LAURENCE M. GOULD.

VI. Project Descriptions

Section VI details the planned field research projects for the 2001-2002 season and is available in Appendix II of this document.

VII. Scientific Equipment

Section VII lists the principal scientific equipment available at McMurdo, South Pole, and Palmer stations and onboard USAP research vessels.

	McMurdo	SPole	Palmer	LMG[1]	NBP[2]	AGO[3]
Astrophysics Aeronomy						
Analyzer, Logic		X				
Antenna, VLF Loop		X	X			
Camera, All-Sky		X				
Camera, Video, Towed Benthic, SCUDIVA				X	X	
Centrifuge, Refrigerated 12K RPM Micro				X	X	
Chart Recorder, Eight Channel		X				
Chart Recorder, Three Channel				X	X	
Chromatography, High Performance Liquid System (HPLC)				X		
Cryogen, Transfer Equipment	X	X	X	X	X	
Cryogen Transfer Lines	X	X				
Data Acquisition Unit (DAU)						X
Data Control Unit (DCU)						X
Dewar, Liquid Helium	X	X				
Dewar, Liquid Helium Storage	X	X				
Dewar, Liquid Nitrogen Storage	X	X	X	X	X	
Filtration Apparatus, Membrane				X	X	
Heating Unit, Air		X				
Hi-Vacuum System				X	X	
Ice Maker				X	X	
Incubator, Percival				X	X	

	McMurdo	SPole	Palmer	LMG[1]	NBP[2]	AGO[3]
Interferometer		X				
Ionosonde, Digital		X				
Laboratory, Portable (Radiation)				X	X	
Leak Detection and Vacuum Pump Equipment		X				
Lidar	X	X				
Line Connector, 1.2 KVA		X				
Liquid Nitrogen Plant	X	X				
Magnetometer, Three Component Air Core Induction		X				
Magnetometer, Three Axis Fluxgate	X					
Neutron Monitor, Super Multisection	X	X				
Nitrogen Liquifier	X	X				
Oscilloscope	X	X	X	X	X	
Oxygen-Analyzing System				X	X	
Photometer, Auroral		X				
Pipette Puller	X					
Power Conditioner		X		X	X	
Pump, Turbomolecular	X	X				
Radiotelescope, Microwave		X				
Receiving System, VLF			X			
Riometers, 30 & 50 MHz	X	X				
Scintillator Array, 16-element		X				
Sky Monitor, Mid Infrared		X				
Sky Monitor, Near Infrared		X				
Signal Generator		X				
Spectral Analyzer		X				
Spectrometer, X-ray (high altitude, long-duration)		X				
Spectrometer, Infrared		X				

	McMurdo	SPole	Palmer	LMG[1]	NBP[2]	AGO[3]
Spectroradiometer, Ultraviolet	X	X	X			
Tape Transport, Dual Density		X				
Tape Drive, Giga Tape 5 Mb		X				
Telescope, 12" (Optical)		X				
Telescope, Gamma Ray		X				
Telescope, Microwave		X				
Telescope, Mid-Infrared		X				
Telescope, NCAR Infrared		X				
Telescope, Optical		X				
Telescope, Submillimeter		X				
Telescopes, Astronomical		X				
Thermal Electric Generator (TEG)					X	
Time Domain Reflectometer (TDR)		X				
Transport, Liquid Helium (leased)		X				
Transport, Liquid Nitrogen	X	X				
Uninterrupted Power Supply (UPS)	X	X	X			
Water Chiller		X				

	McMurdo	SPole	Palmer	LMG[1]	NBP[2]	AGO[3]
Biology						
Aquaria	X		X	X	X	
Analyzer, Carbon/Nitrogen/Sulfur	X					
Analyzer, Infrared,Carbon Dioxide	X					
Analyzer, Infrared, Hydrocarbon	X					
Analyzer, Lactate	X					
Analyzer, Total Organic Carbon	X					
Autoanalyzer			X	X	X	
Autoclave	X	X	X	X	X	

	McMurdo	SPole	Palmer	LMG[1]	NBP[2]	AGO[3]
Balance, Electronic	X	X	X	X	X	
Bath, Hybridization	X					
Bath, Water	X	X	X	X	X	
Bath, Water, Circulating	X		X	X	X	
Bath, Water, Shaking	X		X		X	
Calorimeter			X		X	
Camera, Digital Still	X	X	X	X	X	
Camera, Solid State, for Microscopic Image Analysis	X		X	X	X	
Camera, Still, Underwater	X					X
Camera, Video, for Microscopy	X			X	X	
Camera, Video, Underwater, w/time lapse capability and remote viewing	X		X	X		
Cell Disrupter	X		X	X		
Cell Injector, Micro	X					
Centrifuge, Clinical	X		X	X	X	
Centrifuge, 20K RPM	X		X			
Centrifuge, Refrigerated Speed Vac	X		X	X	X	
Chart Recorder, Single Channel	X		X			
Chart Recorder, Dual Channel	X		X			
Chart Recorder, Three Channel	X		X			
Chiller, Aquarium	X		X			
Chromatography Equipment	X		X			
Chromatography, High Performance Liquid System (HPLC)	X		X			
Chromatography, Gas, System	X		X			
Chromatography, Ion, System	X					
Collector, Fraction	X		X			
Colorimeter	X		X			
Compressor, Air, Scuba Tank	X		X	X	X	

	McMurdo	SPole	Palmer	LMG[1]	NBP[2]	AGO[3]
Cooler, Immersion	X		X	X	X	
Counter, Gamma	X					
Counter, Geiger Muller	X		X	X	X	
Counter, Particle	X		X			
Counter, Scintillation, DPM Output	X		X	X	X	
Counter, Liquid Scintillation			X	X	X	
Cryostat	X					
Data Acquisition System	X		X	X	X	
Datalogger	X		X	X	X	
Deck Unit/Transducer	X			X	X	
Detector, Column Absorbance	X					
Dewar, Liquid Nitrogen Storage	X		X	X	X	
Dive Propulsion Systems	X					
Dry Ice Maker	X		X	X		
Dry Shippers, Liquid Nitrogen	X		X	X	X	
Electrocardiograph	X	X	X			
Electrophoresis Equipment	X		X			
Electroporator	X					
Environmental Room, Temp. Controlled	X		X	X	X	
Evaporator, Rotary	X		X			
Filtration Apparatus, Water	X		X	X	X	
Filtration Apparatus, Membrane	X		X			
Fluorometer	X		X	X	X	
Fluorometer, DNA	X					
Freeze Dryer	X		X			
Freezer, to -20°C	X	X	X	X	X	
Freezer, to -70°C	X		X	X	X	
Freezer, Walk-in	X			X	X	
Furnace, Graphite	X					

	McMurdo	SPole	Palmer	LMG[1]	NBP[2]	AGO[3]
Furnace, Muffle	X		X	X	X	
Gas Partitioner	X					
Hematology Equipment	X	X	X			
Hi-Vacuum System	X					
Homogenizer	X		X	X		
Hood, Fume	X		X	X	X	
Hood, Portable Fume Absorber			X		X	
Ice Maker			X	X	X	
Incubator,Hybridization	X					
Incubator, Low Temperature	X		X	X	X	
Incubator, Percival				X	X	
Laboratory, Portable (for sea ice)	X			X		
Laminar Flow Bench	X		X		X	
Light Pipette	X					
Lipid Analysis System	X					
Luminometer			X			
Melter, Ice Hole	X				X	
Meter, Microoxygen	X					
Meter, Oxygen	X		X			
Meter, pH	X	X	X	X	X	
Microbalance	X		X			
Microcentrifuge	X		X	X	X	
Microscope, Compound, Epifluorescence	X		X	X	X	
Microscope, Compound (for light/dark field microscopy)	X	X	X	X	X	
Evap Microscope, Cold Stage	X					
Microscope, Differential Interference Contrast (DIC)	X		X	X	X	
Microscope, Dissecting (for light/dark field microscopy)	X	X	X	X	X	

	McMurdo	SPole	Palmer	LMG[1]	NBP[2]	AGO[3]
Microscope, Compound (for phase contrast microscopy)	X		X	X	X	
Microscope, Image Analysis System	X		X	X		
Microscope, Inverted, Epifluorescence	X		X			
Microplate Reader	X					
Microtome	X					
Microtome, Cryostat	X					
Oscillograph, Recording, Thermal, 8 Channel	X					
Oscilloscope	X	X	X	X	X	
Osmometer, Vapor Pressure	X		X			
Oven	X	X	X	X	X	
Oxygen-Analyzing System	X		X		X	
Photometer, Integrating (for ATP)	X					
Photometer, Flame	X					
Photosynthesis System	X					
Phototransilluminator	X		X			
Processor, Tissue	X		X			
Projector, Digital	X		X			
Pump, Suction		X	X	X	X	
Pump, Vacuum	X		X	X	X	
Receiver, ATS	X		X			
Receiver, VHF Radio	X		X	X	X	
Recorders, EPC Analog				X	X	
Refrigerator, Explosion Proof	X		X	X	X	
Respirometer, Gilson	X		X			
Scale, Platform, Sled Mountable	X					
Sensor, Irradiance (for dry use)	X		X	X	X	
Sensor, Irradiance (for submersible use)	X		X	X	X	
Sequencing System	X					

	McMurdo	SPole	Palmer	LMG[1]	NBP[2]	AGO[3]
Spectrophotometer, Atomic Absorption	X					
Spectrophotofluorometer	X		X	X	X	
Spectrophotometer	X		X	X	X	
Spectrophotometer, Diode Array	X		X			
Spectroradiometer	X		X	X	X	
Stage, Cooling, Microscope	X		X			
Thermocycler	X		X			
Thermocycler, PCR	X		X			
Thermometer, Digital	X		X	X	X	
Transponder Reader	X					
Ultracentrifuge	X		X		X	
Ultrafiltration Unit	X		X	X		
UV Sensor, Portable	X					
VCR, High Resolution	X					
Vibration-free table	X		X	X	X	
Video System, Underwater	X		X	X	X	
Voltage Clamp	X					
Water Purification System	X	X	X	X	X	
Workstation, PICO Tag	X					

	McMurdo	SPole	Palmer	LMG[1]	NBP[2]	AGO[3]
Computers						
MacIntosh:						
Computer, G3	X					
Computer, iMac	X					
Computer, Desktop, LC		X				
Computer, Desktop, IICI	X		X		X	
Computer, Desktop, Pentium		X				

	McMurdo	SPole	Palmer	LMG[1]	NBP[2]	AGO[3]
Computer, Portable, Powerbook 170	X		X			
Computer, Power 604 Clone	X			X	X	
Computer, Powerbook 5300c	X		X	X		
Computer, Quadra, 700	X					
Computer, Quadra 950	X	X				
Computer, Classic		X				
Macintosh Power PC 63					X	
Macintosh, Duo Power PC, Portable				X		
Macintosh Power PC 7100	X	X			X	
Macintosh Power PC 7200	X		X			
Macintosh Power PC 7300				X		
Macintosh Power PC 8150						
Macintosh Power PC 8600				X		
Macintosh Power PC 9500					X	
Mini:						
DEC Microvax		X	X			
DEC PDP-II		X				
DEC PDP II-73		X				
PC:						
Computer, Desktop, XT		X	X			
Computer, Desktop, 286		X	X	X		
Computer, Desktop, 386	X	X	X	X	X	
Computer, Desktop, 486	X	X	X	X	X	
Computer, Desktop, Pentium	X		X	X	X	
Computer, Portable, 286						
Computer, Portable, 386	X		X		X	
Computer, Portable, 486	X		X	X	X	
Computer, Portable, 586	X					
Computer, Server, 486	X	X	X			

	McMurdo	**SPole**	**Palmer**	**LMG[1]**	**NBP[2]**	**AGO[3]**
Computer, Server, 586	X			X	X	
Workstation:						
HP 9000			X			
SGI 02					X	
SGI Challenge L (Multibeam computers)					X	
SGI Indigo R3000						
SGI Iris					X	
SPARC IPX	X	X				
Sun SPARC 10	X					
Sun U450	X					
Sun Ultra1	X					
Sun Ultra2	X					
Sun SPARC 2	X	X	X		X	
SGI Indy				X	X	
Printers						
Dot Matrix	X	X	X	X	X	
Dye Sublimation, Color	X				X	
Ink Jet, Color	X		X	X	X	
Laser	X	X	X	X	X	
Miscellaneous						
CDRom - R	X		X	X	X	
CD Writer	X		X			
Magneto-optical Drive	X				X	
Digitizer	X					
Plotter, Ink Jet, Monochrome	X			X	X	
Plotter, Pen, Color	X	X	X		X	
Zip Drive	X	X	X	X	X	

	McMurdo	SPole	Palmer	LMG[1]	NBP[2]	AGO[3]
Environmental Monitoring						
Acoustic Release	X			X	X	
Aethelometer		X				
Analyzer, CO	X				X	
Analyzer, NOx	X					
Analyzer, Pesticide/PUF	X					
Analyzer, SO_2	X					
Calibration System, Multigas	X				X	
Concentrator, Turbo-Vap II	X					
Current Meter	X			X	X	
Deck unit/Transducer	X			X	X	
Sampler, Air, Hi-Vol.	X					
Toxicity Analyzer	X					
Water Quality Logging System	X					
Water Quality System	X		X			

	McMurdo	SPole	Palmer	LMG[1]	NBP[2]	AGO[3]
Geology/Geophysics						
Ball Mill	X					
Chronology Clock				X	X	
Data Translation D/A Converters				X	X	
Diamond Drill and Associated Equipment	X					
Echo Sounder, Bathy 2000 "chirp" sub-bottom profiler					X	
Echo Sounder, Knudsen, Sub-bottom Profiler				X		
Echo Sounder, Bathy 2000 "chirp" sub-bottom profiler					X	
Echo Sounder, Simrad EK500					X	
Gravimeter, Portable					X	

	McMurdo	SPole	Palmer	LMG[1]	NBP[2]	AGO[3]
Gravimeter, Sea Fixed					X	
Heliocoder	X					
Jack Hammer	X					
Jumbo Piston Corer					X	
Kasten Corer				X	X	
Microscope, Electronic Stage w/point counter	X					
Microscope, Polarizing with Camera	X					
Microscopes, Petrographic	X	X	X	X	X	
Petrographic Scope					X	
Recorders, EPC Analog				X	X	
Rock Saws	X					
Rock Polisher, Automatic	X			X		
Seismic, Benthos, Single Channel					X	
Seismic Bolt, Long-Life Array, 6 guns, 3000 cubic inches total					X	
Seismic, G/I air-guns (210 cu in)					X	
Seismic, G/I water-gun (25 cu in)					X	
Seismic, ITI multi-channel streamer (48 channel, 25m group interval)					X	
Seismic, ITI single channel streamer					X	
Survey System, GPS	X	X	X	X	X	
Swath bathymetric mapping system					X	
Thin-Section Machine	X			X		
Time Standard		X	X		X	
X-ray Instrument, Diffraction	X					

	McMurdo	SPole	Palmer	LMG[1]	NBP[2]	AGO[3]
Geomagnetism						
Antennas, Dipole		X				
Gradiometer, Magnetic--towed						
Magnetometer, Portable	X	X				
Magnetometer, Quartz, Horizontal		X				
Magnetometer, Standard Induction		X				
Magnetometer, Towed					X	
Magnetograph, Three-component, Standard, Low Sensitivity		X				
Magnetograph, Three-component, Rapid Run, Low Sensitivity		X				
Magnetometer, Visible Recording		X	X			
Time Standard		X			X	

	McMurdo	SPole	Palmer	LMG[1]	NBP[2]	AGO[3]
Glaciology						
Drill, Jiffy w/ Power Head	X		X	X	X	
Drill, Shallow (100 meters)	X					
Drill, Ice Coring, Intermediate (500-1000m)	X					
Generator, Shear Wave	X					
Geoceivers	X	X				
Ice Auger, SIPRE	X	X	X			
Rigsby Stage	X					

	McMurdo	SPole	Palmer	LMG[1]	NBP[2]	AGO[3]
Meteorology						
Barometers	X	X	X	X	X	
Data Loggers	X	X	X	X	X	
Detectors, Aerosol and CN (balloon-borne)		X				
Laser Ceilometer		X				
Precipitation Gauges	X		X			
Pressure Indicators		X	X			
Pyrgeometers	X			X	X	
Pyranometer	X		X	X	X	
Radiotheodolite System, Automatic		X				
Receiver, High Resolution Picture	X		X			
Recorder, Four-Channel		X				
Satellite Receiving Data Manipulation System	X		X		X	
Set of Pyranometers, Tyrhelometers and Net Radiometers		X		X	X	
Temperature Probe Aspirators, Quali-metrics/Weather Measure		X				
Temperature Probes, RTD-Platinum	X	X	X			
Temperature Thermometers	X	X	X	X	X	
Transmitters, PTT	X					
Weather Station	X		X			
Weather Stations, Automatic	X	X	X			
Weather System				X	X	
Wind System and Recorder with Transmitter	X		X	X	X	
Wind Anemometers	X	X	X	X	X	
Wind Indicators	X	X	X	X	X	
Wind Translators		X		X	X	

	McMurdo	SPole	Palmer	LMG[1]	NBP[2]	AGO[3]
Oceanography/Limnology						
A-Frame				X	X	
Acoustic Doppler Current Profiler				X	X	
Acoustic Release with Surface Command Unit	X		X	X	X	
Nutrient Analyzer	X		X	X	X	
Bottom Imaging System, Multibeam					X	
Conductivity Temperature Depth Instrument (CTD)	X		X	X	X	
Current Meter, Electromagnetic	X					
Data Acquisition System	X		X	X	X	
Deep Sea Coring System				X	X	
Depth Finder	X		X	X	X	
Echo Sounder, Biosonics Acoustic Profiler			X			
Flourometer, Fast Repetition-Rate			X	X		
Flourometer, Flow-through				X	X	
Go-Flo Bottles	X		X	X		
Hood Laminar Flow, Portable			X		X	
Hydraulic Boom				X	X	
Hydrodavit				X	X	
Inflatable Boat, Zodiac			X	X	X	
Isotope Van				X	X	
Laboratory Van				X	X	
Launcher, XBT				X	X	
Liquid Helium Vapor Recovery System		X				
Magnetometers	X				X	
Messenger	X		X	X	X	
Metering Sheave	X		X	X	X	

	McMurdo	**SPole**	**Palmer**	**LMG[1]**	**NBP[2]**	**AGO[3]**
Niskin Bottle	X		X	X	X	
PDR System, 3.5 and 12 KHz				X	X	
Plankton Net	X		X	X	X	
Pressure Transducer	X			X	X	
Radar				X	X	
Rosette				X	X	
Salinometer	X		X	X	X	
SAT P-Code GPS				X	X	
SAT VAV/GPS				X	X	
Satellite Navigation				X	X	
Sediment Trap	X			X		
Seismic Systems, Single and Multi-channel					X	
Sonar, Side Scan				X	X	
Thermosalinograph				X	X	
Transmissometer				X		
Trawl Gear				X	X	
Winch, Deep Sea Trawl				X	X	
Winch, Hydrographic				X	X	
Winch, Portable, Electric	X		X	X	X	
Winch, Portable, Gasoline	X		X			
Winch, Portable Hand			X			

	McMurdo	SPole	Palmer	LMG[1]	NBP[2]	AGO[3]
Seismology						
Gravimeter		X				
Gravimeter, Lacoste & Romberg (Marine)					X	
IRIS System		X	X			X
Receiver, GPS	X	X	X	X	X	
Seismograph	X	X	X		X	

	McMurdo	SPole	Palmer	LMG[1]	NBP[2]	AGO[3]
Other						
Cryogen Vaporizer	X					
Data Link, Satellite	X	X	X	X	X	
Drill Press	X	X	X	X	X	
Frequency Counter	X			X	X	
Global Positioning System	X	X	X	X	X	
Handheld Global Positioning System	X	X	X	X		
Lathe	X	X	X	X	X	
LOX Transport	X					
Maritime Fixed Station (INMARSAT)	X		X	X	X	
Meter, Multi	X	X	X	X	X	
Meter, RCL	X				X	
Mill		X				
Milling Machine, Vertical		X				
Nitrogen Generator	X					
Projector, Video	X			X	X	
Resistors and Capacitors, Decade	X			X	X	
Scanner	X	X		X	X	
Tracking System, Satellite	X	X	X			

	McMurdo	**SPole**	**Palmer**	**LMG[1]**	**NBP[2]**	**AGO[3]**
Transceivers, Satellite, ATS-3	X	X	X			
Un-interruptible power supply (UPS)	X	X	X	X	X	
Video Camcorder	X	X	X	X	X	

1 = R/V LAURENCE M. GOULD

2 = R/V NATHANIEL B. PALMER

3 = AUTOMATED GEOPHYSICAL OBSERVATORY

VIII. Transportation & Comms

Section VIII details the number and type transportation facilities and communications equipment for use within the Antarctic treaty area.

Surface, Marine, and Air Transportation Vehicles

McMurdo Station

Truck, (light and heavy)	227
Carrier, Personnel and Cargo (tracked and wheeled)	52
Trailer, (tracked and wheeled)	39
Front-end loader, bucket and forklift	45
Forklift, warehouse	20
Motor toboggans	90
Crane	2
Road grader	4
Roller	4
Tractor, crawler	26
Tractor, wheeled	2
Sweeper, magnet	1
Snow plane	6
Truck, fire, pumper	8
Trencher	2
Aircraft, LC-130	6
Helicopters, Aerospatiale AS-350B-2	3
Helicopters, Bell 212	1
Scraper	2
Backhoe	2

Amundsen-Scott South Pole Station

Cranes	3
Excavator	1
Front Loader, tracked	7
Motor Toboggans	2
Personnel Carrier	5
Snow Plane	2
Tele-handler	1
Tractor Crawler	3
Trencher	1
Truck, light and heavy	2

Palmer Station

Front-loader (wheeled)	2
Motor toboggans	2
Boats, rubber (Zodiac)	16
Forklift, all terrain	1
Telescopic material handler	1
Vehicle, all terrain, 4-wheel	4

Description of Communications Facilities

Note: For information on frequencies, see attached Comms forms (Attachment A). The following projects are contemplated for the FY 2001-2002 season in Antarctica.

McMurdo Station

1. ATC Voice Switch installation and configuration will take place in Mac Ops, Mac Relay, Mac Center, and Raven Ops.
2. Relocate legacy VHF base radio infrastructure from old T-Site facility to the newly completed T-Site building.

3. Relocate NASA support equipment to new T-Site building.
4. Perform all antenna moves and upgrades, including cabling, at T-Site as part of the McMurdo HF modernization project.

South Pole Station

Testing of wireless LAN equipment operating in the 2.4 gigahertz range will take place.

Palmer Station

Satellite earth station installation will take place to provide phone and data connectivity on a full time basis.

Description of Airfields

McMurdo Station

Air Facilities

1. Williams Field - 2 x 10,000ft, skiways on ice shelf
2. Sea Ice Runway - 2 x 10,000 ft runways (on annual sea ice)
3. Pegasus Glacier Ice runway -1 x 10,000
4. McMurdoHelicopter landing pad

Crash Equipment

1. Two Canadian Foremost Chieftains, 1200 gallons AFFF (each)
2. Two Nodwell Flex-Trac equipped with 1350 lb. PKP, 200 gallon AFFF

3. One Nodwell Flex-Trac equipped with 3,000 lb. PKP
4. Seven 150 lb. PKP sled-mounted extinguisher on the flight line
5. Two 3,000 lb. PKP sled-mounted extinguishers at the heli-pad
6. One Pumper/Tanker, 3,400 gallons of water
7. Two Pumpers, 750 gallons (H2O), 1000 GPM

Navigation Aids

1. Precision (course & glide slope) Approach Radar (PAR) and Approach Surveillance Radar (ASR) on primary landing runways, AN/FPN-36 radar
2. AN/TRN-26 TACAN
3. AN/URN-25 TACAN
4. T-1109/GRT-22 UHF radio beacon
5. Terminal Approach Control Radar (GPN-27)
6. Precision Approach Path Indicator (PAPI)
7. Mobile Microwave Landing System (MMLS)

Amundsen-Scott South Pole Station

Air Facilities

1 x 14,000 ft. skiway

Crash Equipment

Three 350 lb. dry chemical units

Navigation Aids

1. PAR and ASR radar, AN/FPN-36

2. AN/URN-25 TACAN
3. T-1109/GRT-22 UHF beacon

Palmer Station

Air Facilities

None. Open field landings on glacier possible

Crash Equipment

None

Navigation Aids

T-1109/GRT-22 UHF beacon

Marble Point Camp

Air Facilities

One helicopter landing pad

Crash Equipment

1. One 350 lb. dry chemical unit
2. One 150 lb. dry chemical unit (PKP)

Navigation Aids

None

IX. Assistance Facilities

Section IX details the facilities available for rendering assistance in Antarctica, including medical, transport services and emergency shelters.

McMurdo Station

Medical Facilities

During the winter-over period there is a four-bed medical and dental facility with 1 doctor and 2 Medical Assistants. These personnel are augmented with up to 12 Emergency Medical Technicians assigned to the Fire Department. During the summer this facility is staffed with 2 Physicians, 1 Physicians' Assistant or Nurse Practitioner, 1 Dentist, 1 Radiographic Technician, 1 Laboratory Technician, 1 Physical Therapist, and 2 Nurses. These personnel are augmented with up to 40 Emergency Medical Technicians assigned to the Fire Department.

Transport Services

From October to mid-December, airlift from McMurdo to Christchurch via C-5, C-141, and C-130 aircraft is available. From mid-December to mid-February, airlift by LC-130 aircraft is available. Transport via surface may be available (see Section II for dates available).

Available Shelter

Over 90 covered structures are available at McMurdo Station.

Amundsen-Scott South Pole Station

Medical Facilities

One civilian doctor and one Physician Assistant are on-station at South Pole year round. There is limited x-ray and medical lab capability on station.

Transport Services

LC-130 aircraft are available only on-call from McMurdo Station from November to mid-February.

Available Shelter

South Pole Station consists of three buildings under a geodesic dome adjoined and connected to a series of four arches also containing buildings. From November through mid-February additional buildings and tent structures are available.

Palmer Station

Medical Facilities

One civilian doctor is assigned to Palmer Station year round. There is limited x-ray and medical lab capability on station.

Transport Services

The R/V LAWRENCE M. GOULD is the primary means of transport to and from Palmer Station. In extreme circumstances, Twin Otter landings are possible on the glacier behind the station.

Available Shelter

Two buildings comprise the available shelter at Palmer Station.

Marble Point Camp

Medical Facilities

None

Transport Services

Helicopter support from McMurdo Station is available (weather dependent).

Available Shelter

Three structures comprise Marble Point Camp with two structures for berthing up to six persons, and one that houses a generator and workshop.

X. Tourism

Section X presents planned itineraries for U.S. based non-governmental activities in the Treaty area.

Abercrombie & Kent International, Inc.

Explorer Shipping Corporation and Abercrombie & Kent International, Inc. of Oak Brook, Illinois, are planning nine cruises to the Antarctic Peninsula during the 2001-2002 season using the M/S EXPLORER.

M/S EXPLORER

Call letters of the vessel are ELJD8; registry is Liberian. The EXPLORER was built in 1969 and is 72.86 meters in length, 14.02 meters in breadth, has a draft of 4.48 meters, and has a Det Norske Veritas +1A1 ICE-A rating. Power is provided by two MAK diesel engines of 1800 hp each, driving a single variable-pitch propeller, type LIANEN - 450 rpm. Navigation equipment includes a Decca radar 10cm, a Raytheon radar 3cm, a JCR radar 3cm, a Satellite Navigation System (SATNAV) and a Trimble global positioning system (GPS). The vessel has two primary transmitters (Main - ST1680A Marine Mobil Bands, 1500 W Pp; Emergency - EB50, 500 W) and 2 VHF Transceivers STR 67 25 W and a VHF Transceiver Shipmate RS 8000 25 W. INMARSAT voice numbers are: Inmarsat B 363698464, and Inmarsat M 7619622012. EXPLORER carries 9 Mark V heavy-duty zodiacs, 4 motor lifeboats for 196 persons, and 4 automatically inflated life rafts for 66 persons. The vessel can accommodate 85-96 passengers, 10 cruise staff, and 60 crew.

Schedules for each of the cruises follows:

Cruise EX-#1
November/December 2001

Ports	**Dates**
Port Stanley, FALKLAND ISLANDS	17 NOV 2001
Falkland Islands	18-20 NOV 2001
At sea	21-22 NOV 2001
South Georgia	23-30 NOV 2001
At sea	01-02 DEC 2001
Port Stanley, FALKLAND ISLANDS	03 DEC 2001

Cruise EX-#2
December 2001

Ports	**Dates**
Port Stanley, FALKLAND ISLANDS	03 DEC 2001
West Falklands	04 DEC 2001
At sea	05-06 DEC 2001
Antarctic Peninsula	07-10 DEC 2001
At sea	11-12 DEC 2001
Ushuaia, ARGENTINA	13 DEC 2001

Cruise EX-#3
December 2001

Ports	**Dates**
Ushuaia, ARGENTINA	13 DEC 2001
At sea	14-15 DEC 2001
Antarctic Peninsula	16-19 DEC 2001
At sea	20-21 DEC 2001
West Falklands	22 DEC 2001
Port Stanley, FALKLAND ISLANDS	23 DEC 2001

Cruise EX-#4
December 2001/January 2002

Ports	Dates
Port Stanley, FALKLAND ISLANDS	23 DEC 2001
West Falklands	24-25 DEC 2001
At sea	26-27 DEC 2001
Antarctic Peninsula	28 DEC-01 JAN 2002
At sea	02-03 JAN 2002
Ushuaia, ARGENTINA	04 JAN 2002

Cruise EX-#5
January 2002

Ports	Dates
Ushuaia, ARGENTINA	04 JAN 2002
At sea	05-06 JAN 2002
Antarctic Peninsula	07-10 JAN 2002
At sea	11-12 JAN 2002
South Georgia	13-15 JAN 2002
At sea	16-17 JAN 2002
West Falklands	18 JAN 2002
Port Stanley, FALKLAND ISLANDS	19 JAN 2002

Cruise EX-#6
January/February 2002

Ports	Dates
Ushuaia, ARGENTINA	19 JAN 2002
Southeast Falklands	20 JAN 2002
At sea	21-22 JAN 2002
South Georgia	23-25 JAN 2002
At sea	26-27 JAN 2002
Antarctic Peninsula	28-31 JAN 2002
At sea	01-02 FEB 2002
Ushuaia, ARGENTINA	03 FEB 2002

Cruise EX-#7
February 2002

Ports	Dates
Ushuaia, ARGENTINA	03 FEB 2002
At sea	04-05 FEB 2002
Antarctic Peninsula	06-10 FEB 2002
At sea	11-12 FEB 2002
Ushuaia, ARGENTINA	13 FEB 2002

Cruise EX-#8
February 2002

Ports	Dates
Ushuaia, ARGENTINA	13 FEB 2002
At sea	14-15 FEB 2002
Antarctic Peninsula	16-20 FEB 2002
At sea	21-22 FEB 2002
Ushuaia, ARGENTINA	23 FEB 2002

Cruise EX #9
February/March 2002

Ports	Dates
Ushuaia, ARGENTINA	23 FEB 2002
At sea	24-25 FEB 2002
Antarctic Peninsula	26 FEB – 01 MAR 2002
At sea	02-03 MAR 2002
South Georgia	04-06 MAR 2002
At sea	07-08 MAR 2002
Southeast Falklands	09 MAR 2002
Port Stanley, FALKLAND ISLANDS	10 MAR 2002

Quark Expeditions

Quark Expeditions of Darien, Connecticut, is planning approximately 31 cruises to the Antarctic during 2001-2002 season using four chartered vessels. The PROFESSOR MULTANOVSKIY will conduct 9 cruises, the KAPITAN DRANITSYN 8 cruises, the PROFESSOR MOLCHANOV 10 cruises, and the KAPITAN KHLEBNIKOV will conduct 3 cruises.

PROFESSOR MOLCHANOV

The vessel was built in 1983 in Finland and designed as an ice-strengthened research vessel. It ha now been refurbished and refitted to provide comfortable passenger accommodation. The vessel's call sign is UAKA, and INMARSAT numbers are 627315410/411. It measures 71.6 meters in length, 12.8 meters in breadth, approximately 4.5 meters in draft, and a displacement of 2,140 tons.

The vessel is powered by two 1,560 hp diesel engines and is capable of sea speeds of 14 knots. The MOLCHNOV has a full compliment of zodiac landing craft. The vessel can accommodate 38 passengers and approximately 30 crew.

Cruise MOL #1
November 2001

Port	Dates
Ushuaia, ARGENTINA	22 NOV 2001
At sea	23 NOV 2001
West Falklands	24 NOV 2001
Port Stanley	25 NOV 2001
At sea	26-27 NOV 2001
South Georgia	28 NOV – 01 DEC 2001
At sea	02-03 DEC 2001
Antarctic Peninsula	04-07 DEC 2001
At sea	08-09 DEC 2001
Ushuaia, ARGENTINA	10 DEC 2001

Cruise MOL #2
December 2001

Port	Dates
Ushuaia, ARGENTINA	10 DEC 2001
At sea	11 DEC 2001
Antarctic Peninsula	12-16 DEC 2001
At sea	17-18 DEC 2001
Ushuaia, ARGENTINA	19 DEC 2001

Cruise MOL #3
December 2001

Port	Dates
Ushuaia, ARGENTINA	19 DEC 2001
At Sea	20-21 DEC 2001
Antarctic Peninsula	22-25 DEC 2001
At sea	26-27 DEC 2001
Ushuaia, ARGENTINA	28 DEC 2001

Cruise MOL #4
December 2001

Port	Dates
Ushuaia, ARGENTINA	28 DEC 2001
At sea	29-30 DEC 2001
Antarctic Peninsula	31 DEC 2001–04 JAN 2002
At sea	05-06 JAN 2002
Ushuaia, ARGENTINA	07 JAN 2002

Cruise MOL #5
January 2002

Port	Dates
Ushuaia, ARGENTINA	07 JAN 2002
At sea	08 JAN 2002
Falkland Islands	09 JAN 2002
Port Stanley	10 JAN 2002
At sea	11-12 JAN 2002

South Georgia	13-15 JAN 2002
At sea	16-17 JAN 2002
Antarctic Peninsula	18-22 JAN 2002
At sea	23-24 JAN 2002
Ushuaia, ARGENTINA	25 JAN 2002

Cruise MOL #6
January/February 2002

Port	**Dates**
Ushuaia, ARGENTINA	25 JAN 2002
At sea	26-27 JAN 2002
Antarctic Peninsula	28 JAN – 01 FEB 2002
At sea	02-03 FEB 2002
Ushuaia, ARGENTINA	04 FEB 2002

Cruise MOL #7
February 2002

Port	**Dates**
Ushuaia, ARGENTINA	04 FEB 2002
At sea	05-06 FEB 2002
Antarctic Peninsula	07-11 FEB 2002
At sea	12-13 FEB 2002
Ushuaia, ARGENTINA	14 FEB 2002

Cruise MOL #8
February 2002

Port	**Dates**
Ushuaia, ARGENTINA	14 FEB 2002
At sea	15-16 FEB 2002
Antarctic Peninsula	17-21 FEB 2002
At sea	22-23 FEB 2002
Ushuaia, ARGENTINA	24 FEB 2002

Cruise MOL #9
February/March 2002

Port	Dates
Ushuaia, ARGENTINA	24 FEB 2002
At sea	25-26 FEB 2002
Antarctic Peninsula	27 FEB – 02 MAR 2002
At sea	03-04 MAR 2002
South Georgia	05-08 MAR 2002
At sea	09-10 MAR 2002
Port Stanley	11 MAR 2002
Falkland Islands	12 MAR 2002
At sea	13 MAR 2002
Ushuaia, ARGENTINA	14 MAR 2002

Cruise MOL #10
March 2002 (Sub-chartered by Oceanwide Expeditions of The Netherlands)

Port	Dates
Ushuaia, ARGENTINA	15 MAR 2002
At sea	16-17 MAR 2002
Antarctic Peninsula	18-19 MAR 2002
South Orkneys	20-22 MAR 2002
South Georgia	23-25 MAR 2002
At sea	26-30 MAR 2002
Tristan da Cunha, CHILE	31 MAR 202

PROFESSOR MULTANOVSKIY

The vessel is of Russian registry and is 235 feet long, 42 feet wide and has a draft of 15 feet. Its gross registered tonnage is 1754. The hull's ice classification is KM*UL[1]A2, Canadian Type A. The call sign is UCLA and INMARSAT numbers are 762926715/717. The MULTANOVSKIY is powered by two 2,300 kW diesel engines and has both bow and stern thrusters. The vessel carries 44 passengers and 32 crew.

Schedules for each of the cruises follows:

Cruise MUL #1
November 2001

Port	Dates
Ushuaia, ARGENTINA	12 NOV 2001
At sea	13 NOV 2001
West Falklands	14 NOV 2001
Port Stanley	15 NOV 2001
At sea	16-17 NOV 2001
South Georgia	18-21 NOV 2001
At sea	22-23 NOV 2001
Antarctic Peninsula	24-27 NOV 2001
At sea	28-29 NOV 2001
Ushuaia, ARGENTINA	30 NOV 2001

Cruise MUL #2
November/December 2001

Port	Dates
Ushuaia, ARGENTINA	30 NOV 2001
At sea	01 DEC 2001
West Falklands	02-03 DEC 2001
At sea	04-05 DEC 2001
South Georgia	06-09 DEC 2001
At sea	10-11 DEC 2001
Antarctic Peninsula	12-16 DEC 2001
At sea	17-18 DEC 2001
Ushuaia, ARGENTINA	19 DEC 2001

Cruise MUL #3
December 2001

Port	Dates
Ushuaia, ARGENTINA	19 DEC 2001
At sea	20-21 DEC 2001
Antarctic Peninsula	22-25 DEC 2001
At sea	26-27 DEC 2001
Ushuaia, ARGENTINA	28 DEC 2001

Cruise MUL #4
December 2001/January 2002 (Sub-charted by Mt. Travel Sobek of El Cerrito, California)

Port	Dates
Ushuaia, ARGENTINA	28 DEC 2001
At sea	29-30 DEC 2001
Antarctic Peninsula	01 DEC - JAN 03 2002
At sea	04-05 JAN 2002
Ushuaia, ARGENTINA	06 JAN 2002

Cruise MUL #5
January 2002

Port	Dates
Ushuaia, ARGENTINA	06 JAN 2002
At sea	07 JAN 2002
West Falklands	08-09 JAN 2002
At sea	10-11 JAN 2002
South Georgia	12-16 JAN 2002
At sea	17-18 JAN 2002
Antarctic Peninsula	19-22 JAN 2002
At sea	23-34 JAN 2002
Ushuaia, ARGENTINA	25 JAN 2002

Cruise MUL #6
January/February 2002

Port	Dates
Ushuaia, ARGENTINA	25 JAN 2002
At sea	26-27 JAN 2002
Antarctic Peninsula	28 JAN -01 FEB 2002
At sea	02-03 FEB 2002
Ushuaia, ARGENTINA	04 FEB 2002

Cruise MUL #7
February 2002

Port	Dates
Ushuaia, ARGENTINA	07 FEB 2002
At sea	05-06 FEB 2002
Antarctic Peninsula	07-11 FEB 2002
At sea	12-13 FEB 2002
Ushuaia, ARGENTINA	14 FEB 2002

Cruise MUL #8
February 2002

Port	Dates
Ushuaia, ARGENTINA	14 FEB 2002
At sea	15-16 FEB 2002
Antarctic Peninsula	17-20 FEB 2002
At sea	21-22 FEB 2002
Ushuaia, ARGENTINA	23 FEB 2002

Cruise MUL #9
February/March 2002

Port	Dates
Ushuaia, ARGENTINA	23 FEB 2002
At sea	24-25 FEB 2002
Antarctic Peninsula	25-28 FEB 2002
South Orkneys	01 MAR 2002
At sea	02 MAR 2002
South Georgia	03-06 MAR 2002
At sea	07-09 MAR 2002
Port Stanley	10 MAR 2002
West Falklands	11 MAR 2002
Port Stanley, FALKLAND ISLANDS	12 MAR 2002

M/V KAPITAN KHLEBNIKOV

The vessel was built in 1981 at the Waratsila Shipyard, Helsinki, Finland. The ship is owned by FESCO, Vladivostok. The call letters are UTSU and the INMARSAT number is 872-1400676. The KHLEBNIKOV is 132.4 meters in length, 26.5 meters in breadth, has a 8.5 meter draft and displacement of 18,000 tons. The vessel is powered by diesel-electric motors producing 22,000 h.p. driving 3 propellers permitting a maximum speed of 19 knots. The vessel is classified as an icebreaker. The KHLEBNIKOV carries four Mark V heavy-duty zodiacs, in addition to two MI2 helicopters for ice reconnaissance and passenger transport. Approximately 112 passengers and 50 crew members will be onboard for each cruise.

Schedules for each of the cruises follows:

Cruise KLB #1

November/December 2001

Port	Dates
Hobart, AUSTRALIA	25 NOV 2001
At sea	26-27 NOV 2001
Macquarie Island	28-29 NOV 2001
At sea	30 NOV – 01 DEC 2001
Pack ice edge	02-04 DEC 2001
Cape Washington	05 DEC 2001
Terra Nova Bay	06 DEC 2001
Coulman Island/Cape Hallett	07 DEC 2001
Cape Hallett/Cape Roget	08 DEC 2001
Possession Island	09 DEC 2001
Cape Adare	10 DEC 2001
Pack Ice	11 DEC 2001
Pack ice edge	12 DEC 2001
At sea	13-14 DEC 2001
Campbell Island	15 DEC 2001
Enderby Island	16 DEC 2001
At sea	17-18 DEC 2001
Hobart, AUSTRALIA	19 DEC 2001

Cruise KLB #2
December 2001/January 2002

Port	Dates
Hobart, AUSTRALIA	27 DEC 2001
At sea	28-29 DEC 2001
Macquarie Islands	30-31 DEC 2001
At sea/Ice Edge	01-02 JAN 2002
Balleny Island	03 JAN 2002
Cape Adare	04 JAN 2002
Coulman Island	05 JAN 2002
Terra Nova Bay/Cape Washington	06 JAN 2002
Dryglaskiy Ice Tongue	07 JAN 2002
Dry Valleys/Cape Evans	08 JAN 2002
McMurdo/Scott Base/Cape Royds	09 JAN 2002
Ross Ice Shelf/Bay of Whales	10 JAN 2002
Bay of Whales	11 JAN 2002
Ross Sea	12 JAN 2002
Cape Hallett	13 JAN 2002
Ice Edge	14 JAN 2002
At sea	15-16 JAN 2002
Campbell Island	17 JAN 2002
Enderby Island	18 JAN 2002
At sea	19 JAN 2002
Lyttleton, NEW ZEALAND	20 JAN 2002

Cruise KLB #3
January/February 2002

Port	Dates
Lyttleton, NEW ZEALAND	20 JAN 2002
At sea	21 JAN 2002
Enderby Island	22 JAN 2002
Campbell Island	23 JAN 2002
At sea	24-25 JAN 2002
Ice Edge	26 JAN 2002
Cape Adare	27 JAN 2002
Coulman Island/Cape Washington	28 JAN 2002

Terra Nova Bay/Drygalskiy Ice Tongue	29 JAN 2002
Dry Valleys/Cape Evans	30 JAN 2002
McMurdo/Scott Base/Cape Royds	31 JAN 2002
Ross Ice Shelf/Franklin Island	01 FEB 2002
Cape Hallett	02 FEB 2002
Cape Roget	03 FEB 2002
Possession Island	04 FEB 2002
Balleny Island	05 FEB 2002
At Sea	06-07 FEB 2002
Macquarie Island	08-09 FEB 2002
At sea	10-11 FEB 2002
Hobart, AUSTRALIA	12 FEB 2002

KAPITAN DRANITSYN

The vessel was built in 1981 at the Waratsila Shipyard, Helsinki, Finland. The ship is owned by FESCO, Vladivostok. The DRANITSYN is 132.4 meters in length, 26.5 meters in breadth, has a 8.5 meter draft and displacement of 18,000 tons. The vessel is powered by diesel-electric motors producing 22,000 h.p. driving 3 propellers permitting a maximum speed of 19 knots. The vessel is classified as an icebreaker. The vessel's call sign is UCJP and INMARSAT numbers are 1405660 or 427300148. The DRANITSYN carries four Mark V heavy-duty zodiacs, in addition to two MI2 helicopters for ice reconnaissance and passenger transport. Approximately 112 passengers and 50 crew members will be onboard for each cruise.

Schedules for each of the cruises follows:

Cruise DSYN #1

November/December 2001

Port	**Dates**
Port Stanley, FALKLAND ISLANDS	10 NOV 2001
At sea	11-12 NOV 2001
South Georgia	13-15 NOV 2001
South Sandwich Islands	16-17 NOV 2001
Weddell Sea	18-19 NOV 2001
Princess Martha Coast	20-26 NOV 2001

Weddell Sea	27-30 NOV 2001
South Orkneys	01-02 DEC 2001
At sea	03-05 DEC 2001
Ushuaia, ARGENTINA	06 DEC 2001

Cruise DSYN #2
December 2001

Port	**Dates**
Ushuaia, ARGENTINA	06 DEC 2001
At sea	07 DEC 2001
Antarctic Peninsula	08-14 DEC 2001
At sea	15-16 DEC 2001
Ushuaia, ARGENTINA	17 DEC 2001

Cruise DSYN #3
December 2001

Port	**Dates**
Ushuaia, ARGENTINA	17 DEC 2001
At sea	18-19 DEC 2001
Antarctic Peninsula	20-25 DEC 2001
At sea	26-27 DEC 2001
Ushuaia, ARGENTINA	28 DEC 2001

Cruise DSYN #4
December 2001/January 2002

Port	**Dates**
Ushuaia, ARGENTINA	28 DEC 2001
At sea	29 DEC 2001
West Falklands	30 DEC 2001
Port Stanley	31 DEC 2001
At sea	01-02 JAN 2002
South Georgia	03-06 JAN 2002
At sea	07 JAN 2002
Antarctic Peninsula	08-12 JAN 2002
At sea	13-14 JAN 2002
Ushuaia, ARGENTINA	15 JAN 2002

Cruise DSYN #5
January 2002

Port	Dates
Ushuaia, ARGENTINA	15 JAN 2002
At sea	16 JAN 2002
Antarctic Peninsula	17-23 JAN 2002
At sea	24-25 JAN 2002
Ushuaia, ARGENTINA	26 JAN 2002

Cruise DSYN #6
January/February 2002

Port	Dates
Ushuaia, ARGENTINA	26 JAN 2002
At sea	27 JAN 2002
West Falklands	28 JAN 2002
Port Stanley	29 JAN 2002
At sea	30-31 JAN 2002
South Georgia	01-04 FEB 2002
At sea	05-07 FEB 2002
Antarctic Peninsula	08-10 FEB 2002
At sea	11-12 FEB 2002
Ushuaia, ARGENTINA	13 FEB 2002

Cruise DSYN #7
February 2002

Port	Dates
Ushuaia, ARGENTINA	13 FEB 2002
At sea	14-15 FEB 2002
Antarctic Peninsula	16-23 FEB 2002
At sea	24-25 FEB 2002
Ushuaia, ARGENTINA	26 FEB 2002

Cruise DSYN #8
February/March 2002

Port	Dates
Ushuaia, ARGENTINA	26 FEB 2002
At sea	27-28 FEB 2002
Antarctic Peninsula	01-04 MAR 2002
At sea	05 MAR 2002
Port Stanley	06 MAR 2002
Falklands	07 MAR 2002
At sea	08 MAR 2002
Ushuaia, ARGENTINA	09 MAR 2002

Orient Lines, Inc.

Orient Lines, Inc. of Fort Lauderdale, Florida, plans to conduct 6 cruises to the Antarctic during the 2001-2002 season using the MARCO POLO.

MARCO POLO

The vessel is ice-strengthened and was built by VEB Mathias-Thesan Werft of Wismar, Germany in 1965 and re-built during 1991-93 under the supervision of Knud E. Hansen, naval architects, and A. & M. Katzourakis, ship designers. Call letters of the vessel are C6JZ7 and it is registered in the Bahamas. The MARCO POLO is 176.28 meters (578.4 feet) in length, 23.6 meters (77.4 feet) in breadth, has a draft of 8.2 meters (26.9 feet), and is 20,502 tons GRT. Power is provided by 2 Saulzer 7 RND 76 diesel engines with power output of 10,500 bhp each. The vessel has twin-screw propellers and is fitted with Denny Brown (UK) fin stabilizers. There are 6 SKL diesel generators capable of producing approximately 3,500 kw. The MARCO POLO is equipped with the latest radio and satellite communications systems (INMARSAT 330869310) and state-of-the-art navigation equipment. The vessel was redesigned to comply with all 1992 "Marpol" rules for waste disposal including an onboard biological treatment plant with a liquid waste disposal system, refuse sorting, pulping and a treatment plant, in addition to a modern refuse incinerator. All lifeboats are semi-enclosed, engine

propelled and capable of saving 1,200 persons. The vessel is also equipped with two high-speed all-purpose passenger tenders and 10 inflatable zodiac landing craft. The staff and crew capacity is 350, whereas the passenger capacity is 850. However during cruises to the Antarctic Treaty area, Orient Lines only intends to carry 400-450 passengers.

Schedules for each of the cruises follows:

Cruise MP #1
December 2001/January 2002

Port	Dates
Buenos Aires, ARGENTINA	31 DEC 2001
At sea	01-02 JAN 2002
West Point Island, Falklands	03 JAN 2002
Port Stanley	04 JAN 2002
At sea	05 JAN 2002
Deception Island/Pendulum Cove	06 JAN 2002
Lemaire Channel/Port Lockroy	07 JAN 2002
Waterboat Pt./Neumayer Channel	08 JAN 2002
Half Moon Island/at sea	09 JAN 2002
At sea	10 JAN 2002
Ushuaia, ARGENTINA	11 JAN 2002

Cruise MP #2
January 2002

Port	Dates
Ushuaia, ARGENTINA	12 JAN 2002
At sea	13 JAN 2002
Deception Island/Pendulum Cove	14 JAN 2002
Lemaire Channel/Port Lockroy	15 JAN 2002
Waterboat Point/Neumayer Channel	16 JAN 2002
Half Moon Island/at sea	17 JAN 2002
At sea	18 JAN 2002
Ushuaia, ARGENTINA	19 JAN 2002

Cruise MP #3
January 2002

Port	Dates
Ushuaia, ARGENTINA	20 JAN 2002
At sea	21 JAN 2002
Deception Island/Pendulum Cove	22 JAN 2002
Lemaire Channel/Port Lockroy	23 JAN 2002
Waterboat Point/Neumayer Channel	24 JAN 2002
Half Moon Island/at sea	25 JAN 2002
At sea	26 JAN 2002
Ushuaia, ARGENTINA	27 JAN 2002

Cruise MP#4
January/February 2002

Port	Dates
Ushuaia, ARGENTINA	28 JAN 2002
At sea	29 JAN 2002
Deception Island/Pendulum Cove	30 JAN 2002
Lemaire Channel/Port Lockroy	31 JAN 2002
Waterboat Point/Neumayer Channel	01 FEB 2002
Half Moon Island	02 FEB 2002
At sea	03 FEB 2002
Ushuaia, ARGENTINA	04 FEB 2002

Cruise MP#5
February 2002

Port	Dates
Ushuaia, ARGENTINA	05 FEB 2002
At sea	06 FEB 2002
Deception Island/Pendulum Cove	07 FEB 2002
Lemaire Channel/Port Lockroy	08 FEB 2002
Waterboat Point/Neumayer Channel	09 FEB 2002
Half Moon Island	10 FEB 2002
At sea	11 FEB 2002
Ushuaia, ARGENTINA	12 FEB 2002

Cruise MP#6
February 2002

Port	Dates
Ushuaia, ARGENTINA	13 FEB 2002
At sea	14 FEB 2002
Deception Island/Pendulum Cove	15 FEB 2002
Lemaire Channel/Port Lockroy	16 FEB 2002
Waterboat Point/Neumayer Channel	17 FEB 2002
Half Moon Island	18 FEB 2002
At sea/Beagle Channel	19 FEB 2002
Chilean Fjords	20-22 FEB 2002
At sea	23 FEB 2002
Puerto Montt	24 FEB 2002
At Sea/South Pacific	25 FEB 2002
Valparaiso, CHILE	26 FEB 2002

Clipper Cruise Lines

Clipper Cruise Lines/New World Ship Management Company LLC, of St. Louis, Missouri, plans to conduct nine cruises to the Antarctic during the 2001-2002 season using the CLIPPER ADVENTURER.

CLIPPER ADVENTURER

The vessel was built in 1975 and rebuilt in 2001. The call letters are C6PG6 and INMARSAT numbers are 330999710/711/712/713/714. The CLIPPER ADVENTURER is 100 meters in length, 16.24 meters in breadth, has a 4.65 meter draft and displacement of 4,364 tons. The vessel has an average cruising speed of 14.5 knots. The vessel is classified by the Lloyd's Register as a 100 A1 Ice Class 1A Passenger Ship LMC. The CLIPPER ADVENTURER carries four 50-person lifeboats and three 25-person life rafts, in addition to ten 15-person Mark V heavy-duty zodiacs. Approximately 122 passengers and 79 crewmembers will be onboard for each cruise.

Schedules for each of the cruises follows:

Cruise CA #1
November 2001

Port	Dates
Ushuaia, ARGENTINA	08 NOV 2001
At sea	09-10 NOV 2001
Antarctic Peninsula	11-16 NOV 2001
At sea	17 NOV 2001
West Point/Carcass Island, Falklands	18 NOV 2001
Port Stanley, FALKLAND ISLANDS	19 NOV 2001

Cruise CA #2
November 2001

Port	Dates
Ushuaia, ARGENTINA	19 NOV 2001
Carcass Island/West Point, Falkland Islands	20 NOV 2001
At sea	21-22 NOV 2001
Antarctic Peninsula	23-27 NOV 2001
At sea	28-29 NOV 2001
Ushuaia, ARGENTINA	30 NOV 2001

Cruise CA #3
November/December 2001

Port	Dates
Ushuaia, ARGENTINA	30 NOV 2001
At sea	01-02 DEC 2001
Antarctic Peninsula	03-06 DEC 2001
At sea	07 DEC 2001
South Orkneys	08 DEC 2001
At sea	09 DEC 2001
South Georgia	10-13 DEC 2001
At sea	14 DEC 2001
Sea Lion Island, Falklands	15 DEC 2001
New Island, Falklands	16 DEC 2001
Port Stanley, FALKLAND ISLANDS	17 DEC 2001

Cruise CA #4
December 2001

Port	Dates
Port Stanley, FALKLAND ISLANDS	17 DEC 2001
Carcass Island, Falklands	18 DEC 2001
At sea	19-20 DEC 2001
Elephant Island	21 DEC 2001
Antarctic Peninsula	22-25 DEC 2001
At sea	26-27 DEC 2001
Ushuaia, ARGENTINA	28 DEC 2001

Cruise CA #5
December 2001/January 2002

Port	Dates
Ushuaia, ARGENTINA	28 DEC 2001
At sea	29-30 DEC 2001
Antarctic Peninsula	31 DEC 2001–04 JAN 2002
At sea	05-06 JAN 22002
Falklands	07 JAN 2002
Port Stanley, FALKLAND ISLANDS	08 JAN 2002

Cruise CA #6
January 2002

Port	Dates
Port Stanley, FALKLAND ISLANDS	08 JAN 2002
Bleaker Island/Sea Lion Island, Falklands	09 JAN 2002
At sea	10-11 JAN 2002
South Georgia	12-14 JAN 2002
At sea	15 JAN 2002
South Orkneys	16 JAN 2002
Antarctic Peninsula	17-22 JAN 2002
At sea	23-24 JAN 2002
Ushuaia, ARGENTINA	25 JAN 2002

Cruise CA #7
February 2002

Port	Dates
Ushuaia, ARGENTINA	25 JAN 2002
At sea	26-27 JAN 2002
Antarctic Peninsula	28 JAN – 01 FEB 2002
At sea	02-03 FEB 2002
Falklands	04 FEB 2002
Port Stanley, FALKLAND ISLANDS	05 FEB 2002

Cruise CA #8
February/March 2002

Port	Dates
Port Stanley, FALKLAND ISLANDS	05 FEB 2002
Falklands	06 FEB 2002
At sea	07-08 FEB 2002
Antarctic Peninsula	09-13 FEB 2002
At sea	14-15 FEB 2002
Ushuaia, ARGENTINA	16 FEB 2002

Cruise CA #9
February 2002

Port	Dates
Ushuaia, ARGENTINA	16 FEB 2002
At sea	17-18 FEB 2002
Antarctic Peninsula	19-23 FEB 2002
At sea	24-25 FEB 2002
Falklands	26 FEB 2002
Port Stanley, FALKLAND ISLANDS	27 FEB 2002

Lindblad Expeditions

Lindblad Expeditions of New York City, New York, plans to conduct seven cruises to the Antarctic during the 2001-2002 season, using the M/V ENDEAVOR.

M/V ENDEAVOUR

The M/V ENDEAVOR (formerly the M/V CALEDONIAN STAR) was built in Germany in 1966, and is registered in the Bahamas. The vessel's call sign is C6BE4 and INMARSAT numbers are 3308188210/211/212. The vessel is 295 feet long, 46 feet wide, and has a draft of 21 feet. The ship can accommodate up to 108 passengers.

Cruise CS#1
December 2001

Port	Dates
Port Stanley, FALKLAND ISLANDS	07 DEC 2001
At sea	08 DEC 2001
Antarctic Peninsula	09-15 DEC 2001
At sea	16 DEC 2001
Cape Horn	17 DEC 2001
Ushuaia, ARGENTINA	18 DEC 2001

Cruise CS#2
December 2001

Port	Dates
Ushuaia, ARGENTINA	18 DEC 2001
At sea	19 DEC 2001
Antarctic Peninsula	20-26 DEC 2001
At sea	27 DEC 2001
Cape Horn	28 DEC 2001
Ushuaia, ARGENTINA	29 DEC 2001

Cruise CS#3
January/February 2002

Port	Dates
Ushuaia, ARGENTINA	29 DEC 2001
At sea	30-31 DEC 2001
Antarctic Peninsula	01-06 JAN 2002
At sea	07-08 JAN 2002
Ushuaia, ARGENTINA	09 JAN 2002

Cruise CS#4
January 2002

Port	Dates
Ushuaia, ARGENTINA	09 JAN 2002
At sea	10-11 JAN 2002
Antarctic Peninsula	12-17 JAN 2002
At sea	18-19 JAN 2002
Ushuaia, ARGENTINA	20 JAN 2002

Cruise CS#5
January 2002

Port	Dates
Ushuaia, ARGENTINA	20 JAN 2002
At sea	21-22 JAN 2002
Antarctic Peninsula	23-28 JAN 2002
At sea	29-30 JAN 2002
Ushuaia, ARGENTINA	31 JAN 2002

Cruise CS#6
February 2002

Port	Dates
Ushuaia, ARGENTINA	31 JAN 2002
At sea	01-02 FEB 2002
Antarctic Peninsula	03-08 FEB 2002
At sea	09-10 FEB 2002
Ushuaia, ARGENTINA	11 FEB 2002

Cruise CS#6
February 2002

Port	Dates
Ushuaia, ARGENTINA	12 FEB 2002
At sea	13-14 FEB 2002
Antarctic Peninsula	15-21 FEB 2002
At sea	22 FEB 2002
South Orkneys	23 FEB 2002

At sea	24 FEB 2002
South Georgia	25-28 FEB 2002
At sea	01-02 MAR 2002
Falklands	03-04 MAR 2002
Port Stanley, FALKLAND ISLANDS	05 MAR 2002

HOLLAND AMERICA LINE

Holland America Line of Seattle, Washington, plans to conduct two cruises to Antarctica during the 2001-2002 season using the M/V RYNDAM.

M/V RYNDAM

The M/V RYNDAM entered into service in 1994 and is registered in the Netherlands. The vessel is 720 feet in length, has a beam of 101 feet, a maximum speed of 22 knots, and has a gross tonnage of 55,451. The RYNDAM's call sign is PHFV and the INMARSAT number is 2302562. The vessel can accommodate approximately 1,266 passengers and has a crew of 602.

Schedules for each of the cruises follows:

Cruise RYN-#1
January 2002

Port	**Dates**
Rio De Janeiro, BRAZIL	05 JAN 2002
At sea	06-07 JAN 2002
Montevideo, Uruguay	08 JAN 2002
Buenos Aires, Argentina	09-10 JAN 2002
At sea	11-12 JAN 2002
Port Stanley, Falkland Islands	13 JAN 2002
Elephant Island	14 JAN 2002
Antarctic Peninsula (cruising only)	15-17 JAN 2002
At sea	18 JAN 2002
Ushuaia, Argentina	19 JAN 2002
Punta Arenas, Chile	20 JAN 2002

Chilean Fjords	21-22 JAN 2002
Puerto Montt, Chile	23 JAN 2002
At sea	24 JAN 2002
Valparaiso, CHILE	25 JAN 2002

Cruise RYN-#2
January/February 2002

Port	**Dates**
Valparaiso, CHILE	25 JAN 2002
At sea	26 JAN 2002
Puerto Montt, Chile	27 JAN 2002
Chilean Fjords	28-29 JAN 2002
Punta Arenas, Chile	30 JAN 2002
Ushuaia, Argentina	31 JAN 2002
At sea	01 FEB 2002
Antarctic Peninsula	02-04 FEB 2002
At sea	05 FEB 2002
Port Stanley, Falkland Islands	06 FEB 2002
At sea	07-08 FEB 2002
Buenos Aires, Argentina	09-10 FEB 2002
Montevideo, Uruguay	11 FEB 2002
At sea	12-13 FEB 2002
Rio de Janeiro, BRAZIL	14 FEB 2002

Other

In addition, other international cruise companies plan to arrange/conduct or support tourism activities in the Antarctic during the 2001-2002 season. Although some American citizens are most likely involved in their planned activities, the reporting of their activities should be done by the companies' own governments.

LAND BASED

Adventure Network International (ANI), a Canadian company with an office in Boca Raton, Florida, plans several 11-17-day excursions to the interior of the Antarctic continent. Travel from Punta Arenas, Chile, to Adventure Network's Patriot Hills base camp (80°20'S, 81°20'W) is via a South African chartered C-130 cargo/passenger aircraft. These various inland excursions will occur during November 2001 - mid-January 2002 using two chartered Twin Otters and their own Cessna C-A185F aircraft.

XI. Refuges

Section XI provides information on existing refuges and survival caches in the McMurdo area, as well as deactivated camps and stations elsewhere on the continent.

McMurdo Area Antarctic Refuges and Survival Caches

Following are the existing refuges consisting of huts or caches that may be used in emergency survival situations. These survival huts and survival caches are located within a 65 nautical mile radius of McMurdo Station and are inspected annually. Information provided includes position and description of location and accommodation, food, fuel, and supplies of other kinds. "Full provisions" indicates sleeping, eating, and cooking utensils.

Mt. Erebus Hut and Cache

Position: 77°30'S; 167°10'E
Hut: Partial provisions for 3 (no sleeping bags), oxygen, radio during summer.
Cache: Full provisions for 6. Located 50 meters from hut.

Cape Crozier Hut and Cache

Position: 77°30'S, 169°40'E
Hut: Wood structure with some provisions. No radio.
Cache: Full provisions for 6 located north of the hut.

Lake Bonney Hut and Cache

Position: 77°42'S, 162°27'E
Hut: Jamesway structure with provisions. No radio
Cache: Located 30 meters from Jamesway structure uphill.

Lake Vida Cache

Position: 77°20'S, 162°00'E
Hut: Full provisions for 6, 30 man/days food. No radio.
Cache: Located approximately 183m from lake on southwestern shore.

Lake Hoare Hut

Position: 76°38'S, 162°57'E
Hut: Wood structure with provisions, sleeps 6.
Cache: Located 30 meters from hut, food, no radio.

Lake Fryxell Hut

Position: 77°36'S, 163°07'E
Hut: Jamesway structure with provisions sleeps 6.
Cache: Located 30 meters from hut, food, no radio.

New Harbor Hut

Position: 77°34'S, 163°31'E
Hut: Jamesway structure with provisions, sleeps 6.
Cache: Located 30 meters from hut, food, no radio.

McMurdo Supported Remote Locations

Siple Dome Camp

Position: 81°39'S, 149°04'E

Camp winterized for the season. Four (4) Jamesway structures remain standing. Food, fuel, survival cache, and heavy equipment were staged on site for use during the 1997-98 field season.

Byrd Surface Camp

Position: 80°01'S, 119°32'E

Survival cache and Jamesway, minimal food and fuel winterized for the season. All wooden structures, heavy equipment and materials removed from the camp.

Deactivated USAP Stations and Camps

Data on unoccupied United States facilities in Antarctica is listed here although such facilities are not considered usable as refuges. Some are so deeply buried in snow as to make them inaccessible, while others are difficult to locate. Information provided: (1) position and description of location; (2) dates established and deactivated or last visited; and (3) estimate of available accommodation, food, fuel, and supplies of other kinds.

Byrd Aurora Substation

Position:	79°26'S, 188°4'W, approximately 64km from present Byrd Station.
Dates of Operation:	March 1963 - October 1963
Description:	Prefabricated shelter, 16 man/months food and supplies, and 9,464 liters of diesel fuel

Camp Neptune

Position: 83°31'S, 57°15'W, Neptune Range of Pensacola Mountains
Dates of Operation: November 1963 - January 1966
Description: 4.9m x 7.3m Jamesway building, 32 drums fuel, 4-6 man/months food, 113 kg. explosives

Patuxent Camp

Position: 84°54'S, 63°W, Patuxent Range of Pensacola Mountains
Dates of Operation: November 1962 - December 1965
Description: 4.8m x 4.8m Jamesway building, 4 drums fuel, 458 man/days food plus cooking utensils

Prebble Glacier Camp

Position: 84°15'S, 164°10'E, at mouth of Prebble Glacier, Queen Alexandra Range
Dates of Operation: November 1966 - February 1967
Description: 4.8m x 4.8m Jamesway building, 4 drums fuel, 1 man/month food supplies

Camp Gould

Position: 78°57'S, 85°45'W, East Heritage Range
Dates of Operation: November 1962 - February 1967
Description: 4.8m x 4.8m Jamesway building, 48 drums fuel, 8-10 man/ months food

Amundsen Glacier Camp

Position: 86°18'S, 160°55'W, adjacent to Amundsen Glacier on the Faulkner Escarpment
Dates of Operation: November 1963 - January 1964
Description: 4.8m x 4.8m Jamesway building, 4 fuel drums, 400 man/days food, cooking utensils

Byrd Coast Camp

Position: 76°55'S, 144°W, in Edsel Ford Range at Mount Farley
Dates of Operation: October 1966 - January 1967
Description: 4.8m x 4.8m Jamesway building, 2 man/months food and fuel

Camp Ohio

Position: 84°52'S, 114°20'W, Ohio Range, Horlick Mountains
Dates of Operation: November 1961 - January 1967
Description: 4.8m x 4.8m Jamesway building, 7 drums fuel, cooking utensils, 2 man/weeks food supplies

Camp Minnesota

Position: 73°30'S, 94°30'W, in northwestern side of Jones Mountain
Dates of Operation: November 1961 - January 1965
Description: 4.8m x 4.8m Jamesway building, unknown quantity of food and fuel

Little Rockford

Position: 79°30'S, 147°19'W, (relocated in 1959 from 79°35'S, 156°46'W)
Dates of Operation: December 1958 - February 1965
Description: 3 Wannigans, 1 improvised shelter, food and fuel unknown

Plateau Station

Position: 79°15'S, 40°30'E
Dates of Operation: December 1965 - January 1969
Description: Main building 21m x 7.6m van; emergency station separated from main building consists of 9m x 2.4m van attached to a 4.8m x 8m Jamesway; 3-4.8m x 8.5m' and 1-4.8m x 4.8m Jamesway huts with limited supply of DFA and mogas available; however, access may be difficult owing to snow cover; 100 man/months of food plus cooking utensils.

Camp Ohio II

Position: 86°S, 127°W, near crashed R4D aircraft
Dates of Operation: November 1962 - January 1965
Description: 4.8m x 7.3m Jamesway, 4 drums fuel, 2 man/months food plus cooking utensils

Roosevelt Island Hut

Position: 80°11'S, 161°39'W
Dates of Operation: 1969
Description: Provisions for 25. No radio

Hallett Station

Position: 72°19'S, 170°13'E
Dates of Operation: January 1957 - February 1973
Description: 4 buildings

Brockton Station

Position: 80°01'S, 178°02'W
Dates of Operation: October 1965 - February 1972
Description: 4 buildings, 14 drums fuel, and 4,164 liters bulk fuel

Marie Byrd Land Camp

Position: 75°45'S, 135°W
Dates of Operation: October - December 1977
Description: 5 Jamesway huts, bulk DFA, food

Ellsworth Mountains Camp

Position: 79°07'S, 85°39'W
Dates of Operation: November 1979 - January 1980
Description: 1 Jamesway hut

McGregor Glacier Hut

Position: 85°08'S, 174°50'E
Dates of Operation: 1982-83 season
Description: Camp buried under snow. No radio

Dome C Camp

Position: 74°39'S, 124°10'E
Dates of Operation: Camp active summer seasons through 1981/82. Last visited Jan. 1996
Description: 8 Jamesway huts, 3,785 liters POL, and 2,722 kg. food

Beardmore South Camp

Position: 85°2'S, 164°15'E
Dates of Operation: October 1984 - February 1986
Description: Wooden module buried under snow, mogas, some JP8 available.

Siple Station

Position: 75°56'S, 84°15'W
Dates of Operation: January 1979 - February 1988
Description: An unsafe enclosed area under-the-snow, and Jamesway huts on the surface.

Upstream Bravo

Position: 83°29'S, 138°06'W
Dates of Operation: February 1994
Description: All structures buried.

XII. Permits, Species Killed, Captured

Information regarding Antarctic Conservation Act Permits issued or species killed or captured during the 2001-2002 season will be reported in Section XII of the Modifications of the United States Antarctic Activities Planned for 2001-2002.

XIII. Radioactive Materials

Section XIII of the 2001-2002 season plans lists the radioactive materials to be used and provides information regarding their form, nuclide, site, and specific use.

PROJECT	NUCLIDE	FORM	SITE	USE
BG-232-O	^{3}H	^{3}H – Water	RV/ LAURENCE M. GOULD & R/V NATHANIEL B. PALMER	Foraging Ecology of Crabeater Seals
BG-235	^{3}H ^{14}C	^{3}H – Thymidine ^{14}C – Sodium Bicarbonate ^{3}H – Leucine	RV/ LAURENCE M. GOULD & R/V NATHANIEL B. PALMER	Winter Distribution and Activities of Sea Ice Microbial Communities in the Western Antarctic Peninsula Region
BG-246-O	^{14}C	^{14}C – Sodium Bicarbonate	RV/ LAURENCE M. GOULD & R/V NATHANIEL B. PALMER	Winter Ecology of Larval Krill: Quantifying Their Interaction With The Pack Ice Habitat
BM-042-P	^{14}C ^{3}H	^{14}C - Bicarbonate ^{3}H - Thymidine	McMurdo Station/Dry Valleys	McMurdo Dry Valleys: A Cold Desert Ecosystem
BM-042-W	^{14}C -	^{14}C - Sodium Bicarbonate	McMurdo Station	McMurdo Dry Valleys: A Cold Desert Ecosystem
BO-005-O	^{14}C ^{3}H	^{14}C – Sodium Bicarbonate ^{3}H – Leucine	McMurdo Station	Antifreeze Proteins in Antarctic Fishes

PROJECT	NUCLIDE	FORM	SITE	USE
BO-047-O	^{14}C	^{14}C – Sodium Bicarbonate	US COAST GUARD POLAR STAR	Interannual Variability in the Antarctic Ross Sea: Nutrients and Seasonal Production
BP-016-O	^{14}C	^{14}C - Sodium bicarbonate	Palmer Station; R/V LAURENCE M. GOULD	Palmer Station/LM GOULD: LTER on the Antarctic Marine Ecosystem: An Ice Dominated Environment - Phytoplankton Ecology Component
BP-045-O	^{3}H	^{3}H – Thymidine ^{3}H – Leucine	Palmer Station R/V NATHANIEL B. PALMER	Transport and Fate of Persistent Organic Pollutants (POP) in Antarctic Coastal Seas
BP-046-O	^{3}H ^{14}C	^{3}H - Leucine ^{14}C - Bicarbonate ^{3}H - Glucose ^{14}C - Acetate ^{3}H – Thymidine ^{3}H – Amino acid mixture	R/V LAURENCE M. GOULD	LTER: Microbiology and carbon flux
BP-134-O	^{35}S ^{14}C	^{35}S – Amino Acid Mixture ^{14}C – Protein	McMurdo Station	Evolutionary Loss of Heat Shock Response In Antarctic Fishes

PROJECT	NUCLIDE	FORM	SITE	USE
OO-257-O	^{63}Ni	^{63}Ni - Foil or Plated source	South Pole Station	South Pole Monitoring for Climatic Change: U.S. Department of Commerce; National Oceanic and Atmospheric Administration, Climate Monitoring and Diagnostics Laboratory (Source is inside an electron capture detector of a gas chromatograph)

XIV. Research Rockets

Section XIV reports the planned use of research rockets. The United States Antarctic Program will launch no research rockets during the 2001-2002 season.

XV. Oceanography - Government

Section XV outlines plans for United States Antarctic Program sponsored oceanographic expeditions during the 2001-2002 season.

R/V NATHANIEL B. PALMER

The R/V NATHANIEL B. PALMER first arrived in the Antarctic Peninsula area in April 1992. The vessel is owned by Edison Chouest Offshore and is of United States Registry. The vessel will start its second long-term charter to support the United States Antarctic Program in April 2002. The R/V NATHANIEL B. PALMER is ice-class ABS A2, is 93.9 meters long, has a beam of 18.3 meters, a design draught of 6.9 meters, and displaces 6800 long tons. The vessel has 13,000 shaft horsepower driving two controllable pitch propellers and is also equipped with both bow and stern thrusters. The vessel is a multidisciplinary research platform, has a crew of 26 and accommodation for 39 scientists. It is designed for year-round operations in Polar regions.

Research Capabilities

The vessel is equipped with a P-Code GPS satellite precision navigation system, fish-finding sonar, sub-bottom profiling sonar, a SeaBeam swath bathymetry system, INMARSAT communications, TeraScan satellite imaging system, and HF and VHF transceivers. The vessel is also equipped with a dynamic positioning system. A deep sea trawl and coring winch and two hydrographic winches are operated through stern and starboard A-frames. One hydrographic winch, equipped with electromechanical cable, leads through a baltic-room arrangement that protects it from the weather. The vessel is also equipped with multi-channel seismic capability, and laboratory space totaling approximately 520 square meters, all located contiguously on the main deck. The vessel also has a suite of portable lab vans. Zodiacs are available for ship-to-shore transport and sample collection.

Ship's Master: Captain Joe Borkowski.

Scientific Programs in the Antarctic Treaty Area

The R/V NATHANIEL B. PALMER will conduct cruises in the Southern Ocean surrounding Antarctica, for scientific research in the following disciplines: Physical and Chemical Oceanography, Marine Geology and Geophysics, and Marine Biology.

Intended Tracks and Schedule

The vessel is currently scheduled for work in the Weddell and Bellingshausen Seas, Bransfield Strait, and Marguerite Bay areas, and to enter a dry dock period during the month of June in Talcahuano, Chile. This will be followed by a two-week maintenance period in July at Punta Arenas, Chile. Ports of call include: Punta Arenas and Talcahuano, Chile; Port Fourchon, Louisiana. The vessel will perform approximately 6 cruises in the Antarctic Peninsula area during the 2001-2002 season. The vessel is tentatively scheduled to transport hazardous waste from Palmer Station back to the United States in September 2002.

R/V LAURENCE M. GOULD

The R/V LAURENCE M. GOULD first arrived in the Antarctic Peninsula in January 1998. The vessel is owned by Edison Chouest Offshore and is of United States Registry. The vessel will be on long-term charter to support the United States Antarctic Program. The R/V LAURENCE M. GOULD is ice-class ABS A1, is 70.1 meters long, has a beam of 14.02 meters, a design draught of 5.48 and displaces 3780 long tons. The vessel has 4,575 shaft horsepower driving two controllable pitch propellers and is also equipped with a bow thruster. The vessel is a multidisciplinary research platform with a crew of 16 and accommodation for 24 scientists. It is designed for year-round operations in Polar regions.

Research Capabilities

The vessel is equipped with a P-Code GPS satellite precision navigation system, fish-finding sonar, sub-bottom profiling sonar, INMARSAT communications and HF and VHF transceivers. A deep sea trawl winch and two hydro-winches are to be operated through a stern A-frame and starboard side-hydro davits. One hydrographic winch, equipped with electromechanical cable, leads through a baltic-room arrangement that protects it from the weather. Various over-the-side sampling equipment will be handled through use of an articulated Hiab crane on the ship's fantail. In addition, it is equipped with laboratories totaling 99 square meters and an additional 27 square meters in portable laboratory vans. Zodiacs are available for ship-to-shore transport and sample collection.

Ship's Master: Captain Warren Sanamo

Scientific Programs in the Antarctic Treaty Area

The R/V LAURENCE M. GOULD will support research during 2001-2002 season that includes biological, chemical, and physical oceanography as well as marine geology and geophysics. The R/V LAURENCE M. GOULD will also provide logistic support to transport scientists, cargo, and personnel to/from Palmer Station.

Intended Tracks and Schedule

The R/V LAURENCE M. GOULD will transport support personnel to and from Palmer Station, provide research support in and around the Bransfield Strait/Marguerite Bay areas, and enter a routine maintenance period and Dry Dock during the month of June in Talcahuano, Chile. The vessel will perform approximately 10 cruises in the Antarctic Peninsula area during the 2001-2002 season.

XVI. Visiting Expeditions

Section XVI provides information on expeditions visiting U.S. stations during the 2001-2002 austral summer. Data will be accumulated during the course of the season and reported in next year's report of modifications to these plans.

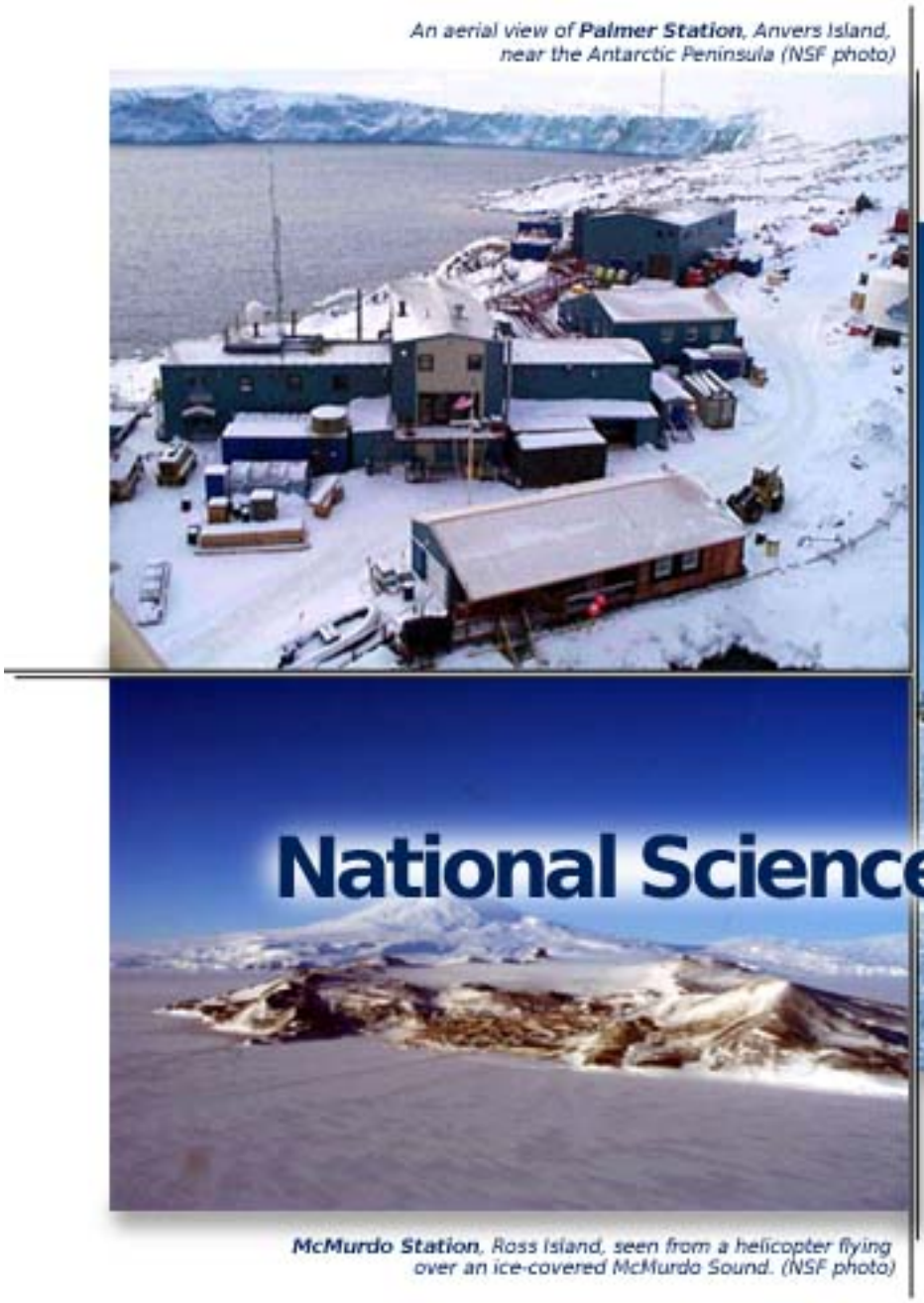
Appendix I

Appendix I of the Activities Planned for 2001-2002 lists the Initial Environmental Evaluation/Environmental Assessments from October 1, 2000 – September 30, 2001.

1. Diversion of Meltwater Around the Refuge Hut at Cape Crozier, Ross Island, Antarctica; signed 16 October 2000
2. Expansion of Facilities at the F6 Camp in the Taylor Valley, Antarctica; signed 16 October 2000
3. Subsurface Investigation at Dry Valley Drilling Project Borehole #6, Lake Vida, Antarctica; signed 5 October 2000
4. Snow Fence Installation to Determine Soil Ecosystem Response to Increased Moisture in Taylor Valleys, Antarctica; signed 5 October 2000
5. Construction of Joint Spacecraft Operations Center at McMurdo Station, Antarctica; signed 6 October 2000
6. Installation and Operation of an Infrasonic Array at Windless Bight near McMurdo Station, Antarctica; signed 27 October 2000
7. Construction and Operation of the MARISAT/GOES Antenna and RF Building at Amundsen-Scott South Pole Station, Antarctica; signed 20 October 2000
8. McMurdo Tracking and Relay Station-2 Antenna Installation at T-Site, McMurdo Station, Antarctica; signed 31 October 2000

9. Construction of a Replacement Telecommunications Facility at McMurdo Station, Antarctica; signed 28 November 2000

10. Continued Use of Assisted Take Off (ATO) Units in Antarctica; signed 15 February 2001



*An aerial view of **Palmer Station**, Anvers Island, near the Antarctic Peninsula (NSF photo)*

*The first of the new buildings at **Amundsen-Scott South Pole Station** in February 2001. In the foreground is the mark for the actual geographic South Pole. (NSF photo by John Rand)*

National Science Foundation

U.S. Antarctic Program 2001-2002

***McMurdo Station**, Ross Island, seen from a helicopter flying over an ice-covered McMurdo Sound. (NSF photo)*

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U.S. ANTARCTIC PROGRAM, 2001-2002

The flags of the original twelve signatories to the Antarctic Treaty surround a bust of Admiral Richard Byrd. To the left is the National Science Foundation's main office in McMurdo, known as the Chalet. *(NSF photo by Peter West)*

The 2001-2002 austral summer brings more than 800 researchers to Antarctica to participate in the U.S. Antarctic Program (USAP) and conduct approximately 148 research projects during the austral summer with some projects continuing through the 2002 austral winter. Supported by over 2,000 civilian contract employees and U.S. military personnel, these researchers will work at the three U.S. year-round stations (McMurdo, Amundsen-Scott South Pole, and Palmer), aboard USAP's two research ships - the icebreaking research ship Nathaniel B. Palmer and the ice-strengthened ship Laurence M. Gould - in the waters of the Southern Ocean, at remote field camps, and with other national antarctic programs at locations around Antarctica.

These projects, funded and managed by the National Science Foundation (NSF), are part of the international effort to understand the Antarctic and its role in global processes. NSF also supports research that can be best or only performed in Antarctica. In addition to the research projects, NSF's Office of Polar Programs (OPP), which manages the antarctic program, supports Teachers Experiencing Antarctica. This program immerses teachers in research as part of their professional development and creates a polar learning community of teachers, students, school districts, and researchers. U.S. Antarctic Program investigators volunteer to include TEA participants in their field parties; NSF selects the teachers competitively. Another OPP program - the Antarctic Artists and Writers Program - provides opportunities for painters, photographers, writers, and others to use serious writing and the arts to increase understanding of the Antarctic and America's heritage there.

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

Highlights

Among the significant research projects scheduled for the 2001-2002 season are:

• **Lake Vostok:** Ice that formed over the last 400,000 years and that had been extracted from the ice sheet above subglacial Lake Vostok in an earlier joint Russian, French, and U.S. project, will be retrieved and analyzed in laboratories in all three countries. Scientists expect to learn more about ancient microorganisms trapped in the ice, and whether they differ from contemporary organisms. The analyses also are expected to provide information about the water in this long-buried lake and the processes that take place on its shores and in its waters.

• **West Antarctica GPS Network (WAGN):** Researchers this season will begin to deploy a series of Global Positioning System transceivers across the interior of the West Antarctic Ice Sheet — an area approximately the size of the contiguous United States from the Rocky Mountains to the Pacific coast. The ability to measure the motions of the Earth's crust in the bedrock surrounding and underlying the West Antarctic Ice Sheet is critical to understanding the past, present, and future dynamics of the ice sheet and its potential role in future global change scenarios, as well as improving the understanding of Antarctica's role in global plate motions. WAGN will complement existing GPS projects by filling a major gap in coverage among several discrete crustal blocks that make up West Antarctica — a critical area of potential bedrock movements.

• **International Transantarctic Scientific Expedition (ITASE):** The U.S. component of the multi-year International Transantarctic Scientific Expedition (U.S. ITASE) will carry out, this season, the third in a series of four traverses over the West Antarctic ice sheet. The broad aim of US ITASE is to develop an understanding of the last 200 years of past West Antarctic climate and environmental change. ITASE is a multidisciplinary program that integrates remote sensing, meteorology, ice coring, surface glaciology and geophysics. This year researchers will continue to collect shallow ice core and snow pit samples for various ice chemical analyses, shallow and deep radar data to look at internal layer reflections and bedrock topography, atmospheric samples, and meteorological readings to understand the current climate of the ice sheet. These data will contribute to a better understanding of the West Antarctic Ice Sheet both today and in the recent past.

• **Killer Whales:** Working aboard a U.S. Coast Guard icebreaker, scientists for the National Oceanic and Atmospheric Administration (NOAA) will obtain tissue samples from live, free-swimming killer whales to determine whether a group of whales, discovered 20 years ago in the vicinity of McMurdo Station, constitute a new species. The Antarctic whales generally are smaller than other killer whales and display a different color pattern.

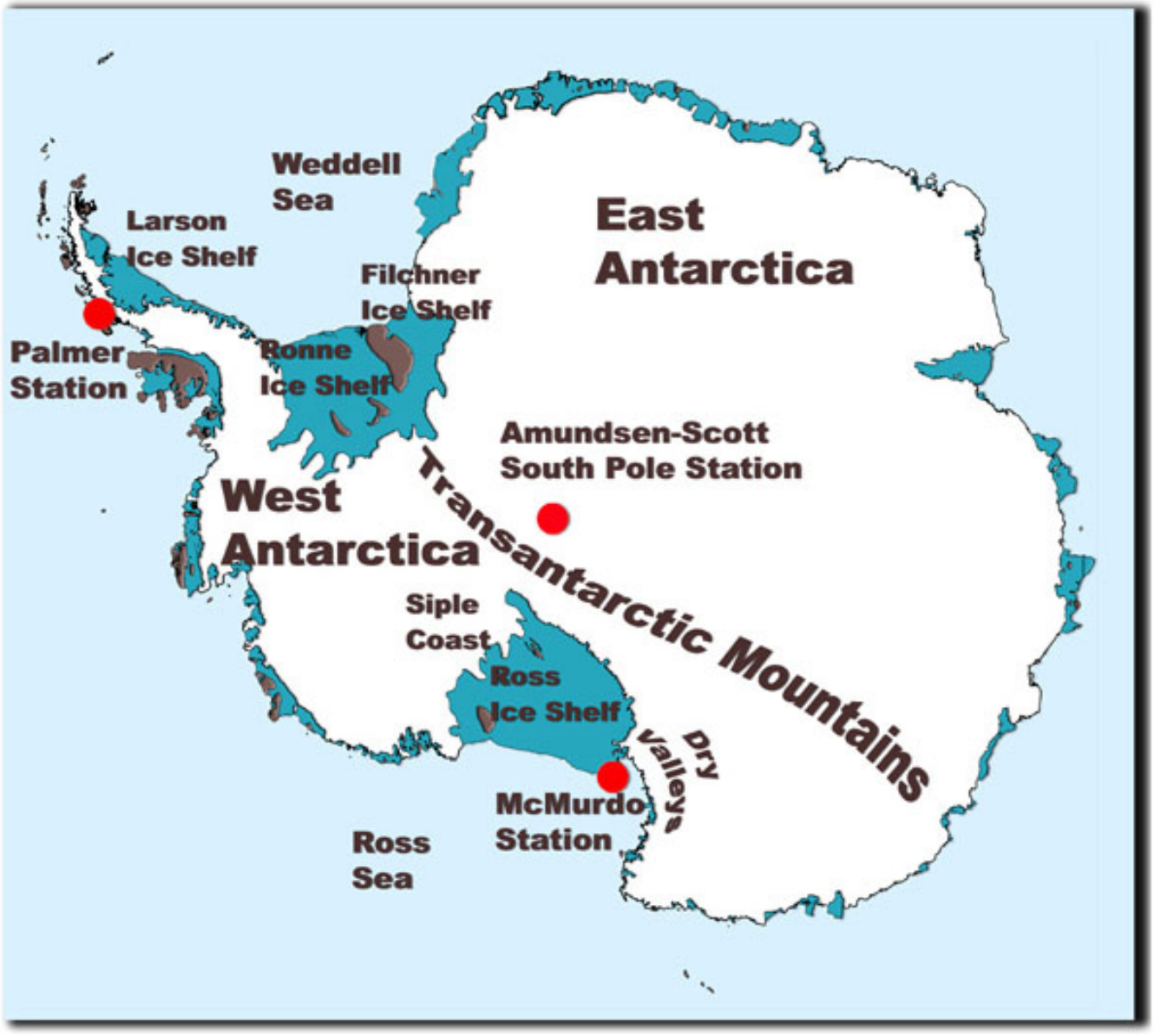
• **Laser Mapping:** As part of a partnership with the U.S. Geological Survey, NSF is collaborating with NASA during the 2001-2002 field-season to test a scanning laser altimeter system in The vicinity of McMurdo Station. The data collected will be used by NSF researchers studying biology, geology, and glaciology and by NASA's ICESat team to assist in the calibration of their data.

• **Southern Ocean Global Ecosystems Dynamics (SO GLOBEC):** Two U.S. Antarctic Program research ships - the icebreaking research ship *Nathaniel B. Palmer* and the ice-strengthened research ship *Laurence M. Gould* -will conduct five cruises in Marguerite Bay on the Antarctic Peninsula region. A continuation of research undertaken in the 2001 research season, the new cruises will deploy a series of moorings, which will include current meters, sensors to measure salinity, temperature and zooplankton concentration, upward-looking acoustic sounders to track ice motion, and acoustic Doppler current profilers.

• **Historic Huts:** Researchers will study the biological and non-biological agents responsible for causing deterioration in a series of historically significant huts built by Antarctic explorers in the early 20th century. Over the past 90 years, the extremes of the polar environment have protected some of the artifacts in the huts from rapid decay, but conservators have become concerned about degradation of these important historical, archaeological sites. They will study the mechanisms and progressive sequence of events taking place during decay processes, test methods to be used to control future deterioration, determine the extent of environmental pollutants in soils at the historic sites, and evaluate chemical spills within the huts.

• **South Pole Astrophysics:** Several telescopes located at the South Pole will continue their investigations into the origins of the universe, including the Degree Angular Scale Inferometer (DASI). Results from DASI last spring helped show scientists evidence of how the universe looked in its infancy. In addition to scientific research, construction of a new elevated building to replace the existing Amundsen-Scott South Pole Station will continue. The construction of exteriors of wings that will house station services, medical facilities and science labs will begin, with the interiors being completed during the next austral winter. The station is scheduled for completion in 2006.

U.S. Antarctic Program, 2001-2002
Sites of major activities



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AERONOMY AND ASTROPHYSICS

Scientists stand outside the Degree Angular Scale Interferometer (DASI), the microwave detector at the Amundsen-Scott South Pole station on 6 January 2001. The detector was used by University of Chicago scientists and others to detect microwave evidence of the Big Bang in which the universe was thought to be created about 14 billion years ago.
(AP Photo, The Milwaukee Journal Sentinel, Ernie Mastroianni)

The polar regions have been called Earth's window to outer space. Originally, this term applied to dynamic events like the aurora, staged as incoming solar plasmas encountered the Earth's geomagnetic fields. Its unique properties create a virtual screen of the polar upper atmosphere on which the results of such interactions can be viewed (and through which evidence of other processes can pass). During the mid-1980s, Earth's window was extended to refer to the "ozone hole" in the polar atmosphere. As scientists have verified an annual loss of ozone in the polar stratosphere, a window previously thought closed (stratified ozone blocking the sun's ultraviolet rays) is now known to "open," consequent to chemical cycles in the atmosphere.

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

• **The stratosphere and the mesosphere:** In these lower regions, current research focuses on stratospheric chemistry and aerosols, particularly those implicated in the ozone cycle.

• **The thermosphere, the ionosphere, and the magnetosphere:** These higher regions derive many characteristics from the interplay between energetically-charged particles (ionized plasmas in particular) and geomagnetic/geoelectric fields. The upper atmosphere, particularly the ionosphere, is the ultimate sink of solar wind energy transported into the magnetosphere just above it. This region is energetically dynamic, with resonant wave-particle interactions, and Joule heating from currents driven by electric fields.

• **The galaxy and the Universe beyond, for astronomical and astrophysical studies:** Many scientific questions extend beyoud the magnetosphere, including a particular interest in the Sun and cosmic rays. Astrophysical studies are conducted primarily at Amundsen-Scott South Pole Station or on long-duration balloon flights launched from McMurdo Station. The capacity of such balloons is expanding dramatically.

All research projects sponsored by this program benefit from (indeed most require) the unique physical conditions found only in the high latitudes, yet their ramifications extend far beyond Antarctica. High-latitude astrophysical research contributes to the understanding of Antarctica's role in global environmental change, promotes interdisciplinary study of geosphere/biosphere interactions in the middle and upper atmosphere, and improves understanding of the critical processes of solar energy in these regions. Life exists on Earth in a balance because of numerous chemical and atmospheric phenomena that have developed in the specific atmosphere of this 4.6 billion year-old spinning planet, in orbit 149,637,000 kilometers around a middle-sized, middle-aged star. The 20th century expansion of traditional astronomy to the science of astrophysics, coupled with the emerging discipline of atmospheric science (See also the Ocean and Climate Systems program), is nowhere better exemplified than in Antarctica.

AMANDA - Antarctic Muon and Neutrino Detector Array.
Robert Morse, University of Wisconsin.

The AMANDA project takes advantage of unique polar conditions to discover and probe the sources - both within our galaxy and beyond - of the shower of very-high-energy neutrinos descending on (and usually passing through) the Earth. Neutrinos are elementary particles, believed to have very little or no mass and no electrical charge. Coursing through the universe, they are able to take any of three forms and interact only rarely with other particles. Thus they arrive at Earth with potentially unique information about where they may have originated. They could be diffuse (made up of contributions from many active galactic nuclei), perhaps even an indicator of the decomposition of the mysterious dark matter now believed to dominate the universe. Or they could be single sources - such as supernova remnants, rapidly rotating pulsars, the gas around black holes, neutron stars, or individual blazars.

AMANDA is the largest detector of neutrinos in the world. Over the last five seasons, the installation of over 600 photomultiplier tubes

[embedded between 1 and 2 kilometers (km) into the ice, oriented downward] has established a natural detector of Cherenkov radiation in the ice. High-energy neutrinos that have sufficient energy to pass through the Earth's mass may collide with an atomic nucleus in the ice or rock near the tubes. Such collisions produce a distinctive eerie blue glow, which the basketball-sized glass tubes can detect for up to several hundred meters through the clear ice.

Previously, 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). In recent years, new sources of high-energy gamma rays have been discovered, such as the source Mrk-421, discovered by NASA's Compton Gamma-Ray Observatory and Mt. Hopkins Observatory. AMANDA is designed to study just such objects, which are believed to emit high-energy neutrinos copiously. Now that first-generation detectors such as AMANDA have been enhanced (the array may one day number 5,000 tubes strung on 80-some cables within one cubic km of ice) neutrino astronomy would appear to be on the verge of detecting high-energy particles that carry information from the outer edges of the universe. (AA-130-O)

Long-duration balloon project.
Danny Ball, NASA/National Scientific Balloon Facility.

As a means of high-altitude exploration, free-flying balloons possess many advantages over satellites. Balloons remain much longer in a specific location, cost a fraction to launch, and are designed to return their instruments safely to Earth. Balloons have been flying for two centuries, but until recently were limited by how long they could stay aloft. The latest scientific balloons, deployed from the National Scientific Balloon Facility (NSBF) in Palestine, Texas, are able to fly missions of 100 days or longer.

The current NSBF effort in Antarctica, known as the Long-Duration Balloon (LDB) program, launches high-altitude balloons carrying scientific payloads into the stratosphere. Many important scientific observations in fields such as hard x-ray/gamma-ray and infra-red astronomy, cosmic rays and atmospheric studies have been made from balloons.

This season the LDB program will focus on supporting the BOOMERanG project (See project AB-148-O). The Ultra Long Duration Balloon Project is an allied NSFB program which will provide launch support for the TIGER project (See project AB-149-O). (AB-145-O)

The Trans-Iron Galactive Element Recorder (TIGER).
Walter Binns, Washington University.

The Trans-Iron Galactive Element Recorder's (TIGER) maiden flight is scheduled for this austral summer. TIGER's complex stack of detectors are expected to retrieve the first measurements ever of high energy [greater than $3x10^8$ electron volts (eV) per nucleon] galactic cosmic rays with atomic numbers between 26 (iron) and 40 (zirconium) - so-called "ultra-heavy galactic cosmic rays." Such energy is believed to originate either in the interstellar medium or to have been freshly synthesized in supernovae. TIGER is expected to go a long way towards determining the source of the material that is accelerated as galactic cosmic rays and the mechanism for injecting that material into the cosmic-ray accelerator.

TIGER will be ferried by NASA's Ultra Long Duration Balloon (ULDB) Project, designed to push the limits of high-altitude, long-duration ballooning. These flights are planned for durations approaching 100 days, to make scientific observations at altitudes above 99 percent of the Earth's atmosphere. This inaugural ULDB balloon is pumpkin-shaped, about 80 by 130 meters and fabricated of polyester and polyethylene. Fueled by a super-pressured system of enclosed gas, the balloon doesn't carry the ballast that zero-pressure balloons need to compensate for day/night changes in pressure, and thus greatly expands the range and flight duration of these craft. TIGER's balloon will fly two revolutions around Antarctica between 77°S and 80°S, to ensure a long collecting time for galactic cosmic rays.

Included in the instrument array are 4 scintillation counters, 2 Cherenkov lightboxes, and a scintillating fiber hydroscope. The total scientific payload of 2200 pounds will require 800 watts of continuous power throughout the 12-hour days and nights. Internet communications will enable scientists to command the instrument and receive immediate data. Following the flight, we will recover the instrument and ship it back to the United States.

TIGER also serves as an engineering model of the ENTICE experiment, one of two instruments that make up the Heavy Nuclei eXplorer mission, recently selected by NASA for a Small Explorer Mission Concept Study. (AB-149-O)

The operation of an extremely-low-frequency/very-low-frequency radiometer at Arrival Heights, Antarctica.
A.C. Fraser-Smith, Stanford University.

Since it was discovered in the 1930s that natural phenomena emit the lowest form of electromagnetic energy - radio waves - the field of radio astronomy has joined the scientific effort to analyze both atmospheric and extraterrestrial signals. The ELF/VLF record of data collected by this project at Arrival Heights - chosen because it is unusually free from man-made electromagnetic interference - now extends unbroken for more than 13 years.

The radiometers at McMurdo operate in both the extra-low- and very-low-frequency (ELF/VLF) ranges, monitoring radio noise from natural sources such as thunderstorms. Characterizing the possible sources of radio interference is important for operational purposes. Since thunderstorm activity generates telltale radio signals, tracking variations in global noise reflects thunderstorm activity and thus can provide information on global climate change.

The Arrival Heights site is one of a network of eight such radiometers operated by Stanford University for the Office of Naval Research. (AO-100-O)

Magnetometer data acquisition at McMurdo and Amundsen-Scott South Pole Stations.
Louis Lanzerotti, University of Alaska Geophysical Institute, and Alan Wolfe,
New York City Technical College.

The magnetosphere is that region of space surrounding a celestial object (such as the Earth or the Sun) where the object's magnetic field is strong enough to trap charged particles. Magnetometers have been installed at selected sites in both polar regions to measure changes in the magnitude and direction of Earth's magnetic field. The unique climatic conditions in Antarctica also permit scientists to view the atmosphere optically (See project AO-104-O) and to correlate such hydromagnetic-wave phenomena with particle-precipitation measurements.

In this project we are measuring such variations with magnetometers installed at conjugate sites in both hemispheres; at McMurdo Station and Amundsen-Scott South Pole Station, Antarctica, and at Iqaluit in the Northwest Territories in Canada. The antarctic systems gather unique data related to the coupling of the interplanetary medium into the dayside magnetosphere, including the magnetospheric cusp region. The data also shed light on the causes and propagation of low-frequency hydromagnetic waves throughout the magnetosphere.

The antarctic magnetometers continue to measure the magnitude and direction of variations in Earth's magnetic field in the frequency range from 0 to about 0.1 hertz, with resolution of about one nanoTesla. These data are being analyzed in the context of other concurrent data acquired by the six U.S. automatic geophysical observatories (AGOs) that are a part of the Polar Experiment for Geophysical Upper Atmosphere Investigations (PENGUIn) program (project AO-112-0); and the data will also be ranged against data obtained from magnetometers operated by Bell Laboratories in the continental United States. (AO-101-O)

High-latitude magnetic pulsations.
Mark Engebretson, Augsburg College, and Roger Arnoldy, University of New Hampshire.

The Earth's magnetic field arises from its mass and motion around the polar axis, but it creates a powerful phenomenon at the edge of space known as the magnetosphere, which has been described as a comet-shaped cavity or bubble around the Earth, carved in the solar wind. When that supersonic flow of plasmas emanating from the Sun encounters the magnetosphere, the result is a long cylindrical cavity, flowing on the lee side of the Earth, fronted by the blunt nose of the planet itself . With the solar wind coming at supersonic speed, this collision produces a "bow shock" several Earth radii in front of the magnetosphere proper.

One result of this process are fluctuations in Earth's magnetic field, called "micropulsations," which can be measured on time scales between 0.1 second and 1,000 seconds. It is known that magnetic variations can significantly affect power grids and pipelines. We plan to use magnetometers (distributed at high latitudes in both the antarctic and arctic) to learn more about how variations in the solar wind can affect the Earth and manmade systems.

We will study these solar-wind-driven variations and patterns at a variety of locations, and over periods of time up to a complete solar cycle. Since satellite systems are now continuously observing solar activity and also monitoring the solar wind, it is becoming feasible to develop models to predict the disruptions caused by such magnetic anomalies. And while our work is geared specifically toward a better understanding of the world and its manmade systems behavior, it will also involve space weather prediction. (AO-102-O)

Antarctic auroral imaging.
Stephen Mende, Lockheed Palo Alto Research Laboratory.

Scientists are only beginning to essay quantitative studies on the dynamic behavior of the magnetosphere. In the past, detail-oriented explorations with space satellites have enabled them to map the average distribution of magnetospheric energetic particle plasma content. 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 aurora because the darkness of polar winter permits continuous optical monitoring; at most other sites, the sky becomes too bright near local mid-day.

The 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 the aurora, scientists get a reliable glimpse into the dynamics of the region of the three-dimensional magnetosphere associated directly with it. This method relies on knowledge relating the type of aurora both to specific energies of precipitation as well as to specific regions of the magnetosphere.

We are deploying an intensified optical, all-sky imager (operating in two parallel wavelength channels, 4,278 and 6,300 Angstroms) to record digital and video images of auroras in the winter darkness. These wavelength bands allow us to discriminate between more- and less-energetic electron auroras and other precipitation. The South Pole Station observations of the polar cap and cleft regions entail measuring auroral-precipitation patterns and then interpreting the results in terms of the coordinated observations of (magnetic) radio-wave absorption images as well as (high-frequency) coherent-scatter radar measurements.

We expect this work to provide insight into the sources and energization mechanisms of auroral particles in the magnetosphere, as well as other forms of energy inputs into the high-latitude atmosphere. (AO-104-O)

Global thunderstorm activity and its effects on the radiation belts and the lower ionosphere.
Umran Inan, Stanford University.

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. Once the direction of the lightning source is known, it can be subjected to waveform analysis and used to track- remotely - the path of the thunderstorms.

The data will also be correlated with data from the antarctic Automatic Geophysical Observatory network, and will be used by scientists studying the magnetosphere and the ionosphere. (AO-106-P)

Extremely-low-frequency/very-low-frequency waves at the South Pole.
Umran Inan, Stanford University.

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 atmosphere 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 (AGO) 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 the multiple sites of the AGO network 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 AGO system. (AO-106-S)

Study of polar stratospheric clouds by LIDAR.
Alberto Adriani, Instituto De Fisica Dell'Atmosfera, Rome, Italy.

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

This project uses an optical radar (LIDAR, Light Detection And Ranging) to study the PSCs, stratospheric aerosol, and the thermal behavior and dynamics of the atmosphere above McMurdo Station. Continuous LIDAR observations provide insight on the formation, evolution, and other peculiar characteristics of these PSCs.

Such an observational activity is also performed in the frame of the Network for Detection of Stratospheric Change (NDSC), a global set of high-quality remote-sounding research stations for observing and understanding the physical and chemical state of the atmosphere (on the web at www.ndsc.ws). McMurdo Station is considered a primary NDSC site for LIDAR observations and for the monitoring of aerosol and clouds in the stratosphere. Such data also provide a complement to the information gained from balloon-borne instruments in project AO-131-O, and thus collaborative activities are being coordinated with the University of Wyoming. (AO-107-O)

A very-low-frequency beacon transmitter at the South Pole.
Umran Inan, Stanford University.

This 3-year project to establish and operate a very-low-frequency (VLF) beacon transmitter at South Pole will measure solar effects on Earth's mesosphere and lower ionosphere. Relativistic electrons - measured at geosynchronous orbit to have energies of greater than 300 kiloelectronvolts - appear to fluctuate in response to substorm and solar activity. During such events, these highly energetic electrons can penetrate as low as 30 to 40 kilometers above the Earth's surface. At that altitude, they can wreak havoc in the atmosphere - they ionize chemical species, create X-rays, and may influence the chemistry that produces ozone.

By comparing how the South Pole VLF signal varies in both amplitude and phase when it arrives at various antarctic stations, the extent of relativistic electron precipitation can be calculated. The transmitter will also produce other data as well - on solar proton events, relativistic electron precipitation from Earth's outer radiation belts, and on the Joule heating components of high-latitude/ polar-cap magnetosphere/ionosphere coupling processes.

VLF data from the South Pole beacon provides a valuable complement to two other efforts. First, to other antarctic upper atmospheric research, such as the Automatic Geophysical Observatory programs and the southern hemisphere coherent HF radar network Super4 Dual Auroral Network (SUPERDARN). Second, to ongoing satellite-based measurements of trapped and precipitating high-energy electrons at both high and low altitudes, the latter collected by the Solar Anomalous and Magnetospheric Particle Explorer (SAMPEX). (AO-108-O)

South Pole Air Shower Experiment-2.
Thomas Gaisser, University of Delaware.

Cosmic rays consist of protons and other atomic nuclei, accelerated (scientists believe) to high energy levels in such distant astrophysical sources 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 the charged particles (primarily electrons) that are produced by interactions of these very high energy cosmic rays.

A nine-station subarray called VULCAN has been constructed to detect the Cherenkov radiation (light emitted by a charged particle moving through a medium at a higher speed than the speed of light within that material, analogous to the shock wave produced by objects moving faster than the speed of sound) 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. (See project AA-130-OO). SPASE-2 has two goals:

First, to investigate the high-energy primary (galactic in origin) cosmic radiation, by determining the relative contribution of different groups of nuclei at energies greater than about 100 teraelectronvolts. 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 muons penetrating the Earth 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. The VULCAN detector further permits the calculation of two other ratios that also depend on primary mass in readings from the showers it detects.

Second, to use the coincident events as a tagged beam. This construction permits us to investigate and calibrate certain aspects of the AMANDA response. This project cooperates with the University of Leeds in the United Kingdom. (AO-109-O)

High-latitude Antarctic neutral mesospheric and thermospheric dynamics and thermodynamics.
Gonzalo Hernandez, University of Washington.

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 strongly restricts the types of wave motion that can occur there, as compared to lower latitude sites. Antarctica attracts

atmospheric scientists for many reasons; a primary draw is that neutral winds perforce can only blow across the Earth's rotational axis. This simple condition has a profound influence on the large-scale dynamics of the atmosphere at high latitude, as only zonal wave-number one mode horizontal motions are possible.

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 (OH), 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) to make simultaneous azimuthal observations of the individual line spectra of several upper atmospheric trace species, most importantly the hydroxyl radical (OH) 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 can also be derived from these multi-azimuth measurements. The simultaneously observed line widths also provide a direct measurement of kinetic temperature. (AO-110-O)

Riometry in Antarctica and conjugate regions.
Theodore Rosenberg and Allan Weatherwax, University of Maryland.

We will continue our studies of the high latitude magnetic ionosphere and magnetosphere, using galactic radio-noise absorption techniques (riometry). Riometers measure the relative opacity of the ionosphere. We are using an imaging riometer system called IRIS (imaging riometer for ionospheric studies) that we developed several years ago; it is now being operated at Iqaluit, Canada; Sondestromfjord, Greenland; and South Pole and McMurdo stations, as well as in all six of the Automatic Geophysical Observatories (AGO) operated by the National Science Foundation in Antarctica.

We are also operating broad-beam riometers at Iqaluit, McMurdo, and South Pole, as well as auroral photometers at McMurdo and South Pole stations. We have helped to extend antarctic coverage by providing imaging riometers for the British Halley Bay and the Australian Davis stations. In the next few years we will build imaging riometers systems for some of the British AGOs. The instruments work synergistically with a number of other instruments that are operated at all of these sites by other investigators.

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 (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 impact, and accurate forecasting could ameliorate these impacts. (AO-111-O)

Polar experiment network for geophysical upper-atmosphere investigations (PENGUIn).
Theodore Rosenberg, University of Maryland at College Park.

The data obtained from automatic geophysical observatories (AGO) 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 are working with 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 select 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 along with in situ observations of the geospace environment by spacecraft, in close cooperation with other nations working in Antarctica, and in conjunction with conjugate studies performed in the Northern Hemisphere. PENGUIn AGO data will be sent to Augsburg College in Minnesota to be processed and distributed to PENGUIn investigators. (AO-112-O)

Auroral dynamics by the all-sky-imager at Amundsen-Scott South Pole Station.
Masaki Ejiri, National Institute of Polar Research, Japan.

The South Pole is a unique platform for observing aurora during austral winter season. As a point on the Earth's rotational axis, the pole provides a unique vantage to observe the airglow and to discern the characteristics of acoustic gravity waves in the polar region, as they vary in altitude and wavelength. We can observe aurora continuously throughout the 24 hours in a day, which allows us to collect data on:

• the dayside polar cusp/cleft aurora (due to the direct entry of the solar wind);

• afternoon aurora that are closely associated with the nightside magnetospheric storm/substorm activities; and

• the polar cap aurora, which is dependent on the polarity of the interplanetary magnetic field.

Research has shown that these auroras develop from precipitating low-energy particles entering the magnetosphere from the solar wind.

Though data have been acquired at the South Pole since 1965 using a film-based, all-sky camera system, newer technology now produces digital images and permits us to process large amounts of information automatically. Currently, we are using the all-sky-imager (ASI), a digital CCD imager monitored and controlled by the Japanese NIPR (National Institute of Polar Research).

These international collaborations should enhance knowledge of the magnetosphere, the ionosphere and of upper/middle atmosphere physics. The HF (high frequency) radars at Halley Bay, Sanae, and Syowa Station provide the vector velocity of ionospheric plasma over the South Pole. These studies should provide further insight into the physics of the magnetosphere, the convection of plasma in the polar cap, and solar wind effects - specifically dayside auroral structure, nightside substorm effects, and polar-cap arcs. (AO-117-O)

Solar and heliosphere studies with antarctic cosmic-ray observations.
John Bieber, University of Delaware.

Cosmic rays - penetrating atomic nuclei and electrons from outer space that move at nearly the speed of light - continuously bombard the Earth. Colliding with nuclei of molecules found in the upper atmosphere, they create a cascade of secondary particles that shower down toward 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 Amundsen-Scott South Pole Station) provide a long-term historical record that supports efforts to understand the nature and causes of solar/terrestrial and cosmic-ray variations, as they are discerned 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 electronvolts. 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. (AO-120-O)

Effects of enhanced solar distrubances, during the 2000-2002 solar-max period, on the antarctic mesophere-lower-thermosphere (MLT) and F regions composition, thermodynamics, and dynamics.
Gulamabas Sivjee, Embry Riddle Aeronautical University.

While variations in the Sun's energy affect people in obvious ways - driving the weather and the seasons - there are actually many cycles and variations of deeper interest to science, on scales from seconds to centuries to eons. One of the most basic is the 11-year cycle when the Sun's magnetic poles reverse direction (the 23rd of which - since reliable observations began - has just recently peaked), and sunspots and other solar activity wax to peak levels. NASA is using this opportunity to conduct its TIMED (Thermosphere-Ionosphere-Mesosphere-Energetics and Dynamics) satellite study, which will focus on the region between 60 and 180 kilometers above the Earth's surface.

Taking advantage of the timing of both of these events, we will use observations in the visible and near-infrared ranges of upper-atmospheric emissions above South Pole Station to study the heating effects of auroral electrical currents in the ionosphere, as well as planetary waves and atmospheric tides.

TIMED will provide data on the temperature, winds, and tides of Earth's upper atmosphere, especially above the poles as it passes overhead. But tracking satellites often have difficulty differentiating between variations in location or time. The South Pole ground-based observations will be valuable in sorting out the time-location question. (AO-129-O)

Measurements of polar stratospheric clouds, condensation nuclei, and ozone during the austral winter and spring.
Terry Deshler, University of Wyoming.

We are continuing a series of observations to characterize the particles in polar stratospheric clouds (PSCs; known to be critical to ozone depletion) and will make additional observations that may provide the first indications of ozone recovery. Using balloon-borne instruments, we will take PSC particle-size distribution measurements during the early- and mid-winter period (when PSC activity is greatest), and during late winter, when ozone loss begins. The ozone measurements will begin in late August and continue through October.

The fundamental measurements from the PSC instruments provide estimates of the size and concentration of the particles that form in these clouds. Heterogeneous chemistry - which activates chlorine so that it can then destroy ozone - occurs on the surface of these particles. From such measurements one can estimate the volume of PSCs, as well as their surface area.

These results help scientists to:

• quantify existing models for chlorine activation and ozone loss models;

• calculate denitrification/dehydration rates; and

• estimate particle composition.

We are also estimating the composition of particles by inferring their index of refraction, through continuing collaboration with the McMurdo LIDAR measurements of Alberto Adriani, Istituto di Fisica Dell'Atmosfera, Rome (See project AO-107-O).

In addition to the aerosol measurements, we will continue to develop annual profiles of the ozone in late winter and spring, when stratospheric chlorine levels are peaking. This provides (at a minimum) a measurement base to detect the first signs of ozone recovery. As the season warms, ozone depletion falls off and is expected to be altitude-dependent. Such vertical ozone profiles provide one of the crucial tools needed to observe the first signs of recovery following the decline in stratospheric chlorine. These measurements are archived in the data base of the Network for the Detection of Stratospheric Change. (AO-131-O)

Dynamics of the mesophere and lower thermosphere using ground-based radar and TIMED instruments.
Susan K. Avery, University of Colorado, Boulder.

This is a propitious time to study a number of atmospheric phenomena, because of the recently-peaked 11-year solar cycle, and NASA's TIMED satellite mission (See project AO-129-O). In addition to measurements derived from instruments on TIMED, we are installing a meteor radar at Amundsen-Scott South Pole Station. Concentrating on the dynamics of the mesosphere and lower thermosphere, we are looking at:

• the space-time decomposition of wave motions;

• delineation of the spatial climatology over Antarctica with emphasis on the structure of the polar vortex;

• dynamical response to energetic events; and

• inter-annual variability.

The proposed meteor radar is a VHF system capable of measuring the spatial structure and temporal evolution of the horizontal wind field over the South Pole. Spatial climatology data will also come from existing ground-based radars at Davis Station, Syowa Station, Rothera Station, and the Amundsen-Scott base.

As NASA's TIMED satellite orbits over the South Pole, wind and temperature data will provide counterpoint and corroborative information. Thus, experiments based both in space and on the ground may be mounted, and data that was previously reliant on a single source can be better validated. (AO-284-O)

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CENTER FOR ASTROPHYSICS IN ANTARCTICA

Center for Astrophysical Research in Antarctica (CARA)
John Carlstrom, University of Chicago.

Astronomers probe the infrared (IR), submillimeter and millimeter wavelengths of the electromagnetic spectrum in search of data that could suggest answers to some of the seminal questions about the formation of the Universe; such as:

• the formation of large-scale structure in the early Universe,

• the origin of star-forming molecular clouds,

• the origin and evolution of protostars and young stars, and

• the interaction between molecular clouds and young stars.

Antarctica is an ideal spot for such research, with its long dark winter and uniform weather conditions. The extreme winter cold (with temperatures as low as -82°C) dessicates the atmosphere, essentially removing the water vapor that complicates submillimeter-wave astronomy. These conditions make the infrared spectrum of sky above the polar plateau consistently clearer and darker than anywhere else on Earth, enabling 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 other 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 and principal investigators listed below are currently part of CARA. John Carlstrom, University of Chicago.(AC-370-O)

Antarctic Submillimeter Telescope and Remote Observatory (AST/RO)

AST/RO, located in the dark sector of Amundsen-Scott South Pole Station, is a 1.7-m submillimter-wave telescope probing the electromagnetic wavelength spectrum between 200 and 2,000 microns. The telescope operates continuously through the austral winter and is being used primarily for spectroscopic studies of neutral atomic carbon and carbon monoxide in the interstellar medium of the Milky Way and Magellanic Clouds. Neutral carbon is the fourth most abundant element in the Universe. Vital to the chemistry and cooling processes of the interstellar medium, it is the only common element for which scientists can observe all variations - atomic, molecular, ionized and as graphite in dust grains.

There is a ring visible at the center of the Milky Way, about 30,000 light years away. This phenomenon is about 1,900 light years across and consists of gigantic clouds of interstellar gas, ten million times more massive than our Sun. Only by observing the spectral emissions for carbon dioxide were scientists using AST/RO recently able to confirm that the density of hydrogen remains just below the critical value that would set off gravitational processes leading to a burst of star formation.

The telescope is available to the worldwide astronomical community on a proposal basis, and many individual projects are carried out each year. In addition to ongoing maintenance, operations, and site testing, we will begin preparing this austral summer for installation of a new 1.4 THz hot-electron bolometer detector system (the TREND project). Antony Stark, Smithsonian Institution. (AC-371-O)

Automated Astrophysical Site Testing Observatory (AASTO)

Currently located a few hundred yards from the geographical south pole, AASTO is a state-of-the-art laboratory designed especially for polar work. Virtually autonomous, it powers and heats itself and harbors a half dozen instruments arrayed to assess those conditions on the high antarctic plateau that are relevant to the deployment of large telescopes. Collecting data on the electromagnetic spectrum from the ultraviolet to the sub-millimeter range, AASTO also monitors temperature, atmospheric pressure, and wind speed and direction.

By the end of the 2001-2002 field season, we will have completed almost all of our measurements at the South Pole location. The next phase entails moving AASTO to the new French-Italian station at Dome C. We also will continue to refine the AASTO power system, and

to examine alternative sources of energy. John Storey, University of New South Wales, Australia. (AC-372-O)

Degree Angular Scale Interferometer (DASI)

DASI is a 13-element interferometer designed to measure anisotropies in the Cosmic Microwave Background (CMB) Radiation - over a large range of sensitivities - and to determine its angular power spectrum. DASI's ability to provide angular coverage ($140 < l < 910$) complements the MAP satellite and other CMB experiments, and it dovetails with the VIPER telescope and the future millimeter and submillimeter capabilities it will gain through the ACBAR project.

During austral winter 2000, DASI measurements of the angular power spectrum of the CMB anisotropy over scales of 0.2 to 1.5 degrees provided a test of the inflationary model for the origin of the universe. These data also contribute a unique perspective on calculations for the total energy density and the density of normal matter in the universe. This austral summer, we will perform yearly cryogenic maintenance on the receivers in place (which operate at 30 GHz), and also plan to install new 100 GHz receivers to expand the scope for fine-scale CMB observations. John Carlstrom, University of Chicago. (AC-373-O)

VIPER Telescope

VIPER, a 2.1-m off-axis telescope, extends CARA's observations to CMB structures having smaller angular scales. It is in this range where cosmological models differ most in their predictions, and where data from VIPER should help to determine the power spectrum anisotropy. During the 2001 austral winter, VIPER hosted ACBAR - extending anisotropy observations to higher frequencies and SZE (Sunayaev-Zel'dovich effect) observations to smaller angular scales - to map fine-scale structure in the CMB and to study galaxy clusters. This austral summer we will test SPARO in preparation for future observations but will reinstall ACBAR for the 2002 austral winter. Jeffrey Peterson, Carnegie-Mellon University. (AC-375-O)

Submillimeter Polarimeter for Antarctic Remote Observing (SPARO)

SPARO, which was deployed to the South Pole in 1999, operates on the Viper 2-meter telescope. A 9-pixel, 450-micron polarimetric imager, it requires only infrequent cryogen refills, thus simplifying maintenance during the winterover. The South Pole offers superb conditions for SPARO observations, extending the reach of submillimeter polarimetry. That discipline is based on the fact that magnetic particles polarize and align perpendicular to the direction of a magnetic field. By measuring the polarization of thermal emissions from magnetically aligned dust grains, SPARO extends the study of interstellar magnetic fields to regions of low-column density that cannot be studied from other sites.

SPARO resembles 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 location, however, yields a much enhanced submillimeter sensitivity to extended emissions. Giles Novak, Northwestern University. (AC-376-O)

Arcminute Cosmology Bolometer Array Receiver (ACBAR) Instrument

We plan to install the ACBAR receiver on the Viper telescope, and prepare it for winter observations. ACBAR, a 16-element, 300 mK bolometer array, will be used to map the CMBR with high-angular resolution. The instrument's wide range is designed to minimize foreground contamination, enabling it to search for distant galaxy clusters, and to measure the velocity of nearby, known clusters. Many scientists believe that the key to the CMB will be found in yet undiscovered clusters of galaxies, which ACBAR is designed to detect. William Holzapfel, University of California, Santa Barbara. (AC-378-O)

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BIOLOGY AND MEDICINE

A researcher hauls in a *Dissostichus mawsoni* from the icy waters of McMurdo Sound. Scientists are studying how the fish keep their blood from freezing in the 28ºF water.
(NSF photo by Aaron Spitzer)

Antarctica is a place like no other - as an intriguing habitat, a scientist's dream. A land where water is scarce - truly a desert - despite containing more than two-thirds of the world's freshwater supply trapped in the ice. Though it borders the world's major oceans, the Southern Ocean system is unique in the world, a sea where average temperatures don't reach 2°C in summer, where even the water itself is so unique that it can be identified thousands of kilometers away in currents that originated here. As the Earth makes its elliptical journey around the Sun each year, tilted on its rotational axis, the Sun "sets" in April, not to be seen again until September. And the ice - unimaginable, incomparable vastness of ice - in a dozen different varieties, at times and in places several thousand meters thick, two major ice sheets (the East larger than most countries), changing dynamically all the time.

Adaptations and behavior developed in response to these extreme conditions provide insight into the intricacies, as well as the fundamental processes, of evolution. These extremes have also driven the development of ecosystems simple enough to reveal wonderfully clear pieces of the web of life on Earth.

The Biology and Medicine program funds research to improve understanding of antarctic ecosystems and life forms - their physiology, genetics, behavior, adaptations, and relationships. Projects range across all organizational levels - from the molecule, gene, cell and organism to relationships within communities and ecosystems, to the level of global processes and the biosphere. This is another area of inquiry where scientific goals and benefits extend far beyond learning (in this field, about flora and fauna) in the high latitudes. Support is focused on the following areas:

• **Marine ecosystem dynamics:** Among the research topics are understanding the natural variability of marine ecosystems; correlating the structure and function of the marginal ice-zone ecosystem with oceanic and atmospheric processes; exploring the sources of nutrition and their influence on prey and on primary production; and the role of marine phytoplankton in carbon-dioxide cycling.

• **Terrestrial and limnetic ecosystems:** Organisms in ice-free areas and in perennially ice-covered lakes show remarkable adaptations to extreme environments. Relatively few species thrive here, which facilitates the study of ecosystem dynamics and the interpretation of experiments, although much more remains to be learned about adaptive mechanisms and evolutionary processes.

• **Population biology and physiological ecology:** At the next level, looking at relationships among organisms, studies have focused on the variability and dynamics of populations of krill and other zooplankton. Ecological relationships among and between fish species, marine mammals, and birds have also been the object of much research, with many issues still to be further explored. Advances in genetic testing now permit scientists to establish relationships between individuals and species in the wild that were previously unverifiable. As organized programs of antarctic science enter their fifth decade (some even longer), data sets and ongoing observations are elucidating manmade as well as natural changes.

• **Adaptation:** Antarctic extremes present a fundamental research opportunity; topics include low-temperature photosynthesis and respiration; enzymatic adaptations and adaptive physiology, such as the development in fish of antifreeze compounds and modifications to the circulatory system in seals; also continuing interest in the response of (and impacts upon) organisms to increased UV-B radiation from the ozone hole. Here too, new molecular DNA advances have had a profound impact on the types of studies that can be mounted.

• **Human behavior and medical research:** Antarctica's extreme climate and terrain impose a quite spartan and unconventional existence upon scientists and others who live and work there. As people are subjected to social, psychological, and physiological

stresses (exacerbated during the winter isolation) research opportunities arise. Studies focus on epidemiology, thermal regulation, immune system function, individual behavior, and group dynamics.

Function and chemical nature of ice-active substances associated with sea-ice diatoms.
James Raymond, University of Nevada at Las Vegas.

Sea-ice diatoms (a particular class of algae) are plentiful in McMurdo Sound, Antarctica, in the ice platelet layer and congelation ice. Previous work suggests these particular diatoms produce certain extracellular ice-active substances (IASs), molecules with large molecular weights that appear to be glycoproteins. They are widely distributed in the Southern Ocean, occur in both summer and winter sea ice, are associated with many, if not all, of the diatoms found in sea ice, and are apparent as darkly stained areas in the sea ice. Because similar molecules have not been found in temperate water diatoms, they apparently have a function related to cold or icy environments.

The IASs represent a novel type of ice-binding molecule that is distinct from the antifreeze proteins and glycoproteins found in some fish species. Since they are ubiquitous in the antarctic sea-ice communities but absent in warmer regions, they would appear to have an important role in polar communities. But what is that role? Our studies focus on that question and others about the nature of these molecules.

While different in structure, however, the IASs do share some properties with fish antifreezes, and so understanding their ice-binding properties and chemical structure will make it possible to better understand how this family of molecules interacts with ice. Finally, unlike the fish antifreezes, the IASs are produced in large quantities in nature - perhaps they could be used in other applications.

We will examine additional questions about the function and chemical nature of these unusual substances:

• Preliminary evidence suggests the IASs have cryoprotective properties. To explore this possibility, we will try to assess the IASs' ability to prevent freeze-thaw damage in a test enzyme (LDH) as well as in whole cells and also their ability to inhibit the recrystallization of ice, which is a common measure of antifreeze activity in plant studies.

• The IASs are known to bind to ice crystals. To better understand the binding mechanism we will conduct additional studies to determine the specific crystal faces to which they bind.

• We will try to better characterize the chemical nature of the carbohydrate and protein components found in the IASs, using mass spectrometry, amino-acid sequencing, and other techniques.

• Finally, we will also attempt to raise antibodies against the IASs, as these will have several uses in determining the origin, seasonality, relatedness, and possibly the function of these molecules. (BO-001-M)

Antifreeze protein antarctic fishes: Ecological and organismal physiology, structure-function, genetics, and evolution.
Arthur DeVries, University of Illinois.

Despite temperatures that can dip below 0°C, antarctic waters provide a life sustaining environment for a number of fish species. How are they able to take the most frigid waters on earth through their gills without themselves freezing? A primary reason are the so-called antifreeze proteins, an adaptation found in a number of polar and subpolar species. These biological molecules have a similar effect to antifreeze in a mechanical engine. The Southern Ocean provides the ideal laboratory and molecular biology the ideal probe to study this phenomenon. As the world's coldest marine environment, the near-shore waters of Antarctica, replete with ice crystals, hover just above seawater's freezing point.

We are studying the physiology of fish and larvae from these waters to see how ice grows in biological tissues - a crystallization process called nucleation - and how antifreeze glycoproteins (AFGP) inhibit it. Evolving the antifreeze function has enabled the antarctic notothenioids to colonize their frigid habitats very successfully. We are mounting comprehensive multidisciplinary analyses of this adaptation at the level of the gene as well as the protein.

Specifically, we will

• examine the structure of antifreeze proteins;

• refine the molecular model of how these proteins adsorb ice and inhibit ice crystal growth;

• study the physiological parameters governing the natural growth of ice crystals;

• pinpoint the chromosomal locus of the gene family and its protease progenitor gene;

• sketch its evolutionary history by calibrating the rate of notothenioid nuclear protein coding sequences; and

• focus on when these AFGPs develop during embryogenesis and early larval stages. (BO-005-M)

Use of a long-term database and molecular genetic techniques to examine the behavioral ecology and dynamics of a Weddell seal *(Leptonychotes weddellii)* population.
Donald B. Siniff, University of Minnesota-Twin Cities.

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 now enable scientists to examine the DNA of groups of seals, as well as individuals. This new lens provides insight into the seals' genetic histories, breeding systems and reproductive fitness. We know that breeding males behave characteristically; looking at this behavioral ecology and their mating systems through the lens of their DNA permits scientists to project backwards in time and correlate the seals' reproductive success with the effective size of their populations.

We are testing hypotheses, estimating parameters, and producing models and studies of population demographics by using and building on the long-term data set. We will also explore population dynamics by tracking immigration and emigration into and out of the group.

We are continuing with several collaborative efforts:

• In one, blood, scat and diet samples will be collected for researchers studying Weddell seal blood chemistry, health parameters, blood parasites, and diet.

• In another, small video cameras mounted on some of the seals will produce data for Japanese scientists studying diving and other underwater behaviors of free-ranging seals.

• And a remote camera surveillance will be set up to observe the spacing patterns of adult females, both on the ice and underwater.

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) in particular, as well as how marine mammals more generally, compete. (BO-009-O)

Hunting behavior and energetics of free-ranging Weddell seals.
Randall Davis and Markus Horning, Texas A&M.

Weddell seals *(Leptonychotes weddellii)* are the apex predators in the antarctic marine ecosystem, in large part because of behavioral and energetic adaptations that enable them to forage in the cold, dark antarctic fast-ice environment. Earlier work pioneered the use of an animal-borne video system/data logger to record the behavior, physiology, and locomotor performance of marine mammals at depth. For the first time, we witnessed seal hunting strategies, predator-prey interactions, and were able to make corresponding estimates of diving metabolism. Here we follow up on those results, and hope to provide insight into marine mammal foraging tactics and contribute to the fields of physiology (diving and energetics) and ecology (foraging theory and behavioral ecology).

By using isolated-ice-holes, we formerly preserved the seals' ability to choose the depth and duration of a dive, but left them no alternative but to return to a single place to breathe, thus limiting their range. We didn't permit them to haul out of the water or interact with other seals on the ice, and thus they may have been exposed to fewer prey than when foraging naturally. Now we want to remove those constraints and focus on the behavior and energetics of completely free-ranging seals. Although the "constrained" study demonstrated important new principles in Weddell seal foraging and has increased understanding of diving behavior and swimming performance, we believe that it is now essential to determine whether those principles apply to unconstrained animals.

To answer this question, we will test hypotheses related to general foraging strategy, foraging location, searching mode, prey detection, locomotor performance, the cost of diving, and foraging efficiency of free-ranging Weddell seals. In addition, we will examine locomotor performance and behavior during diving to estimate the costs associated with hunting, and the benefits gained from hunting (type and frequency of prey captures).

The study will continue to employ a multidisciplinary team of scientists with highly skilled technical support. The results will advance the understanding of the foraging ecology of Weddell seals and create a basis for similar research on other species of marine mammals that are more difficult to study in the open ocean. (BO-017-O)

The chemical ecology of shallow-water marine macroalgae and invertebrates on the Antarctic Peninsula.
James B. McClintock and Charles D. Amsler, U. of Alabama, Birmingham.

In a number of plant species, evolution has adapted the basic strategy of developing chemical substances designed to defend the organism. One general group of these substances are classified as defensive secondary metabolites. We plan to explore three "cost/benefit" ideas that are often woven into viable theories on the evolution of chemical defenses.

• The Resource Availability Model of chemical defense. The proposed research will examine whether macroalgae (grown under reduced light to limit carbon) will produce greater amounts of defensive compounds than will those grown in an optimal light environment. A related question is whether antarctic macroalgae found in the nutrient-rich peninsula region are likely to develop chemical defenses that include nitrogen compounds.

• The Optimal Defense Theory in macroalgae and invertebrates. The proposed research will determine how much chemical defenses are more abundant in tissues with a high energy content, such as reproductive tissue and offspring (larvae). A related question is whether larvae that rely on lecithin (for nutrition) use chemical defenses more than do larvae relying on plankton.

• What about habitat? How do chemical defenses vary across different areas? Using previous work in the Ross Sea as a starting point, we will seek out possible evolutionary factors that might subserve any variations we find.

The program should also advance our general understanding of the evolution of chemical defenses. We hope to elucidate the nature and role of bioactive agents in the specific ecology of antarctic marine benthos (that is, organisms living at the bottom of, or in very deep, marine environments). (BO-022-O)

Dynamics of predator-prey behavior in the Southern Ocean.
Richard Viet, City University of New York; College of Staten Island.

Seabirds foraging in the Antarctic necessarily respond to the abundance and locations of their prey, which is primarily krill (Euphausia superba). These planktonic, shrimp-like crustaceans are found in swarms in sea ice and elsewhere, provide the primary diet for whales and other species, and themselves dine on phytoplankton and algae. In Antarctica, the seabirds and krill collaborate on a spectacular and economically important ecosystem, especially in the Elephant Island region.

This project brings two groups of undergraduate students to the Antarctic to help with the collection of data on the abundance of seabirds and their foraging behavior. They will be tutored in mathematical modeling, to begin the process of making scientific sense of their observations, and will also acquire a broad collection of skills by collecting data on physical and biological oceanography.

We will study bird behavior near krill swarms and then compare it to behavior in areas with no krill. From such comparisons, we hope to build foraging models that predict the dispersion of birds under differing levels of krill abundance. The goal is to quantify the link between prey abundance and bird behavior - long-term, we hope to be able to predict the impact of future changes in krill stocks on seabirds.

The heuristic element of this project is twofold. First, the project will expose inner city college students, through their work on an oceanographic research vessel, to diverse research topics and methods, ranging from behavioral ecology to physical oceanography. Then, back at the College of Staten Island, they will apply basic mathematical reasoning and computer modeling to a real world problem of which they have hands-on experience - determining how foraging choices made by seabirds can ultimately impact their reproductive success. (BO-023-O)

Studies on the impact of sewage-associated microorganisms on indigenous seal and bacterial populations and drinking water quality at McMurdo Station.
John Lisle, Montana State University.

Human impacts on the environment are typically complex and often reverberate through a wide ecological spectrum. While a comparatively pristine environment, Antarctica is still a populated continent, with all of the inherent issues and challenges of environmental protection. For years, human sewage has been released into the seawater at McMurdo Station, untreated except for the process of maceration (which dilutes or softens a material by steeping it in liquid). What are the impacts on the marine ecosystem?

This project focuses on bacteria known to thrive in the sewage deposits, tracing their progress into the drinking-water intake at Intake Jetty, and also into other organisms and indigenous species, such as Weddell seals. One of the bacteria previously associated with this problem is Clostridium perfringens, which researchers have suspected were colonizing Weddell seals in the area of the sewage. These and other deposit-feeding invertebrates appear to assimilate the nutrients associated with the sewage and to increase body mass and organ sizes.

These earlier results are driving this work, which will use more advanced genetic molecular biology and more sensitive culture-based techniques to determine a number of issues:

• Are the sewage-associated bacteria and viruses the specific ones that are colonizing Weddell seals?

• Are these microorganisms exchanging their DNA with indigenous species, thus potentially altering the procaryotic gene pool of this ecosystem?

• Are they entering the drinking water system at McMurdo Station?

• The microbiological quality of marine and drinking waters at McMurdo Station is currently monitored, but are we underestimating the risks to the marine environment and to human health?

The results from this study should help in the evaluation of current monitoring systems and the design of remediation efforts. A sewage treatment plant is currently planned for McMurdo Station, and these data will provide a baseline for efforts and studies of ecosystem recovery. The data will shed light not only on the coastal waters off of McMurdo Station but also on other coastal waters around Antarctica that may be similarly affected by the discharge of untreated human sewage. (BO-024-O)

Temperature compensation in antarctic pteropods: An integrative approach.
Robert Dudley, University of Texas at Austin.

Life in frigid polar waters reveals many adaptations; creatures have developed physiologic specializations so as to function and react more effectively in the cold. The long-standing hypothesis holds that animal taxa indigenous to these climates evolved the ability to regulate basal and active metabolic rates better than their temperate-zone counterparts; but this theory remains contentious and - in any event - has been applied only to fish and benthic invertebrates.

Polar pteropods, small gastropod molluscs commonly found in antarctic zooplankton, are abundant, metabolically active, and provide a different species (another taxon) in which to probe thermal compensation mechanisms that may subserve the physiological processes underlying locomotion.

To explore these phenomena, we will use two different sister pteropod species, one from the polar and one from a temperate zone. Experiments will focus on basal and metabolic rates and mitochondrial energetics; also on biomechanical and on neural responses to different water temperatures and viscosities - all in the context of locomotor performance. The neurons that underlie the swim-system will be evaluated at different temperatures, with particular reference to resting potentials, firing thresholds, action potential durations and ion-channel kinetics. A central question is the extent to which all three aspects (metabolic, biomechanical and neural) may provide polar pteropods a coordinated ability to compensate for thermal conditions and extremes.

Not only should this investigation provide fundamental physiological and behavioral information for this taxon, but we hope to systematically evaluate the hypothesis of cold adaptation across organizational levels in pteropods. We may also be able to shed light more generally on the nature of thermal and locomotor constraints for the many invertebrate taxa living and moving within polar waters. (BO-030-O)

Factors regulating population size and colony distribution of Adélie penguins in the Ross Sea.
David G. Ainley, H.T. Harvey and Associates, California.

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 will investigate one such possibility - previously-documented changes in the region's climate. We will look at the birds' nesting habitat as a function of access to food and hope to distinguish the relative importance of the key resources that constrain the growth of colonies. A number of behavioral and demographic mechanisms may influence a colony's growth, relative to its initial size and distribution pattern. One good candidate is a phenomenon known as philopatry - how breeding effort and success relates to the balance achieved by immigration/emigration.

As the first empirical study to consider the geographic structuring of a seabird population, we expect our results to increase understanding of how populations regulate themselves, and the patterns they follow when they disperse. We also hope to elucidate the effects of climate change (as indicated by changes in the extent of 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, fluctuations in Adélie penguins have been analyzed as an indicator of such anthropogenic impacts on antarctic resources as fishery catches and disturbances created by tourism. But without the regional perspective on penguin life history this project is undertaking to develop, researchers will have difficulty trying to distinguish changes due to man from those caused by nature.

During the 2000-01 summer season, the arrival of iceberg C16 provided a natural experiment, which suggested insights into the competitive effects of one colony on its neighboring colonies. The iceberg blocked the very numerous Cape Crozier penguins from foraging as far west as they normally do; this allowed the smaller numbers of Cape Bird and Beaufort Island penguins to forage much farther east than normal.

C16 has remained through the winter, and we will continue to pursue this de facto experiment in competition for spatially limited food resources. Moreover, the very large iceberg B15A has since grounded in a way that may block the return of penguins to Cape Bird and Cape Royds in the 2001-2002 season. This may provide a second de facto natural experiment with insight into the processes that affect the tendency of young penguins to return to their birth place, and of adults to return to the colony where they formerly bred.

Landcare Research New Zealand (LCRNZ, independently funded) has collected data and tested new equipment during two preliminary field seasons. This project will build on their results, and they will collaborate with us throughout the lifetime of the project. (BO-031-O)

Investigations of abandoned penguin colonies in Antarctica.
Steven Emslie, University of North Carolina.

Climate change is assumed to be a pivotal factor in the success of many species. This project will investigate the history of Adélie penguins in late Holocene Antarctica. By locating and examining the fossil remains of former colonies, scientists hope to develop a model of when they thrived and when colonies were abandoned - and thus their success - relative to climate change. This model could inform current science on the relationship between climate and population dynamics.

Our study will integrate data from the ecological, geological and paleobiological records with satellite-imagery analyses. The climate factor will be inferred by data contemporaneous with the fossil evidence, in particular the extent of the sea ice and marine productivity. The population factor will be developed through field and laboratory investigations of abandoned colonies along coastal Antarctica.

Researchers will first collect surface and subsurface bones, feathers, and eggshell fragments preserved at these sites; later, in the lab, scientists can reconstruct the occupation history of each abandoned colony, through standard and radiocarbon analyses. Sediments from each site will be sifted to recover organic remains (such as squid beaks and fish otoliths) believed to be staples of the penguin diet. Statistical analysis of such indicators can trace the changing size of the colony at specific prehistoric times, and thus prey consumption becomes a proxy for population success. This timeline can then be matched to past episodes of climate change, which are well documented for the late Pleistocene and Holocene in ice-core and marine sediment records.

We expect these ancient responses by penguins to climate change (as indicated by the paleoecological record) to parallel those observed in Antarctica today, where regional warming has been documented over the past 20 to 50 years. Ultimately we will be able to test the hypothesis that Adélie penguins - for decades and centuries - have been responding to climate change in a predictable manner and that those responses can be anticipated, relative to fluctuations in sea-ice extent and marine productivity. (BO-034-O)

Investigations on deterioration in the historic huts of the Ross Sea region of Antarctica.
Robert A. Blanchette, University of Minnesota.

During the first two decades of the 20th century - Antarctica's "Heroic Era" - Europeans mounted a handful of expeditions in hopes of reaching (and claiming) the geographical South Pole. Base camps established in the McMurdo Sound region - by Scott at Cape Evans and by Shackleton at Cape Royds - were abandoned once the expeditions were over, leaving behind thousands of artifacts, as well as the huts they built for shelter and storage. Over the intervening 90 years, the extremes of the polar environment have actually protected some of the artifacts from rapid decay, but conservators have recently become concerned about serious degradation of what is an important historical, archaeological site.

Some of the most exigent threats:

• Wood in contact with the ground is being destroyed by a specific wood-destroying fungus. Various molds and cellulose-degrading fungi are attacking artifacts made of leather, textiles, and other organic materials.

• Exterior wood is being degraded by non-biological deterioration processes as well, including salt, ultraviolet radiation, and wind erosion.

• Chemical damage within the huts is apparent, and the soils on site are contaminated with aromatic hydrocarbons from petroleum products.

We plan to 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 to be used to control future deterioration, determine the extent of environmental pollutants in soils at the historic sites, and evaluate chemical spills within the huts. The goal is to provide the scientific data required by conservators to help protect these important historic sites for future generations. But the project should also shed scientific light on these unique deterioration processes, as well as augment scientific understanding of the biology of antarctic microorganisms and the biodiversity of microbes present in this unusual environment. (BO-038-O)

Penguin-krill-ice interactions: The impact of environmental variability on penguin demography.
Wayne Trivelpiece, NOAA Southwest Fisheries Science Center.

How well organisms thrive in their environment is often revealed by basic ecological relationships. For two decades at Admiralty Bay on King George Island in the Antarctic Peninsula region, data have been collected on several species of penguins, including the Adélie, gentoo and chinstrap. Looking at some of the basic aspects of the lives of these predators - such as survival and recruitment, population size and breeding success, and diets and foraging ecology - scientists have been able to develop and test key hypotheses about variability in the antarctic marine ecosystem.

This project focuses on one of these relationships. As the extent of sea-ice cover changes with the season and year-by-year, krill (a key food web species in the Southern Ocean that accounts for nearly 100 percent of the prey eaten by dominant predators such as baleen whales, seals, and penguins) are more or less abundant, which directly affects the population biology of the penguins. Years with heavy winter and extensive sea ice paradoxically favor krill recruitment, because larval krill find refuge and food in the sea-ice habitat. The long-term seabird research indicates that in those same, heavy sea-ice years, Adélie but not chinstrap penguins are also favored.

To explore these relationships, we will capture adult and juvenile penguins periodically to band, measure, and weigh them, and to collect blood and diet samples for genetic and physiologic studies. During the breeding season, the penguins and the sea ice will be observed by satellite. Another aspect of the population biology of penguins relates to the possible impact of commercial fishing, 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 that focuses on fisheries management. (BO-040-O)

Seasonal dynamics of giant agglutinated foraminifera.
Samuel Bowser, New York State Department of Health.

Found in all marine environments, foraminifera ("forams") are single-celled, shelled (agglutinated) creatures with a key role in the ocean food web. They may be planktonic - floating in the water - or benthic, living on shells, rock, seaweed, or in sand or mud at the bottom of the ocean. Their characteristic habitats, and the chemistry of their shells (which reflects qualities of the local water they live in) make them very useful to scientists as an indicator of when and under what conditions they lived. Antarctica and the Southern Ocean ecology is no exception.

Previous studies have shown that the forams assemblage in Explorers Cove in McMurdo Sound consume a wide variety of prey, ranging from bacteria through a taxonomically diverse group of metazoans, including juvenile invertebrates. These studies have been restricted to specimens collected from October through early December, immediately following the austral winter.

But in the succeeding months, the austral summer shows a burst of biological productivity, both under the ice and in the benthos. Lacking studies during this period, we do not know how the forams might be responding to this summer food pulse. We plan to document changes in relevant abiotic and biotic factors in the Explorers Cove benthos from austral spring to late summer and to characterize how the agglutinated foram community structure responds; looking at such indices as species composition, densities, size distribution, and others. To accomplish these analyses we will use sediment cores, underwater microscopy, molecular tools, isotope analysis of lipids, and some other newly refined methods.

We expect these combined approaches to elucidate the roles played by larger agglutinated forams in the Explorers Cove benthic food web, especially how these roles may change consequent to the summer food pulse. Further, the results of these studies should have wider significance in the ocean sciences because Explorers Cove and its agglutinated foram assemblage are comparable to many bathyal and abyssal deep-sea localities.

To enhance insight into marine processes associated with global climate change, we are also collaborating with investigators from Russia, to

• test the universality of meltwater turbidity impacts documented in the Arctic,

• assess changes (by adapting modern biochemical and molecular assays) in the living foraminiferal assemblage in response to glacial meltwater, and

• explore ways of revealing the imprint of glacial proximity in the antarctic fossil record. (BO-043-O)

Inter-annual variability in the antarctic-Ross Sea (IVARS): Nutrients and season production.
Walker Smith, Virginia Institute of Marine Sciences.

Oceanographers and other scientists - during the past few decades - have found significant variations in Southern Ocean biogeochemical processes from year to year. Some of the more significant of these inter-annual variations are ice extent and concentration, the composition of herbivore communities, and the distributions and reproductive success of bird and marine mammals.

Surprisingly - because it is so central to the food web - little is known about how phytoplankton production varies from year to year, or what role these variations may play. The production system in the Ross Sea consists predominantly of two major functional groups - diatoms and Phaeocystis antarctica, a colonial haptophyte. In this project, we will collect time-series data and assess the inter-annual variations of the production of phytoplankton in the southern Ross Sea, Antarctica.

The Ross Sea provides a unique setting for such an investigation, for a number of reasons. We can build upon a de facto time-series already ongoing in the Ross Sea because so many studies have been conducted there in the last decade. Also, it is established that there are fewer species there (relative to some other sites) and that seasonal production is as great as anywhere in the Antarctic. Most importantly, seasonal production of both the total phytoplankton community (as well as its two functional groups) can be estimated from late summer nutrient profiles.

Inter-annual variations in seasonal production (and of the two major taxa of producers) may be an important factor in the growth and survival of higher trophic levels within the Ross Sea food web. They also shed light on the natural variability of the suite of biogeochemical processes in the region. Having a scientific handle on that baseline of change is important, because of the scientific efforts to model how climate may change in the future. As climate changes, so certainly too will biology be profoundly affected, and to model and evaluate such change we need to place it in the context of "natural" inter-annual variability. (BO-047-O)

Facultative sex-ratio adjustment by female king penguins in response to mate quality.
Paul Nolan, Auburn University

Considerable evidence has accumulated suggesting that female birds may exert control over the sex ratio of their offspring. Under optimal conditions, more female chicks are produced; when poor environmental conditions prevail, more of the young are males. Several plausible explanations have been suggested for this:

• In some cases, young males disperse and so under stressful conditions do not compete with parents or siblings.

• In other instances where habitat conditions are favorable, mothers with new chicks are assisted by older female offspring, increasing reproductive success.

• In species that lay clutches with multiple eggs, there can be chicks of both sexes and self-assessment of parent condition may not be as crucial.

But what about other species, where only one or two eggs are laid during each breeding season, such as penguins? With a higher de facto investment in each egg, females who would apply this sex-ratio allocation strategy must be very capable of assessing the condition of both their habitat and that of their would-be mates. Penguins are dominant predators in their environment and shifts in a population parameter as fundamental as offspring sex ratio might reflect changes in climate or in distribution and abundance of food resources.

To determine if females are controlling the gender of chicks, we are focusing on the sex ratio of king penguin chicks in the context of the conditions of their parents. We plan to determine the sex of the chicks through DNA analyses of blood samples, a new method to be tested on king penguins in this project. Quantifying parental condition employs standard measures, such as body size, parasite load, and immunocompetence. We will also explore whether plumage coloration - as it is in other bird and fish species - might be an indicator of condition in penguins. Plumage color is from diet-derived carotenoids and may be a useful proxy for evaluating health and fitness.

The results of this work, which will be conducted in collaboration with scientists from the French Antarctic Program, should provide a better understanding of penguin population dynamics and the complex mechanisms of environmental biofeedback. (BO-068-O)

Phylogeny, reproductive mode, and parasitism in antarctic cidaroid sea urchins.
John Pearse, University of California, Santa Cruz.

Where did most antarctic biota originate? Forty million years ago, Antarctica separated from Australia and effectively isolated circumantarctic habitats. The isolation of antarctic biota from the rest of the world's oceans was nearly complete when Antarctica pulled away from South America 15 million years later; the Antarctic Circumpolar Current and the Polar Frontal zones developed to mitigate migration of most species.

The deep sea here does not follow the pattern, however, as it is continually replenished by cold, sinking antarctic bottomwater. Because many endemic antarctic species show apparent affinities to species in the deep sea, a sharp research question arises. Did deep-sea organisms invade and radiate into the antarctic benthos after it became isolated and cooled down, or did antarctic biota provide the source of deep-sea organisms?

To address this issue, we focus our research on cidaroid sea urchins, as part of an international antarctic deep-sea biodiversity program to be conducted on the German Antarctic program's research vessel *Polarstern.* The cruise will be conducted in the Scotia and Weddell Seas, and we hope to collect material from the antarctic shelf to the floor of the adjacent deep sea.

Phylogenetic analysis should help to resolve the origin of this group of organisms. We will also study larval development, which is unknown in some species. Finally, we will examine a fungus-like parasite that occurs on the spines of some species of antarctic cidaroids to place this parasite into a recognized higher taxonomic category and to set the context for understanding how it influences echinoid development. This project will provide new information on a understudied part of the world's ocean and should contribute to general work on the world's biodiversity. (BO-069-O)

Evolutionary loss of the heat-shock response in antarctic fishes.
Gretchen Hofmann, Arizona State University, Tempe.

Evolution has crafted a way for organisms to respond to the stress of abrupt environmental changes, in particular a sudden elevation of temperature. Commonly viewed as a "universal" characteristic of organisms, the heat-shock response (HSR) triggers previously inactive genes to synthesize one or more classes of molecular chaperones, known as heat-shock proteins (Hsps). But what about Antarctica, where such a sudden burst of heat is so unlikely? In previous studies on a cold-adapted, stenothermal antarctic teleost fish, *Trematomus bernacchii,* it was determined that this adaptational response has been lost over evolutionary time.

If evolution at subzero temperatures has indeed altered the gene expression patterns for molecular chaperones in antarctic fish, then the study of how cells respond to temperature at a molecular level may be a legitimate, new frontier in biology . At this stage, however,

though HSR - perhaps the quintessential example of the environmental regulation of gene expression - has been well-described at the cellular level, there is little information on how the response is actually regulated in ectothermic animals in a natural environment.

We hope to build upon that evolutionarily significant observation by examining this profound change in the environmental regulation of gene expression on two levels. First, we will try to establish how widespread the loss of the HSR might be in the suborder Notothenoioidei, including antarctic and non-antarctic members of the group. Second, we will try to determine the nature of the lesion in gene expression that accounts for the loss of the expression of stress-inducible genes in antarctic species. Both of these objectives will entail experiments on closely related, cold temperate species from New Zealand waters.

Ultimately, the lesions in the Hsp gene expression in antarctic notothenioids may serve to highlight aspects of the "cellular thermostat" and to provide key information about the actual molecular response mechanism triggered by environmental stress. The results should contribute to our knowledge of the environmental physiology and evolutionary biology of the antarctic notothenioid fishes, as well as enhance our understanding of the extreme stenothermality in these fish. (BO-134-O)

Diversity, vertical distribution, and metabolic activities of inorganic sulfur-cycling prokaryotes in Lake Fryxell, Antarctica.
Michael Madigan, Southern Illinois University.

Cold environments comprise more than 90 percent of Earth's biosphere. Our scientific knowledge is not proportional, however, for relatively little is known about the diversity, physiology, phylogeny, and metabolic activities of cold-loving (psychrophilic) microorganisms.

Focusing on bacteria involved in the process of cycling sulfur at 0ºC in the lakes of the McMurdo Dry Valleys, specifically Lake Fryxell, we hope to add to that store of knowledge. Though it contains significant levels of sulfide in the water column, Lake Fryxell is meromictic; that is, its waters do not fully circulate throughout the basin. The sulfide produced by sulfate-reducing bacteria works at distinct levels, fueling the autotrophic metabolisms of anoxygenic phototrophs and sulfur-oxidizing chemolithotrophs.

To dissect the microbiology and microbial ecology of sulfur cycling that occurs throughout the depths of Lake Fryxell, we will conduct in-situ biodiversity studies, isolation and laboratory cultures, and molecular analyses of metabolic activity. We are targeting three key metabolic genes in the process (pufM, csoS1 and dsr) and will focus the biodiversity studies on Proteobacteria.

We expect our results to

• reveal for the first time the biodiversity of sulfur-cycling prokaryotes active in an important nutrient cycle at permanently cold temperatures;

• make available new genetic resources (of psychrophilic phototrophs, sulfur chemolithotrophs, and sulfate-reducing bacteria) for basic research and for biotechnological exploitation; and

• reveal the most ecologically significant sulfur-cycling prokaryotes in Lake Fryxell and identify metabolically important organisms that remain to be cultured.

In addition to enhancing our understanding of the sulfur cycle in microbes - and the lowest temperature limits at which it can occur - this work also has implications for exobiology (the study of extraterrestrial life), suggesting how we might recognize and even cultivate microbial life beyond the planet. (BO-0174-O)

Gene expression in extreme environments: Extending mircoarray technology to understand life at its limits.
Alison Murray, Desert Research Institute.

One of the most difficult challenges facing scientists who study life in extreme environments is observing the organisms in situ, and then extrapolating those observations into descriptions that capture both the unique aspects of life and the adaptations required for survival. The antarctic marine psychrophiles (cold-loving organisms) provide an excellent model group of extreme microorganisms to study; very little is known about their biological and functional diversity or about the metabolic adaptations they have developed to live at -1.8ºC.

Such work may well have fairly direct practical benefits. DNA microarray technology can be applied to studies of life in extreme environments and may identify new genes for use in biotechnology. You begin by identifying specific adaptations to extreme environments and then try to detect genes that are uniquely expressed to subserve them. By discovering these genes in natural (though extreme) environments, we not only learn about their functions, but might obviate the need for having to cultivate them.

The details of this work entail

• sequencing six large bacterial genomic DNA fragments isolated directly from antarctic marine psychrophiles;

• constructing two different types of DNA microarrays designed to identify genes being actively expressed in uncultivated microorganisms living in the sub-zero marine waters of the Antarctic;

• optimizing specific aspects of microarray technology for use with environmental samples; and

• developing a transferable methodology that will be useful for other researchers in accessing gene expression information directly from the natural environment. (BO-179-O)

Diving biology of emperor penguins.
Paul J Ponganis, Scripps Institution of Oceanography.

Because the emperor penguin *(Aptenoidytes forsteri)* lives within the pack ice zone of the Antarctic, its advanced ability to dive has been a 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

recorded longest of 22 minutes was nowhere near that record depth. They provide an excellent model to investigate the physiology and behavior of diving birds and mammals - in this study specifically, thermoregulation, underwater behavior, and the homoeostatic regulation of myoglobin.

Working with emperors (captured from McMurdo Sound) in a man-made corral with dive holes, we hope to elucidate both the physiological and behavioral mechanisms underlying the breath-holding capacity of these diving birds. To probe how these physiological limits may affect the natural diving behavior and ecology of the penguins, we will focus on the role of decreased body temperature in extending the duration of aerobic metabolism during diving; also we will explore how organs and tissue tolerate oxygen deprivation. Mounting a small camera on some birds will permit us to examine their behavior during their dives. We are able to correlate changes in body temperature (in the body's core and in muscle) with which prey they ingest as well as with their wingstroke frequency.

At the molecular biology level, we will examine transcriptional control of the myoglobin gene to probe the high myoglobin concentration of emperors, as well as the large increases in myoglobin concentration during chick development. At the end of the study, all animals will be released at the ice's edge. (BO-197-O)

Antarctic killer whales.
Robert Pitman, National Oceanic and Atmospheric Administration.

Twenty years ago a new species of killer whale was described from Antarctica - smaller than the typical species found worldwide and with a different color pattern. During the course of previous work all around Antarctica, we have collected a couple dozen tissue samples from the typical form of killer whale but have yet to encounter the diminutive form, believed to be resident in the Ross Sea and around McMurdo. In this project, we plan to gather as many as 50 biopsy specimens from live, free-swimming killer whales and use molecular genetics to study killer whale systematics. The goal is to verify whether there are in fact two species of killer whales.

Working from a U.S. Coast Guard icebreaker in the Ross Sea area and enroute to McMurdo from Christchurch, we will use either a crossbow, or a specially modified .38 caliber rifle. With these we shoot darts that collect the tissue without harm to the animal and then float on the surface where they may be readily collected. (BO-289-O)

Planktonic invertebrate larvae and biogeography of Antarctica.
Rudolf Scheltema, Woods Hole Oceanographic Institution.

Because continental drift has isolated antarctic ecosystems since the Early Oligocene (about 40 million years ago), most invertebrate fauna commonly found there are native only to that region. Despite this extensive isolation, however, some benthic groups are comprised significantly (from 20 to more than 50 percent) of non-native species. To account for such species, scientists have proposed that intermittent reciprocal exchange must occur between populations resident on South America and Antarctica.

One hypothesis is that geographical distribution could be maintained and genetic exchange accomplished through the passive dispersal of planktonic larvae. We intend to target this hypothesis and hope to show that this dispersal actually occurs. To do so, we must demonstrate two facts:

• Larvae of sublittoral species actually can be found across the Drake Passage; further, that these do belong to species that can be found in South American and antarctic faunas.

• A hydrographic mechanism exists that can be used to explain how passive transport of larvae occurs between the two continents.

To address these two requirements, we will make transects of plankton samples across the Drake Passage and examine the possibility of cross-frontal exchange of larvae at the subantarctic and polar fronts of the Antarctic Circumpolar Current; we will also explore the possible transport of larvae in mesoscale rings. Our results should demonstrate that other species may be profitably examined using molecular techniques that compare individuals from bottom populations of both South America and Antarctica. (BO-281-O)

Origin and evolution of antarctic and deep-sea macroinfauna: Systematics and reproductive patterns of polychaetes.
James Blake, University of Massachusetts.

The International Antarctic Benthic Deep-Sea Biodiversity Program (ANDEEP) begins field work on the German research icebreaker Polarstern during the 2001-2002 austral summer. This larger project will conduct the first baseline survey of the deep-water (benthic) fauna found in the Weddell and South Scotia Seas, deeper than 1,000 meters. This relatively unexplored terrain is vital because it may contrast dramatically with what is known about the benthos of the Antarctic Shelf. The latter is fairly isolated, geographically and hydrologically, and has a richly described and interesting fauna; the former is a region scientists know much less about, though it is certain that its plate tectonic history has provided it with a rich and changing variety of habitats and environmental conditions over time and that it continues to maintain many connections with the surrounding Atlantic, Pacific, and Indian Oceans.

Our component of ANDEEP addresses the following themes:

• the origins of the deep-sea benthic fauna in relation to the antarctic shelf and links to the deep-sea faunas of the Atlantic and Pacific Oceans;

• development of hypotheses to explain high biodiversity in the deep sea;

• deep-sea benthic community structure in the Southern Ocean; and

• biological process, including reproduction and larval development of benthic invertebrates.

Our initial data will focus on seven polychaete families; we hope to enhance understanding of the origins and evolution of these families in the Southern Ocean. During two cruises, we will collect materials to map the spatial and bathymetric distributions of polychaete families while incorporating GIS mapping software. We will also examine the systematics of the selected polychaete families, and

observe larval and post-larval stages to understand the mode of larval dispersal for antarctic and deep-sea polychaetes. (BO-292-O)

Development of a classification scheme for species/habitat associations and biodiversity in antarctic benthic communities: Antarctic international collaboration.
Rikk Kvitek, California State University, Monterey Bay.

This project is a collaboration with investigators from the Italian Antarctic program's ENEA project, who hope to develop a species/habitat classification scheme for antarctic benthic communities near the shores of Terra Nova Bay. High-resolution acoustic remote sensing is a major tool for mapping seafloor communities just offshore of continental margins. It can produce a detailed and spatially accurate Geographic Information System (GIS) map of physical habitat diversity, and develop an appropriate scheme for classifying this diversity.

Italian biologists have developed video of Terra Nova Bay biotic communities with their georeferenced Remotely Operated Vehicle (ROV). The GIS map effort will attempt to relate spatial patterning of epifaunal biodiversity with variation in habitat types from 20-200 meters deep.

If successful, the approach and associated geophysical classification scheme would provide a cost-effective tool for the screening and initial assessment of marine areas proposed as Antarctic Specially Protected Areas (ASPAs). A byproduct of this work will be establishing a physical baseline map of the proposed ASPA at Terra Nova Bay - a crucial set of data in the ongoing effort to assess or monitor habitat change due to natural or anthropogenic disturbance. With such a framework in place, follow-up surveys could be done on an as-needed basis after specific episodes of concern or as part of a regular, acoustic mapping program to assess rates and changes characteristic to the area. (BO-320-O)

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LONG-TERM ECOLOGICAL RESEARCH

Ecology has taken its place among science's vital, strategic disciplines, thanks to ever-greater awareness of how the web of life and Earth's other dynamic processes constitute a closed and coherent system. As part of this evolution, NSF's Long-Term Ecological Research Program (LTER), begun in 1980, has grown into a network of 24 research sites, established to acquire long-term data sets from Alaska to Puerto Rico to Antarctica. Such a geographical spread is necessary to collect information on a variety of ecosystem types; such as, grassland, desert, forest, tundra, lake, stream, river, agricultural and coastal systems.

To enhance understanding of ecological phenomena, the program focuses on the role of cyclical/episodic events (ranging from years to decades to centuries) in the structure and function of these distinctive ecosystems. The Antarctic Biology and Medicine Program supports two of these LTER project sites to facilitate research on unique aspects of antarctic ecology; one near Palmer Station in the Antarctic Peninsula, and the other in the McMurdo Dry Valleys.

The Palmer Station/Antarctic Peninsula LTER program is ideally sited to probe a fundamental issue: As the pack ice varies (seasonally and year-to-year), what happens to the antarctic marine community; that is, how do ecological processes influence organisms at different trophic levels? The Palmer Station LTER research program was initiated during the 1991-1992 season with the installation of an automatic meteorological station, annual research cruises in the austral summer, and a focused research program at the station facility. During the austral fall and spring seasons, process-study research cruises develop data that can be compared to that collected from other coastal systems in the Antarctic Peninsula.

The McMurdo Dry Valleys LTER project is more wide-ranging - due to its unique site - and stages interdisciplinary study of aquatic and terrestrial ecosystems in a cold desert region of Antarctica. The area is one of the most fascinating and contrarian spots on Earth. In fact, it is as unearthly as any; NASA scientists wondering what conditions on Mars might be like came here - an island of rock in a sea of ice, the largest ice-free area in Antarctica - where winds howl, what little water there is dessicates or evaporates, and where the only creatures that can survive are microorganisms, mosses, lichens, and relatively few groups of invertebrates; higher forms of life are virtually non-existent.

Thus, LTER projects based here take advantage of perhaps the coldest and driest ecosystem on Earth, where life approaches its environmental limits; as such this may be seen as an "end-member" in the spectrum of environments included in the LTER network. Why is it necessary to conduct long-term ecological research in such a place? All ecosystems are dependent upon liquid water and are shaped to varying degrees by climate and material transport; but nowhere is this more apparent than in the McMurdo Dry Valleys. In very few of Earth's environments do minor changes in solar radiation and temperature so dramatically affect the capabilities of organisms to grow and reproduce as happens in the dry valleys. Thus, this site may well be an important, natural, regional-scale laboratory for studying the biological effects of climate changes attributable to human activity. While the antarctic ice sheets respond to climate change on the order of thousands of years, the glaciers, streams, and ice-covered lakes in the McMurdo Dry Valleys often experience nearly immediate (and sometimes profound) change. As such, this area would be one of the first where the effects of climate change in Antarctica should be observed.

The overall objectives of the McMurdo Dry Valleys LTER are to understand the influence of physical and biological constraints on the structure and function of dry valley ecosystems and to understand the modifying effects of material transport on these e cosystems. Though driven by the same basic processes found in all ecosystems (for example, microbial use and re-mineralization of nutrients) these dry valley ecosystems lack many of the confounding variables - such as diverse and fecund biota and many levels of plants and higher animals - indigenous to other ecosystem research.

Long-term ecological research on the antarctic marine ecosystem, an ice dominated environment: The Palmer LTER program.
Raymond Smith, University of California at Santa Barbara.

The Palmer Long-Term Ecological Research (LTER) project is focused on one major ecological issue: To what extent does the advance and retreat of sea ice each year physically determine spatial and temporal changes in the structure and function of the antarctic marine ecosystem? Evidence shows this dynamic variability of sea ice to have 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. Four hypotheses driving our research are that sea-ice is a major factor that regulates:

• 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 key species, as the magnitude and timing of sea-ice changes can have 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 krill (a primary food), which enhances the survivorship and reproductive success of Adélie penguins. 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 will link ecosystem processes to environmental variables and which will also simulate spatial/temporal ecosystem relationships; and

• 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, having both physical and biological consequences; these changes in turn can develop other loops and linkages that influence each other.

The participants for the 2001-2002 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 and Robin Ross, 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 role of natural legacy on ecosystem structure and function in a polar desert: The McMurdo Dry Valley LTER program.
W. Berry Lyons, Ohio State University.

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, providing vital water and nutrients that have a primary influence on the 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 soil to assess the role of physical constraints on the structure and function of the ecosystem. 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 was 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 a context to study biological processes and to explore material transport and migration. During the second phase of this LTER project, we are extending our research by continuing to investigate the McMurdo Dry Valleys as an "end-member" system, hoping 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/diversity, and biogeochemical processes - by continuing monitoring projects and long-term experiments.

Understanding the structure and function of the McMurdo Dry Valleys ecosystem requires deciphering the 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. We continue to focus on the integration of the biological processes within and among the lakes, streams and terrestrial ecosystems that comprise the McMurdo Dry Valley landscape. Our interdisciplinary research team will continue to use modeling and other integrative studies to synthesize data and to examine the McMurdo Dry Valleys ecosystem.

During the 2001-2002 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. (BM-042-D)
Peter T. Doran, University of Illinois at Chicago.

• Glacier mass balance, melt, and energy balance; climate monitoring in Taylor, Wright, Victoria, and Beacon valleys. (BM-042-F)
Andrew Fountain, Portland State University.

• Chemistry of streams, lakes, and glaciers. (BM-042-L)
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. (BM-042-M)
Diane McKnight, University of Colorado

• Lake pelagic and benthic productivity; microbial food webs. (BM-042-P)

John Priscu, Montana State University at Bozeman.

• The influence of environmental conditions on carbon and nitorgen 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. (BM-042-W)
Diana Wall, Colorado State University;
(BM-042-V)*Ross A.Virginia, Dartmouth College.*

Transport and fate of persistent organic pollutants (POPs) in antarctic coastal seas.
Hugh Ducklow, College of William and Mary.

Being distant and largely isolated from the industrialized world, the antarctic region is typically considered pristine. In the last two decades, however, concern about long-range atmospheric transport of persistent organic pollutants (POPs) has escalated throughout the global environment. POPs are highly stable organic compounds that persist in the environment, accumulate in the fatty tissues of most living organisms and are generally toxic to humans and wildlife. They come from pesticides, industrial and combusion processes.

But Antarctica is not just another place that could suffer the random, transboundary drifting of these noxious substances. Its polar location and unparalleled climatic characteristics raise unique issues of atmospheric transport, cold condensation, and deposition on sea ice. Because the climate changes so dramatically, sea ice comes and goes - covering as little as 4 million square kilometers (sq km) in February to as much as 20 million sq km in September. Vast webs of microbial life undergo seasonal production and decomposition. Antarctic food webs are thus vulnerable to those POPs that do migrate this far.

Cooperating with the Palmer Long-Term Ecological Research program (LTER) and sailing on their R/V Nathaniel B. Palmer winter cruise, we hope to document the accumulation of selected model POPs in sea-ice and the water column along the west Antarctic Peninsula. We also hope to add to the burgeoning global dataset on the biological/chemical processes that influence the rate of POP decline, turnover and residence time. (BP-045-O)

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SOUTHERN OCEAN GLOBAL OCEAN ECOSYSTEMS DYNAMICS (SO GLOBEC)

GLOBEC researchers prepare to collect blood samples from a crabeater seal on the sea ice in Marguerite Bay off the Antarctic Peninsula.
(NSF photo)

The goal of the U.S. Global Ocean Ecosystems Dynamics (U.S. GLOBEC) program is to understand and ultimately predict how populations of marine animal species respond to changes in climate, both natural and anthropogenic. Research in the Southern Ocean indicates a strong coupling between climatic processes - via the annual formation and destruction of sea ice - and ecosystem dynamics. As participants in the Southern Ocean GLOBEC program (SO GLOBEC), we will investigate the dynamic relationship between physical processes and ecosystem responses by identifying 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 how krill survive and become available to higher trophic levels (including penguins, seals, and whales). To accomplish this we 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

• 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 the 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 continue our 2-year field study in mid-March 2002 (the late austral fall). Working in the Antarctic Peninsula region until mid-August 2002, we will conduct five cruises aboard the two ships in and around Marguerite Bay. The results of the integrated SO GLOBEC program will improve our power to predict the fate and condition of living marine resources, especially with respect to local and global climatic shifts.

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, including current meters, sensors to measure salinity, temperature and 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. These data should quantify the spatial and temporal variability of the (presumed) clockwise flow of water masses through the bay, and help to 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 three major components:

• to collect, analyze, and archive Acoustic Doppler Current Profiler (ADCP) and Conductivity-Temperature-Depth (CTD) data - in order 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 to establish effective parameters for the vertical movement of heat, salt, and nutrients.

The results of our project will provide a unified data base, linking 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.

Collecting data on the small-scale temperature and salinity structure of the ocean's surface layer, we will study the effect of stratification and turbulence on the biochemical and biological processes under the winter sea ice. These modification processes work through mixing that is associated with shear instabilities of the internal wave field, double diffusion of salt and heat, and mixing driven by surface stress and convection. We will use two microstructure profilers to resolve 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. With repeated regional surveys for temperature, salinity, nutrients, and oxygen, we will define the water masses in the Marguerite Bay region. Also, data will be collected with a moored current-meter and temperature array, as well as by acoustic surveys of the upper ocean current structure. Through models, we will link water column and sea-ice processes with the biology of krill and its predators. Three types of models will be used to synthesize physical and biological models over the continental shelf - 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; Donald Perovich, U.S. Army's Cold Regions Research and Engineering Laboratory.

The optical properties of snow and sea ice evolve over the winter and vary greatly, both spectrally and spatially. These properties are important elements of the physical environment and 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 impact both predator and prey, influencing snow and ice algae, water-column productivity and visibility. They are also essential in satellite observations as proxy indicators of geophysical sea-ice parameters. To follow the temporal and spatial evolution of this snow and ice marine ecosystem, we will try to create improved quantitative models, deploying an array of instrumented ice beacons, augmented by periodic, ship-based and satellite observations and by 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 examined in conjunction with the marine biological and physical oceanography components.

Southern Ocean GLOBEC: Primary production in the water column.
Maria Vernet, Scripps Institution of Oceanography, University of California, San Diego.

Focusing on primary production in the water-column, 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 study krill shrinkage and mortality rates, and krill aggregation behavior. The results will be analyzed in coordination with components using other 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. The instruments in the package include an acoustic backscatter sonar system, a video plankton recorder and an environmental sensor system. We will use a remotely-operative vehicle 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 areas of sea ice that provide food of differing quality and quantity. In an effort to understand the overall age-specific dynamics of krill in winter, we will coordinate with krill study components focusing on adults in the water column.

Southern Ocean GLOBEC: Krill physiology, distribution, predation and fish ecology.
Jose Torres and Kendra Daly, University of South Florida.

This project will focus on krill physiology, using measures of respiration, excretion, and proximate analysis. We will conduct feeding experiments using various measurement techniques. Under-ice surveys and sample collection will provide information on krill abundance and distribution. Also, we will investigate the distribution and abundance of fishes and squid - krill predators - 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), and to establish markers for dietary history, we will apply new biochemical approaches based on lipids that are specific to different food resources. 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; William Fraser, Montana State University.

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

Southern Ocean GLOBEC: Foraging ecology of crabeater seals.
Daniel Costa and Daniel Crocker, University of California, Santa Cruz; 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. These data will be coordinated with other study 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 1 to 2 years. The deployment of a large-aperture, autonomous, hydrophone array in the antarctic will use passive acoustics as a tool to detect and count 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. The relative importance of the two as a function of scale, however, has not been investigated systemically. To accurately represent patchiness in a circumantarctic 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.

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OCEAN AND CLIMATE STUDIES

USAP's icebreaking research ship *Nathaniel B. Palmer* in the sea ice. *(NSF photo)*

Though it borders the world's major oceans, the Southern Ocean system is like no other in the world, with four times more water than the Gulf Stream, 400 times more than the Mississippi River. It is a sea where average temperatures don't reach 2°C in summer, where even the water itself is so distinctive that it can be identified thousands of miles away in currents that originated here. These Antarctic Bottom Waters provide the major source of cooling for the world's oceans. In fact, if the earth is a heat engine, Antarctica should be viewed as its circulatory cooling component.

The climate in Antarctica is also unique, linked as it is to the extreme conditions of the land and sea below the troposphere (the inner region of the atmosphere, up to between 11 and 16 kilometers). This ocean/atmosphere environment defines and constrains the marine biosphere, and in turn has a dynamic relationship with the global ocean and with weather all over the planet. Few major energy exchanges on Earth can be calculated without factoring in these essential antarctic phenomena. As such, they are both an indicator and a component of climate change.

The Ocean and Climate Studies program sponsors research that will improve understanding of the high-latitude ocean environment, including the global exchange of heat, salt, water, and trace elements; there is also an emphasis on sea-ice dynamics, as well as the dynamic behavior and atmospheric chemistry of the troposphere. Major program elements include:

• **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 sea water 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 map oceanic processes across a range of temporal and spatial scales.

• **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 the global exchange of heat, momentum, and trace constituents.

Abrupt climate change studies.
Martin Visbeck, Lamont-Doherty Earth Observatory.

High on the list of pressing issues for the science of climatology in the twenty-first century is deciphering rapid climate change. We know that human activities are changing the composition of the radiative active gases in the atmosphere - a basic component of Earth's climate system. But when you try to model the coupled climate system with its many inputs, you find unexpected phenomena strongly amplifying climatic perturbations and producing nonlinear responses. The science of chaos had its origins in meteorology.

Several processes in the high latitudes have been identified as possible causes of significant, or rapid, future climate change - deep convection in the southern oceans, which is coupled to the global ocean circulation; the waxing and waning of sea ice, with its impact on the planet's albedo; and changes of regime in coupled ocean/atmosphere phenomena.

Ongoing scientific observations can further our insight into the processes that are thought to play an important role, providing the data needed to develop, test, validate and surpass global climate models. Over time, this process of perfecting global climate models provides a better handle on how the overall system might respond. When maintained over a long time period, the data enable researchers to track

the state of the climate system and establish the baseline necessary for any predictions.

This project fits into that larger context by collecting a series of long-term observations to

• monitor the outflow of Weddell Sea Bottom and Deep Water, as well as other components acknowledged as sensitive indicators of climate change in the Southern Ocean;

• analyze the historical data sets and coupled climate models for ice/ocean/atmosphere interactions, with emphasis on ocean-heat transport variability; and

• investigate how antarctic deep-water forms and varies and its role in large-scale circulation models.

This austral summer we will work from the R/V *Nathaniel B. Palmer* to recover and redeploy 3 instrument moorings that were originally deployed during cruise 99-3 of the R/V *Laurence M. Gould* near the South Orkney Plateau. Time permitting, we hope to occupy CTD/tracer stations along the track between the current meter sites. The CTDs record current, temperature, and salinity variables within 500 meters of the ocean bottom. We will also obtain water samples for current/temperature/density profiles and tracer chemistry, both at the moorings and between sites.(OO-124-O)

Longwave radiation processes on the antarctic plateau.
Stephen G. Warren and Von P. Walden, University of Washington.

Thermal infrared ("longwave") radiation is an important component in the energy balance between the atmosphere and Earth's surface. On the antarctic continent, radiation processes dominate the surface energy budget. In summer, the budget involves four terms - incoming solar radiation, reflected solar radiation, long-wave radiation emitted by the atmosphere, and long-wave radiation emitted by the snow surface. In winter, after the sun sets, the short-wave terms fall to zero. The emitted long-wave radiation increases with temperature, so the surface temperature is determined by the balance of radiation fluxes.

Our project entails an experimental study of long-wave radiation processes near the surface at Amundsen-Scott South Pole Station. We have been taking high-resolution spectral measurements of the long-wave radiation at the snow surface. A Fourier-transform Interferometer installed in late 2000 operated for a full year, and at the beginning of the 2001-2002 austral summer, we will remove our instruments and collect the recorded data. Supporting observations were also made of how temperature and humidity vary with height in the lower atmosphere, and of the ice crystals in the atmospheric boundary layer. The research has also included experiments on emission characteristics - of snow, of ice crystals in the atmosphere, of clouds, and of greenhouse gases near the surface.

The newly developing climatology of cloud properties relies on the determination of concurrent environmental conditions (such as cloud-base altitude, temperature, and humidity-structure), and the sizes and concentrations of ice crystals. This work, based on more detailed radiation processes, should, improve climate models.(OO-201-O)

Antarctic Meteorological Research Center (AMRC), McMurdo Station.
Charles Stearns, University of Wisconsin.

The Antarctic Meteorological Research Center (AMRC), one of three research centers in the Crary Science and Engineering Center at McMurdo Station, is a resource for meteorological research as well as a test bed for improving operational synoptic forecasting. The Man-Computer Interactive Data Access System (McIDAS) - a versatile computer-based system developed by the University of Wisconsin for organizing, manipulating, and integrating environmental data - forms the basis of AMRC. It captures the flow of antarctic meteorological information from polar-orbiting satellites, automatic weather stations, operational station synoptic observations, and research project data. It also receives environmental data products, such as weather forecasts, from outside Antarctica, and acts as a repository for existing archived data bases.

The AMRC was established in the 1992-93 austral summer season and consisted of work stations capable of manipulating and displaying Advanced Very High Resolution Radiometer data, based on the existing satellite-imagery-acquisition system. This was followed by the acquisition and integration of a system that provided data collection, data display and archiving, scientific applications, network communications, and remote user access.

The system currently produces the Antarctic Composite Infrared Image (ACII), a mosaic of images from four geostationary and three polar-orbiting satellites, and is used for both forecasting and research purposes. We also continue to generate products and support users.(OO-202-O)

Atmospheric oxygen variability in relation to annual-to-decadal variations in terrestrial and marine ecosystems.
Ralph F. Keeling, Scripps Institution of Oceanography.

Oxygen, the most abundant element on the Earth, comprises about a fifth of the atmosphere. But much of the Earth's oxygen resides in other chemical species (in water, rocks, and minerals) and, of course, in flora and fauna that 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; our project includes a subset of sample collections being made at a series of baseline sites around the world.

These data should help to improve estimates of the processes whereby oxygen is cycled throughout the global ecosystem, specifically, through photosynthesis and atmospheric mixing rates; also improve predictions of the net exchange rates of carbon dioxide with biota, on land and in the oceans. An important part of the measurement program entails developing absolute standards for oxygen-in-air, to ensure stable long-term calibration. We are also 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 should help enhance our understanding of the processes that regulate the buildup of carbon dioxide in the atmosphere and of the change processes - especially climate change - that regulate ecological functions on land and in the sea.(OO-204-O)

Isotopic measurements of atmospheric molecular hydrogen (H_2).
Paul Quay and Richard Gammon, University of Washington

Molecular hydrogen (H_2) is the second most abundant reactive gas in the troposphere, where photochemical reactions form, and destroy, formaldehyde (HCHO). Consequent to these processes other chemicals are cycled - carbon monoxide (CO), methane (CH_4), and non-methane hydrocarbons. Despite its central role, the global H_2 budget is currently balanced only to within about 50 percent. Scientists talk of one day using H_2 as an important source of energy, yet such work would seem to depend on a better understanding of its global budget. We are measuring isotopes in order to investigate the atmospheric hydrogen (H_2) budget.

Deuterium (^2H) studies provide a good tracer for this work and can indicate the relative importance, to the formation of H_2, of the soil versus photochemical sinks. We are measuring the ratio of deuterium to hydrogen:

• in marine locations,

• in areas where biomass is being burned,

• in the H_2 produced by the photolysis of HCHO, and

• during soil uptake of H_2.

This work should help to resolve the current discrepancies in the global budget of H_2, and enhance understanding of the significance of increasing concentrations of CO, CH_4, and H_2 in the troposphere. (OO-221-O)

Measurements of the size, shape, scattering-phase function, and extinction coefficient of ice crystals at Amundsen-Scott South Pole Station.
R. Paul Lawson, SPEC, Inc., Boulder, Colorado.

Clouds are both the cause and result of atmospheric phenomena; one of their primary roles is as a reflector of solar energy - coming both from space and radiated/reflected from the Earth. And what are clouds? Broadly, clouds form when rising damp air expands to the point that it approaches saturation. With nowhere else to go, water molecules condense onto any local, available aerosol particles - the aggregation becomes a cloud. A number of theoretical and experimental studies have demonstrated that a cloud particle's size as well as its shape - and specifically ice crystals - strongly determine how it will reflect and radiate light (and energy).

Looking especially at cirrus clouds (the patchier, wispier filaments that appear in bands across the sky), this project will classify cloud particles by size and shape and will also investigate the light-scattering properties of ice crystals in the atmosphere above Amundsen-Scott South Pole Station. In cooperation with an ongoing radiation transfer program, we will deploy two high-resolution, digital cloud-particle imagers. The particle images, concentrations, and size distributions will be processed on site. Our software permits us to reject artifacts, and to compute various size and shape parameters, scattering characteristics, and ice/water proportions.

These data will complement several concurrent experiments on the emission characteristics of snow, ice crystals in the atmosphere, and greenhouse gases near the surface. With measurements of such environmental conditions as cloud-base altitude, temperature, and humidity structure, our data should allow us to develop new algorithms to substantially improve representations of radiation processes in general circulation models. We also expect to enhance the climatology of cloud-particles and cloud properties. (OO-226-O)

Chlorine- and bromine-containing trace gases in the antarctic.
Reinhold A. Rasmussen and M.A.K. Khalil, Oregon Graduate Institution of Science and Technology.

Although the Earth's climate is a massively complex system, at certain levels of the atmosphere interactions are predictable. Disregarding the ubiquitous and dynamic water vapor, more than 99.9 percent of atmospheric molecules are either nitrogen, oxygen, or the chemically inert "noble gases" (chiefly argon). Scientists have confirmed this baseline medium as largely unchanged for several hundred million years. However, much of the atmospheric "action" - acid rain, ozone depletion, smog - comes from the reactive trace species, which occur in small amounts but precipitate many crucial chemical events. There are thousands of these, but fewer than 200 are commonly present in a typical volume of air. It is not known for how long and in what proportions these have been prominent actors in atmospheric chemistry.

Chlorofluorocarbons, for example, are one problematic species, but a suite of other airborne trace constituents to be found in atmospheric gases derive 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 project continues to investigate seasonal trends in trace gas concentrations, by collecting a year-long suite of air samples at Palmer Station. They will be analyzed at the Oregon Graduate Center for a number of trace components, especially chlorine- and bromine-containing species. This work contributes to a better understanding of the buildup of trace constituents, particularly those of high-latitude marine origin. (OO-254-O)

South Pole monitoring for climate change. Amundsen-Scott South Pole Station.
Dr. David Hofmann, Climate Monitoring and Diagnostics Laboratory, National Oceanic and Atmospheric Administration; South Pole Station.

The National Oceanic and Atmospheric Administration has been conducting studies to determine and assess the long-term buildup of trace atmospheric constituents that influence climate change and the ozone layer. Time-series analyses of long-term data provide insight into several phenomena of particular interest. These include:

• seasonal and temporal variations in greenhouse gases,

• stratospheric ozone depletion,

• transantarctic transport and deposition,

• the interplay of the trace gases and aerosols with solar and terrestrial radiation fluxes that occur on the polar plateau, and

• the development of polar stratospheric clouds over Antarctica.

Project scientists measure carbon dioxide, methane, carbon monoxide, stable isotopic ratios of carbon dioxide and methane, aerosols, halocarbons, and other trace constituents. Flask samples are collected and returned for analysis, while concurrent *in situ* measurements are made of carbon dioxide, nitrous oxide, selected halocarbons, aerosols, solar and terrestrial radiation, water vapor, surface and stratospheric ozone, wind, pressure, air and snow temperatures and atmospheric moisture. Air samples at Palmer Station are also collected.

These measurements allow us to determine the rates at which concentrations of these atmospheric constituents change; they also point to likely sources, sinks, and budgets. We also collaborate with climate modelers and diagnosticians to explore how the rates of change of these parameters affect climate. (OO-257-O)

Drake Passage expendable bathythermograph program.
Janet Sprintall, Scripps Institution of Oceanography.

The Antarctic Circumpolar Current (ACC) is a powerful force that drives waters in the Southern Ocean - four times as fast as the Gulf Stream, for example. The current is even stronger wherever the distance between Antarctica and neighboring land is narrowed. These are the so-called chokepoints, such as The Drake Passage off the tip of South America and the sea regions between Antarctica and both the Cape of Good Hope and Tasmania. To determine the fluctuations in the transport of the ACC, scientists deploy bottom pressure gauges and similar instruments; this data can then be ranged against currents in the subtropical and subpolar gyres, and viewed in the context of the wind field over the southern oceans. Specifically since 1996, scientists in this research project have been collecting 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.

Using high-density expendable bathyermographs (XBT) launched from the R/V *Laurence M. Gould*, we will measure current, temperature, and depth for seasonal and year-to-year temperature fluctuations in the upper ocean within the Drake Passage. Since the water changes more rapidly there, we will execute frequent casts across the Subantarctic, Polar, and ACC fronts. (OO-260-O)

Collection of atmospheric air for the NOAA/CMDL worldwide flask sampling network, Palmer Station. *Dr. David Hofmann, Climate Monitoring and Diagnostics Laboratory, National Oceanic and Atmospheric Administration, Palmer Station.*

The National Oceanic and Atmospheric Administration has been conducting studies to assess the long-term buildup of trace atmospheric constituents that influence climate change and the ozone layer. Time-series analyses of long-term data provide insight into several phenomena of particular interest. These include:

• seasonal and temporal variations in greenhouse gases,

• stratospheric ozone depletion,

• transantarctic transport and deposition,

• the interplay of the trace gases and aerosols with solar and terrestrial radiation fluxes that occur on the polar plateau.

Personnel at Palmer Station will collect air samples to be analyzed for carbon dioxide, methane, carbon monoxide, stable isotopic ratios of carbon dioxide and methane. Flasks will also be collected for analysis of halocarbons, nitrous oxide, and other trace constituents.

These measurements allow us to determine the rates at which concentrations of these atmospheric constituents change; they also point to likely sources, sinks, and budgets. We also collaborate with climate modelers and diagnosticians to explore how the rates of change of these parameters affect climate. (00-264-0)

Operation of an aerosol sampling system at Palmer Station.
Colin G. Sanderson, Environmental Measurements Laboratory, U.S. Department of Energy.

Radionuclides are atoms emitting radioactive energy, some of which occur naturally in the surface air. It is these - as well as nuclear fallout and any accidental releases of radioactivity - that the Environmental Measurements Laboratory's (EML) Remote Atmospheric Measurements Program (RAMP) is designed to detect and monitor. Since 1963 EML, as part of the U.S. Department of Energy, has run the Global Sampling Network to monitor surface air. The RAMP system provides on-site analysis in thirteen different locations around the world, including Palmer Station, Antarctica. Using a high-volume aerosol sampler, a gamma-ray spectrometer, and a link to the National Oceanic and Atmospheric Administration's ARGOS satellite system, we will continue sampling air at Palmer Station for anthropogenic radionuclides. (00-275-0)

Antarctic automatic weather station program: 1998-2001.
Charles Stearns, University of Wisconsin at Madison.

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 and put to several uses, including operational weather forecasting, accumulation of climatological records, general research purposes, and specific support of the U.S. Antarctic Program - especially the LTER program at McMurdo and Palmer Stations. The AWS network has grown from a small-scale program in 1980 into a significant data retrieval system that is now extremely reliable, and has proven indispensable for both forecasting and research purposes. This project maintains and augments the AWS, as necessary. (OO-283-M) (OO-283-P) (OO-283-S)

Does iron fertilization lead to enhanced carbon sequestration?
Ken Buesseler, Woods Hole Oceanographic Institution.

While it is demonstrated that adding iron (which often migrates on wind-borne dust) can stimulate phytoplankton growth and alter biogeochemistry in the upper ocean, we know little about how iron affects sinking particle fluxes. Two questions present themselves:

• Did iron play an important role in past climatic variations in carbon dioxide (CO_2)?

• If ocean ecosystems were to be deliberately manipulated in the future - iron fertilization has been proposed to offset carbon dioxide emissions - what long-term impact would the iron have on CO_2?

To answer those we need to be able to quantify how iron loading affects export fluxes of carbon and associated elements. This project does just that, measuring changes in the export of particulate organic carbon and particulate organic nitrogen, using the naturally occurring radionuclide thorium-234 (^{234}Th) during the Southern Ocean Iron Experiment (SOFeX). Using time-series profiles of ^{234}Th obtained both within and beyond the SOFeX study area, we will study how iron loading and its impact on community structure affects the export response. We will also calculate how adding iron impacts both carbon and nutrient fluxes.

Information on the export response of the upper ocean to iron enrichment should provide valuable information necessary to address the two questions cited above. (00-288-0)

Measurement of combustion effluent carbonaceous aerosols in the McMurdo Dry Valleys.
Anthony D. Hansen, Magee Scientific Company.

Though Antarctica remains comparatively pristine, there is heightened awareness of the impact the human presence and scientific work being undertaken there could have. To continue a series of assessments of the long-term environmental impact of the U.S. Antarctic Program's operations, we plan to generate a database detailing the abundance of carbonaceous aerosols in the McMurdo Dry Valleys.

The Long-Term Ecological Research (LTER) study site in the McMurdo Dry Valleys supports a fragile, nutrient-limited ecosystem that could be significantly affected by human activities. Of special concern are deposits of particles from carbonaceous aerosols ("black carbon"). These could result from the exhaust of diesel power generators and helicopter operations within the McMurdo Dry Valleys; it is even possible that combustion products from McMurdo Station about 100 kilometers away could migrate to the study area. For three austral summers, we are deploying a real-time optical analyzer at the LTER site to measure the concentration of black carbon, polycyclic aromatic hydrocarbons, and other filterable organic compounds useful in fingerprinting combustion products. (OO-314-O)

Shipboard acoustic Doppler current profiling on *Nathaniel B. Palmer and Lawrence M. Gould.*
Teresa K Chereskin, Scripps Institution of Oceanography; Edward Firing, University of Hawaii.

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 technology (sound-wave transmission and reflection), this project is exploring upper ocean current velocities. We are building a quality-controlled data set in one such sparsely sampled and remote 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 USAP research ships *Nathaniel B. Palmer and Laurence M. Gould.*

Part of our long-term science goal is to characterize the temporal and spatial velocity structure in the Southern Ocean. This entails measuring the seasonal and annual changes in upper ocean currents within the Drake Passage and then combining this information with similar temperature observations, to see how the heat exchange varies and how it drives upper ocean currents. (OO-315-O)

Field experiments and modeling of the breakup of antarctic sea ice.
John P. Dempsey, Clarkson University.

The sea ice in Antarctica comes and goes with the seasons - from as little as 4 million square kilometers (sq km) in February to as much as 20 million sq km in September. For scientists this marks something of a moving target, and the internal dynamics of the ice pack could be much better described than they are at present. This project focuses on 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.

Researchers will conduct experiments on the deformation and fracture of sea ice in McMurdo Sound by applying a series of controlled stresses and observing their effects. A key effect is the initiation and growth of microcracks within the ice; large ice floes do not fracture in the same way as small ones do. Thus, for experiments to yield information that is valid for the larger scales that concern scientists, the test scales must be fairly large, some tens of meters. With these maneuvers we hope to gain detailed information on the microstructure of the ice (such as crystal structure, brine channels, and other flaws in the ice fabric) and establish a sound theoretical framework to guide experimental work and the generation of models.

In one component of this project, we are collaborating with the New Zealand Antarctic program; that effort 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. (OO-316-O)

Record of atmospheric photochemistry in firn at South Pole.
Roger Bales and Joseph R. McConnell, University of Arizona Desert Research Institute, University of Nevada.

Scientists are eager to develop models about Earth's history, based on their knowledge of current, active dynamic processes. 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 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.

Amundsen-Scott 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 context 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. The summer conditions will also permit us to sample two snow pits around the perimeter of the snow stake field intensively (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. (OO-324-O)

Particle export and remineralization in the Southern Ocean south of Australia: A Woods Hole Oceanographic Institute contribution to the Australian SAZ project.
Susumu Honjo, Woods Hole Oceanographic Institute.

Carbon dioxide (CO_2) - the single most abundant greenhouse gas - is a crucial variable in global atmospheric calculations and has been increasing a half percent a year for a decade. However, data for 200,000 years shows that CO_2 tracks with global temperature changes; and we have been in an historical period of global warming for over 25 years. Aside from the question of whether CO_2 spikes cause - or are caused by - the temperature shift, another basic issue concerns the extent of CO_2 that is anthropogenic (that is, from man-made, industrial sources).

This project is developing data to document whether intermediate depth water masses that are ventilated in the high southern latitudes can provide a temporary reservoir for anthropogenic CO_2. Shedding light on that question will help scientists understand the role of this region in the long-term trends - and the inter-annual variability - of atmospheric carbon-dioxide levels.

We will deploy and maintain a deep-sea sediment trap mooring in the Polar Frontal Zone south of Australia; this mooring complements a similar one in the Subantarctic Zone deployed by the Australian Antarctic Cooperative Research Center. We are using a radionuclide technique to evaluate the efficiency of the sediment traps and will develop data on the production of particulate matter, remineralization, and export.

Mesoscale, seasonal and inter-annual variability of surface-water carbon dioxide in the Drake Passage.
Taro Takahashi, Lamont-Doherty Earth Observatory, Columbia University.

The Southern Ocean provides an important component of the global carbon budget. Cold surface temperatures - with consequent low vertical stability, ice formation, and high winds - produce a very active environment where the atmospheric and oceanic reservoirs readily exchange gaseous carbon. The Drake Passage is the narrowest point through which the Antarctic Circumpolar Current and its associated fronts must pass; this so-called chokepoint provides the most efficient site to measure the latitudinal gradients of gas exchange.

Working from the R/V *Laurence M. Gould*, we will use equipment designed to measure both dissolved carbon dioxide (pCO_2) and occasional total carbon dioxide in the surface waters during transects of the Drake Passage. This work extends similar measurements made aboard R/V *Nathaniel B. Palmer*, and complements other data collected on surface temperatures and currents. These several data sets, supplemented by satellite imagery, will enable scientists to make estimates of the net production and carbon export by the biological community, as well as the basic targets - a quantitative description of the sources of pCO_2 variability and a calculation of CO_2 fluxes between the ocean and the atmosphere.

Natural iron fertilization of the Southern Ocean from melting sea ice.
P. Ross Edwards and John Donat, Old Dominion University.

Sea ice acts as a natural depository for wind-borne dust, which often carries iron into the ecosystem, thus spurring phytoplankton production. But there is currently no reliable information on the magnitude of this phenomenon in the upper layers of the Southern Ocean; despite the fact that simple flux calculations suggest this could be the dominant iron source, as much as three times greater than all other sources combined.

Taking advantage of an October 2001 cruise of the Australian icebreaker *Aurora Australis*, we will investigate the concentration of biologically active iron in the sea ice and its snow cover. Our objective is to evaluate both the concentration and the bioavailability of iron in the seasonal sea ice of the Southern Ocean south of Australia. Sample data - when combined with other sea-ice observations and sea-ice drift models - should greatly enhance our knowledge of antarctic iron biogeochemistry.

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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 with two important goals - to detect any unforeseen effects, and to verify the actual impact and scope of those effects that were anticipated.

The Protocol on Environmental Protection to the Antarctic Treaty also requires that environmental impacts be monitored. The U.S. Antarctic Program (USAP) is developing an Environmental Monitoring Program designed to detect and measure any impacts from science and operations at its research stations in Antarctica. Only with a sustained and coherent monitoring program can a reliable basis for sound environmental management decisions - and possible improvements - be established. Data obtained from the monitoring program will be used to document baseline conditions, verify operational impact, and monitor activities undertaken to recover from accidental impacts to the environment.

Spatial and temporal scales of human disturbance - McMurdo Station, Antarctica.
Mahlon Kennicutt, II, Texas A&M University.

Antarctica represents perhaps one of the most carefully-tended and strictly-monitored habitats on Earth. Aside from the manifest desire to protect the flora, fauna and the atmosphere of a relatively pristine environment, there is the 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 impacts that can be foreseen or detected.

This 3-year project is collecting a system of observations that should enable scientists 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;

• how efficiently this observational system documents relevant changes in important habitat characteristics; and

• the usefulness of various approaches to reference or control locations.

We will use 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. (EO-318-O)

GEOLOGY AND GEOPHYSICS

Karina Zavala, a Johns Hopkins graduate student, breaks up a sample of igneous rock from the Dry Valleys. Her group, led by Bruce Marsh, brought more than 1,000 pounds of rocks back to the states from Antarctica. *(NSF photo by Josh Landis)*

Antarctica is not only one of the world's seven continents, but also comprises most of one of its dozen major crustal plates, accounting for about nine percent of the Earth's continental (lithospheric) crust. Very little of this land is visible however, covered as it is by the vast East Antarctic Ice Sheet and the smaller West Antarctic Ice Sheet. The ice sheets average some 3 kilometers deep - a virtual vault, 90 percent of the ice on Earth is here. And it is heavy, depressing the crust beneath it some 600 meters (m). These physical characteristics, while not static, are current. Yet thanks to the sciences of geology and geophysics, powered by modern instruments and informed by the paradigm of plate tectonics/continental drift, Antarctica is also a time machine.

Geologists have found evidence that there was once a forested supercontinent in the Southern Hemisphere, which they call Gondwanaland. Before the Earth's constantly shifting plate movement began to break it up 150 million years ago, Antarctica was a core piece of this assembly; its adjoining land has since become Africa, Madagascar, India, Australia and South America. Though the Antarctic Plate has drifted south only about a centimeter each year, geologic time eventually yields cataclysmic results. The journey moved it into ever colder, high-latitude climates, at a rate of about 4°C for each million years; eventually life conditions had changed dramatically, and Antarctica arrived at a near polar position. This stounding story - written in a language of rock and fossils - is locked in and beneath the ice, the sea, and in the bedrock below both.

As the ice sheets developed, they assumed what has become a key role in modulating global climate, through their interaction with oceanic and atmospheric circulation. As a bonus, the South Pole also presents a strategic point to monitor the Earth's current seismic activity. Antarctica is the highest continent on Earth (about 2,150 m above sea level), with its fair share of mountains and volcanoes; thus many generic questions of interest to Earth scientists worldwide also apply to this region. Some specific issues focused on by the Geology and Geophysics program include:

• determining the tectonic evolution of Antarctica and its relationship to the evolution of the continents from Precambrian time (600 million years ago) to the present;

• determining Antarctica's crustal structure;

• determining how the dispersal of antarctic continental fragments may have affected the paleocirculation of the world oceans, the evolution of life, and the global climate (from prehistoric times to the present);

• 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 will be simplified as scientists improve their models of where, when, and how crustal plate movement wrought Antarctica and its surrounding ocean basins. The Geology and Geophysics program funds investigation into the relationships between the geological evolution of the antarctic plate and the life and processes that can be deduced to accompany it - paleocirculation of the world ocean, paleoclimate of the Earth, and the evolution of high-latitude biota. A current emphasis is the West Antarctic Ice Sheet Program (WAIS), research focused on the smaller of the continent's two ice sheets, conducted also under the aegis of the Glaciology program. Several important research support activities are also underway:

• **Meteorites:** In a partnership with NASA and the Smithsonian Institution, the program supports meteorite collection through the Antarctic Search for Meteorites (ANSMET) and chairs an interagency committee that is responsible for curating and distributing samples of the antarctic meteorites.

• **Mapping and geodesy:** In partnership with the U.S. Geological Survey (USGS), the program supports mapping and geodetic activities as an investment for future research in earth sciences. The U.S. Antarctic Resources Center (US-ARC) constitutes the USAP contribution to the Scientific Committee on Antarctic Research (SCAR) library system for earth sciences information; housed here is the largest collection of antarctic aerial photographs in the world, as well as many maps, satellite images, and a storehouse of geodetic information.

• **Marine sediment and geological drill cores:** In a partnership with the Antarctic Marine Geology Research Facilty at Florida State University, the program manages and disseminates marine sediment and geological drill cores mined in Antarctica. The collection includes an array of sediment cores as well as geological drill cores from the Dry Valley Drilling Project, the CIROS drilling program, and the Cape Roberts Drilling Project. The facility fills requests for samples from researchers worldwide, and also accommodates visiting researchers working on site.

Global positioning system measurement of isostatic rebound and tectonic deformation in Marie Byrd Land, West Antarctica.
Bruce Luyendyk, University of California at Santa Barbara.

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. Or, 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 - depending on its magnitude - it could 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.

For this study we have installed 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 4 years (beginning during the 2000-2001 austral summer) and operate in concert with GPS stations being installed in the Transantarctic Mountains in a separate project; the result will be a baseline array deployed 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 (mm) per year for horizontal, and 2 mm 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 is a joint project between the University of California at Santa Barbara scientists and a team at the Jet Propulsion Laboratory at the California Institute of Technology.(GF-121-O)

Antarctic Mapping and Geodesy.
Jerry L Mullins and Richard E Witmer, U.S. Geological Survey.

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 Research Program.

Year-round data acquisition, cataloging, and data dissemination activities will continue in the U.S. Antarctic Resource Center for geospatial information. 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 additional 1:50,000 scale topographic maps in the McMurdo Dry Valleys region. Such topographic studies provide a uniform base map on which to ensure that scientific information (from geology, glaciology, biology and other areas) is spatially accurate. These, as well as the 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.

Further, in the austral summer of 2001-2002, we will collaborate with the National Aeronautics and Space Administration Airborne Topographic Mapper Program to collect very high-resolution elevation data in portions of the McMurdo Dry Valleys and vicinity. The detailed land surface characterizations will be tested for feature recognition in the Beacon Valley, glacier studies in the Taylor Valley, and geologic applications in the Mt. Discovery area. The data will be tested for positional accuracy and resampled to provide regularly spaced observations for use in models and science. The USGS team will work with selected scientists to develop elevation data at resolutions that best serve their research needs. The data will then be used to develop elevation models at a variety of resolutions, as appropriate.

Very high-resolution data also will be collected for use by the ICESat research community to calibrate their 70-meter elevation data in Antarctica. The McMurdo Dry Valleys comprise a primary site for calibration and validation of NASA's ICESat satellite, scheduled for launch in December 2001. The primary sensor on ICESat is a laser altimeter, designed to measure the surface elevation very precisely, within the 70-meter footprint of the laser.

Because the altimeter will be operated with off-nadir pointing, it is equally important to calibrate for mounting angle as well as for range. A calibration site for such a sensor requires precise knowledge of local topography, which must be a stable, snow-free surface region with minimal vegetation. Angle calibration is also enhanced if you have variable surface slopes of moderately large amplitude (10-20 degrees).

With accurately measured surface elevations, the Dry Valleys provide a nearly ideal calibration site for ICESat. Furthermore, the Dry Valleys are in the region of the maximum altitude for the orbit of ICESat, allowing measurement errors to be detected through comparisons with measurements from other parts of the world. No other site in the world can provide this unique combination of features. (GO-052-L, GO-052-M, GO-052-P & GO-052-S)

Stability of land surfaces in the McMurdo Dry Valleys: Insights based on the dynamics of subsurface ice and sand-wedge polygons.
Bernard Hallet, University of Washington.

The dynamic nature of climate has received more public attention, as concerns grow about warming and the recent occurrence of seemingly extreme weather events. In this context, understanding the inherent variability of Earth's climate - how humans can and do affect Earth's environment - is becoming increasingly important. This project focuses on the landscape features and soils of Antarctica's dry valley region to provide a more complete understanding of past climatic and environmental conditions.

One important means of improving our understanding of the planetary climate system is to examine its past behavior, using the Earth as a natural laboratory. One of the most extreme changes in the climate system during the last few million years was the transition from a warm period in the Pliocene to an ice-age world. Scientists believe that during this interval relatively mild conditions in Antarctica gave way rapidly to intense glacial conditions, catalyzing the growth of what has become 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 help resolve 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 specimen may be the oldest ice on Earth; if so, it will provide strong evidence of long-term stability of the East Antarctic Ice Sheet, and may also afford a rare glimpse into 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 resulting disruptions of the soil. (GO-053-O)

ANSMET (the Antarctic Search for Meteorites).
Ralph Harvey, Case Western Reserve University.

Since 1976, ANSMET (the Antarctic Search for Meteorites program) 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.

• First, 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.

• Second, 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 the fierce katabatic winds, which can deflate the ice surface and expose 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, a spectacular concentration of meteorites can be unveiled.

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" about the composition of asteroids, planets, and other bodies of our solar system. ANSMET recovers samples from the asteroids, the Moon and Mars for a tiny fraction of the cost of returning samples directly from these bodies.

During the 2001-2002 field season, ANSMET's main field party will visit the Meteorite Hills region near the headwaters of the Darwin Glacier. Systematic searching at this site began last season, when 740 meteorite specimens were recovered. This season will extend systematic searches to regions visited only sporadically last year. Two members of this field party will visit the nearby Finger Ridges icefield to further explore that meteorite-find site, where 3 meteorites were recovered in 2000-2001. A second field party dedicated to high level reconnaissance may be deployed to several icefields immediately south of the Beardmore Glacier. (GO-058-O)

Tracking the West Antarctic rift flank.
Paul Fitzgerald and Suzanne L. Baldwin, Syracuse University.

Reconstructing the motion of the Earth's crustal plates throughout geologic time is rarely as simple as looking at a blueprint. Geological evidence often suggests conflicting narratives, and newly developing techniques often provide critical information to further resolve the puzzle. The timing and mechanisms for the formation of the rift system in West Antarctica and the Transantarctic Mountains is illustrative.

The western side of the West Antarctic rift system extends along the Transantarctic Mountains and then into West Antarctica, along the northwestern flank of the Ellsworth-Whitmore Mountains crustal block. However, the rift flank is expressed quite differently along the Transantarctic Mountains than it is in West Antarctica. When did the rift and its associated rift flank form?

Some scientists have suggested a significant component of uplift as responsible for much of the relief of the rift flank in the last few million years. However, fission track data from the Ellsworth-Whitmore Mountains crustal block indicates that although most of the erosion exposing the rock strata (denudation) occurred there in Late Jurassic/Early Cretaceous times, 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. We hope to shed some light on this controversy by determining the timing of uplift and denudation at key localities to allow us to determine the patterns of uplift and denudation along the West Antarctic rift shoulder.

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 plan to use thermochronologic techniques for this work, specifically apatite fission track thermochronology and 40Ar/39Ar thermochronology. All laboratory work will be undertaken at Syracuse University. Data that integrates both fission track and 40Ar/39Ar thermochronology should produce a better understanding of the geological evolution of the continent.

We know that the Transantarctic Mountains were largely created during the Cenozoic. But then why didn't a large rift-flank mountain range arise in West Antarctica? Most of the West Antarctica rift system is buried under floating ice shelves or the West Antarctic ice sheet and its history is poorly known. If we can specify the uplift and denudation history, as well as the tectonic evolution of the rift flank, we will be able to further constrain the history of the rift zone itself. (GO-059-O)

Evolution and biogeography of Late Cretaceous vertebrates from the James Ross Basin, Antarctic Peninsula.
Judd Case, St. Mary's College and James E. Martin, South Dakota School of Mines and Technology.

The study of evolution has always been driven by the surprising appearance of fossils and species in disparate areas of the world. An example is the James Ross Basin along the eastern Antarctic Peninsula region. Paleontologists have found fossils that paint a vivid picture of vertebrate biogeography (that is, dispersals and separations due to moving landmasses) from about 80 to about 65 million years ago. The Cape Lamb and Sandwich Bluff geological units of the Lopez de Bertodano Formation exhibit a mixture of marine and terrestrial deposits. From these sedimentary deposits, researchers have already recovered plesiosaur and mosasaur marine reptiles; plant-eating dinosaurs; a meat-eating dinosaur; and a variety of modern bird groups, including shorebirds, wading birds and lagoonal birds.

The Antarctic Peninsula and Patagonia represent the western-most portion of the Weddellian Paleobiogeographic Province, a region that extends from Patagonia through the Antarctic Peninsula and western Antarctica to Australia and New Zealand. Within this province lie the dispersal routes for interchanges of vertebrates among South America, Madagascar and India, and Australia.

As the result of previous work, we hypothesize that an isthmus between more northern South America and the antarctic craton served to bring typical North American terrestrial dinosaurs, such as hadrosaurs (duck-billed dinosaurs), and marsupials and marine reptiles swimming along the coast, to Antarctica in the Late Cretaceous. We also believe this region has served as the cradle for the evolution - if not the origin - of groups of modern birds and the evolution of a suite of typical southern hemisphere plants.

To confirm and expand upon these hypotheses, we plan to continue investigations into the latest Cretaceous deposits of this area; these studies in vertebrate paleontology will be conducted in collaboration with investigators from the Argentine Antarctic Institute (Instituto Antartico Argentino). During January 2002 and 2003, we will undertake fieldwork to recover new specimens to test biogeographic and evolutionary hypotheses concerning Late Cretaceous vertebrates in Gondwana, exploring the eastern slopes of Cape Lamb, Sandwich Bluff and False Island Point on Vega Island, and the Santa Marta Cove area of James Ross Island.

We expect this work to uncover important new insights about the evolution and geographic dispersal of several vertebrate species in particular; such results should also provide data important to understanding the development and evolution of life on Earth. (GO-061-O)

Global climate change and evolutionary ecology of antarctic mollusks in the Late Eocene.
Richard B. Aronson, Dauphin Island Sea Lab

The Eocene epoch ran from about 55 to 35 million years ago, when evidence suggests that global climate change had an important influence in Antarctica. Formerly cool-temperate conditions in the region began to shift to the polar climate that has persisted until now. As temperatures dropped, shallow-water, antarctic marine communities began to change, and these effects are still evident in the peculiar ecological relationships observed among species living in modern antarctic communities.

In particular this Late Eocene cooling reduced the abundance of fish and crabs, which in turn reduced skeleton-crushing predation on invertebrates. Thus dense populations of ophiuroids (brittlestars) and crinoids (sea lilies) began to appear in shallow-water settings. 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. Dense ophiuroid and crinoid populations remain common in shallow-water habitats in Antarctica today, but at temperate and tropical latitudes they have generally been eliminated by predators. The persistence in Antarctica of these populations is an important ecological legacy of climatic cooling in the Eocene.

For the antarctic ophiuroids and crinoids, the influence of declining predation is now well documented; but the effects of cooling on the more abundant mollusks have not been investigated. Our project will examine the evolutionary ecology of gastropods (snails) and bivalves (clams) in this same Late Eocene time frame. Based on the predicted responses of mollusks to declining temperature and changing levels of predation, we will test a series of hypotheses in the La Meseta Formation on Seymour Island. 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.

Since Seymour Island contains the only antarctic fossil outcrops readily accessible from this crucial period in Earth's history, such investigations provide a unique opportunity to learn how climate change may have affected antarctic marine communities. In practical terms, models suggest that global climate change - over the next few decades to centuries - is predicted to increase upwelling in some temperate coastal regions, which would lower water temperatures. Recent ecological evidence suggests this could lower predation in those areas. Our model of the La Meseta faunas' response to global cooling in the late Eocene should enhance understanding of the dynamic structure of modern benthic communities. (GO-065-O)

Dry valleys seismograph project.
Carl Mulcahy, U.S. Geological Survey; and Martin Dougherty, Science Applications International Corporation.

One recurrent issue in seismography is noise; that is, 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 that is 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 borehole seismometer [100 meters (m) deep] and a vertical short-period instrument at 30 m. 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 along 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, an Australian base. (GO-078-O)

Mount Erebus Volcano Observatory: Gas emissions and seismic studies.
Philip R. Kyle and Richard C. Aster, New Mexico Institute of Mining & Technology.

Mount Erebus on Ross Island is Antarctica's most active volcano; also the only one with a persistent 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 certain phenomena; especially how gas is given off by magma, and 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 alkalic 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 to the antarctic environment;

• understand the role of volcanism as a source of carbon-dioxide emissions to the atmosphere, especially for a highly alkalic 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. We also plan to expand development of the current software to register automatic and precise timing of when and where earthquakes occur.

Deformation studies to monitor the movement of magma inside the volcano will be made, using GPS campaign-style geodetic measurements, supplemented by an array of permanent continuous operating GPS stations. During the 2001-2002 field season, we will maintain and repair the equipment - a video camera, wind generators, permanent GPS stations, a broadband seismometer, environmental sensors and power supplies installed near the summit of Mount Erebus last year.

Field-based observations will include measuring emission rates of carbon dioxide, sulfur dioxide, radionuclides, trace gases, and metals. We will use these data to evaluate the potential impact of gas emission from Erebus on the snow chemistry of the East Antarctic Ice Sheet. To study volatile zoning in the magma chamber supplying the lava lake, we will also examine short-term variations in the emission rates of fluoride, chloride, sulfur dioxide, and metals. We plan to re-occupy a GPS network on the flanks and summit of the volcano to examine any deformation that may have occurred. Finally, we will install a continuously operating GPS station at Abbott Peak.

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 for 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. (GO-081-O)

A GPS network to determine crustal motions in the bedrock of the West Antarctic Ice Sheet: Phase I - Installation.
John Anderson, Rice University.

The system of continental shelves in Antarctica reflects a diverse glaciomarine geology. Scientists hypothesize that the glacial systems of the Antarctic Peninsula - having smaller ice masses, at a more northerly location - have been more responsive to climate change and sea-level rise than either the West Antarctic or East Antarctic Ice Sheets. Currently, some of the Antarctic Peninsula ice shelves are retreating as fast as 1 kilometer per year. But the key questions have by no means been settled - Why are these systems behaving so differently? And, are the changes due to recent atmospheric warming in the region, or are they simply the final phase of retreat since the last glacial maximum?

To contribute to this debate, we are testing a hypothesis - that the history of glacial retreat within the Antarctic Peninsula region has been differential and quite complex, with different glacial systems retreating at different rates and at different times. It would appear that this complex recessional history reflects the different sizes, as well as different climatic and physiographic settings, of the various glacial systems in the region. To address how these systems may have responded to sea-level and climate change during the Late Pleistocene to Holocene time interval, a better glacial history is needed.

We plan to acquire new marine geological and geophysical data from the continental shelf, building on an extensive seismic data set and hundreds of sediment cores collected along the Peninsula during cruises in the 1980s. We hope to establish when different glacial systems were grounded on the shelf, the extent of grounded ice, and the larger outlines of the history of glacial retreat. Key to this investigation is the acquisition of swath bathymetry, side-scan sonar, and very-high-resolution, sub-bottom (chirp) profiles from key drainage outlets.

These new data should provide the necessary geomorphologic and stratigraphic framework to reconstruct the Antarctic Peninsula glacial record. In such a paleohistorical context, models of future glacier and ice-sheet activity should be enhanced. (GO-083-O)

A GPS program to monitor motions in the bedrock of the West Antarctic Ice Sheet.
Ian Dalziel and Frederick Taylor, Institute of Geophysics, University of Texas; Robert Smalley, University of Memphis; and Michael G. Bevis, University of Hawaii.

The bedrock that underlies the West Antarctic Ice Sheet (WAIS) is not well described. Without a reliable evaluation of its history - both tectonic and ice-induced crustal motions - we will never be able to fully comprehend the past, present and future dynamics of the WAIS. Without that knowledge, we cannot develop reliable global change scenarios for the future, nor accurately factor the antarctic region into global plate movements. Currently, permanent Global Positioning System (GPS) networks to measure bedrock movement are established only on the fringe of the WAIS; they cannot provide the data on subglacial volcanism, active tectonics, and ice streaming that are needed.

This project is focused on establishing baseline, long-term, reliable geodetic measurements of the crustal motion in the bedrock beneath the WAIS. To obtain them, we will build a West Antarctica GPS Network (WAGN) of at least 15 GPS sites across the west antarctic interior - an area comparable to that from the Rocky Mountains to the Pacific coast - over 2 years beginning in the 2001-2002 austral summer.

This first summer, we will initiate the WAGN network and test precision and velocities at the most critical sites. The embryonic network will begin to fill a major gap in GPS coverage by looking for potential bedrock movements. If crustal motions are relatively slow, meaningful results will only begin to emerge over the next 5 years or so. Once it is permanently established, however, the network should yield increasingly meaningful results with the passage of time. Indeed, the slower the rates turn out to be, the more important it is to start measuring early.

WAIS bedrock is so scattered and remote that to erect a continuous string of permanent GPS stations would rival the building of the American transcontinental railroad. Instead, we plan to follow the Multi-modal Occupation Strategy (MOST). This entails "roving" receivers (based in permanent monuments set in solid rock outcrops) in place for only a short time at each site, providing data that can be ranged against permanent GPS readings elsewhere. Each of these "bases" can be converted in the future to a permanent, autonomous station when more logistics and satellite data linkage throughout West Antarctica are in place. When detectable motions occur, we can reoccupy the most critical sites, obtain more reliable velocities, and make decisions about reoccupying the entire network.

We expect the results of this project to establish important early indicators of crustal plate dynamics beneath the WAIS. As scientists take these into account in refining their models, future measurements and a time-series of the geodetic data should gradually produce a more constrained picture of WAIS subglacial dynamics; that is, plate rotations and both elastic and viscoelastic motions caused by deglaciation and ice-mass changes. (GO-087-O)

TAMSEIS: A broadband seismic experiment to investigate deep continental structure across the east-west antarctic boundary.
Douglas Wiens, Washington University.

Antarctica's outline shape looks generally like Australia, though half again as large; but beneath its enormous ice sheet lies evidence of its origin. East Antarctica has a bedrock continent-like foundation, while the ice sheet over West Antarctica - a third the area - in fact covers a series of "islands." West Antarctica shares a geologic history with the South American Andes Mountains, the result of plates colliding and subducting. East Antarctica is more like a large coherent chunk that broke free of the supercontinent Gondwanaland and drifted to a new position at the bottom of the world. The boundary between these two regions (with their disparate geologic pedigrees) is called the east-west antarctic boundary, and the crust and upper mantle here reveals many important and interesting distinctions, which tells the basic story of the tectonic development of Antarctica.

In November 2000 we began making seismic measurements - using three different arrays and a total of 44 seismic stations - all geared to evaluating geodynamic models of the evolution of Antarctica that rely on data about the crust and upper mantle. 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.

One basic question is, How were the Transantarctic Mountains formed? Though widely considered a classic example of rift-flank uplift, there is little consensus about the exact uplift mechanism. Many theories have been proposed, ranging from delayed phase changes to transform-flank uplift. All of these make various assumptions about upper mantle structure beneath and adjacent to the rift-side of the mountain front.

Another focus will be the structure of the east antarctic craton, the highest ice block in the world. Was this anomalous elevation a prime driver in the onset of glaciation there? More to the point, how did it arise? Proposed models include isostatic uplift from thickened crust, anomalously depleted upper mantle, and thermally modified upper mantle, as well as dynamic uplift. How far the old continental lithosphere extends 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 (formation).

When completed and analyzed, this comprehensive set of data and theory testing will enable new maps of the variation in crustal thickness, upper mantle structure, anisotropy, and mantle discontinuity topography across the boundary of East and West Antarctica, providing a much enhanced foundation for understanding the geodynamics of the antarctic. (GO-089-O)

Logistics support for global seismographic network stations at the Amundsen-Scott South Pole and Palmer stations.
Rhett Butler, Incorporated Research Institution for Seismology.

Seismology, perhaps as much as 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 not only fundamental for the study of the earthquakes, but also 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, IRIS (the Incorporated Research Institution for Seismology) 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 (NSF) and in cooperation with the U.S. Geological Survey) has developed and installed the Global Seismographic Network (GSN). The GSN now has about about 135 broadband, digital, high-dynamic-range, seismographic stations around the world, all with real-time communications.

The GSN seismic equipment at Amundsen-Scott South Pole Station and at Palmer Station, Antarctica, was installed jointly by IRIS and ISGS, who together continue to operate and maintain them. The GSN sites in Antarctica are vital to seismic studies of Antarctica and the Southern Hemisphere. The state-of-the-art seismic instrumentation is an intrinsic component of the NSF effort to advance seismology and Earth science globally. (GO-090-P and GO-090-S)

Development of a luminescence dating capability for antarctic glaciomarine sediments: Tests of signal zeroing in the Antarctic Peninsula.
Glenn Berger, Desert Research Institute, and Eugene Domack, Hamilton College.

Paleoclimatology - the study and reconstruction of ancient weather, climate and their likely effects - is not an exact science. Climatic indicators, such as marine sediments that have been abundantly deposited over the last 2 million years surrounding Antarctica, provide useful information about such phenomena as the waxing and waning of ice sheets - but only to the extent that these fossils can be accurately dated.

Traditionally, radiocarbon dating with the naturally occurring isotope 14C has proved reliable for specimens as old as 40,000 years, perhaps even up to 70,000 years, though problems such as the "reservoir effect" can also limit its reliability and range. However, increasing amounts of 14C in the atmosphere have compromised its precision. A more recently developed method, photon-stimulated-luminescence sediment dating (photonic dating) has been used in temperate latitudes for eolian and waterlain deposits and proved reliable over a larger span of Quarternary time - from decades to hundreds of thousands of years. The question has yet to be answered, however - can this method be reliably used in polar regions?

Marine sediments in and around Antarctica pose special difficulty because polar onditions can limit the sunlight that detrital grains are exposed to. Since the thermoluminescent test involves reflecting the last time a sample was exposed to light (what is known as the clock-zeroing process), antarctic glaciomarine depositional settings and processes could undermine the potential reliability of photonic dating of antarctic marine sediments, and ages could be overestimated if grains were not exposed to daylight before deposition. Other processes could also compromise photonic dating. For example, transport of terrigenous suspensions by neutrally buoyant "cold-tongue" (mid-water) plumes may be common around Antarctica, yet the effect of such transport on luminescence zeroing is unknown. Typical marine cores taken near Antarctica may contain an unknown fraction of detrital grains from cold-tongue and near-bottom suspensions.

In this project, we will collect detrital grains from a variety of "zero-age" (modern) marine depositional settings within the Antarctic Peninsula, where representative antarctic depositional processes have been documented and where logistics permit access.

By systematically studying the effectiveness of luminescence-clock-zeroing in antarctic glaciomarine settings we hope to determine whether photonic dating can be reliably applied to antarctic marine sediments in the future. In the process, we expect to develop refined sedimentological criteria for selecting future samples. If we can validate photonic-dating in this environment, scientists would gain a numeric geochronometer extending well beyond the age range of ^{14}C dating, and be better able to answer a number of broader questions about the timing and extent of past glaciations near and on the antarctic shelves. (GO-092-O)

Permian-Triassic basin history of southern Victoria Land and the Darwin Mountains.
John Isbell, University of Wisconsin.

The Earth is believed to have once consisted of a single land mass, a supercontinent called Pangea, composed of all the continental crust that now makes up the various continental and island surfaces. As tectonic forces began to break up the land mass about 150 million years ago, Gondwanaland was born (as was Laurasia); its southern portion would eventually become Antarctica. Before this split, around 250 million years ago, geologic features extended across what would become separate continents. One of the largest depositional basins was the "Gondwanide foredeep," more than 10,000 kilometers long, extending across the land that would become southern South America, South Africa, the Falkland Islands, Antarctica, and Australia.

Antarctica's central location in this ancient assemblage, between South Africa and Australia, make southern Victoria Land and the Darwin Mountains key areas for testing paleogeographic and paleoclimatic models. Such work will further 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.

Our project is a collaborative sedimentological, palynological, and paleomagnetic study of Permian and Lower Triassic strata in these areas. We will recover paleomagnetic signatures from Permian and Triassic petrified wood, silicified peat, and coal, which were cemented during early diagenesis (the process of undergoing chemical, bioilogical and physical change until metamorphism is reached). Paleopalynological analyses - the study of fossilized microscopic organisms - will provide time control for the succession.

We hope to be able to:

• determine a Late Paleozoic (as Gondwanaland drifted over the South Pole) glacial/deglaciation history for southern Victoria Land and the Darwin Mountains,

• document Permian strata to better understand the environments of high-latitude fluvial coal-bearing deposits,

• document Triassic lithofacies to better understand high-latitude conditions during the Early-to-Middle Triassic "coal gap" interval,

• provide a well-constrained stratigraphic framework for the Permian-to-Lower Triassic succession,

• test the diachronous and inversion tectonic models for the Panthalassan Margin of southwestern Pangea, and

• construct better paleogeographic models for Gondwanaland by obtaining new Gondwanaland reference poles for the Permian and Triassic. (GO-094-O)

Acquisition and operation of broadband seismograph equipment at Chilean bases in the Antarctic Peninsula region.
Douglas Wiens and Gideon P. Smith, Washington University.

The present-day tectonics and seismological structure of the Antarctic Peninsula and 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 the 1996-97 field season, broadband seismographs were installed at strategic locations; one on the tip of South America and three more in the South Shetland Islands and on the Antarctic Peninsula. In succeeding years, seven more were added to the network, which has yielded excellent data and some suggestive early results. As the project continues, cumulative data 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 (IRIS) 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. (GO-97-O)

Neogene-Quaternary volcanic alignments in the Transantarctic Mountains-Ross Sea region.
Terry J. Wilson, Ohio State University.

Plate tectonics has become the reigning paradigm to explain both the evolution and the current dynamics of the Earth. But in addition to the more dramatic movement of the Earth's crustal plates, the crust also contains buoyancy forces that contribute to basic calculations, and distinguishing between these and plate boundary forces is important. The "Antarctic Stress Map Project" (ASMAP) initially will obtain data on these forces from Neogene/Quaternary volcanic vent alignments within the Transantarctic Mountains and adjacent West Antarctic rift system in the Ross Sea region.

We will map the distribution, alignments, and morphologies of volcanic cones and other volcanic features using high-resolution satellite imagery (for example, SPOT and SAR) and aerial photographs. Field tests will assess any structural associations that we can find between 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 to define neotectonic stress states throughout this sector of Antarctica.

We will be able to analyze the stress regime in the context of other ongoing studies of contemporary tectonics and paleo-kinematics of the Transantarctic Mountains rift flank and adjacent rift system. This new stress field data, derived from the unique antarctic setting, will help to constrain the role of plate-boundary and crustal buoyancy forces in actively deforming intraplate regions. (GO-099-O)

Relative frequency and phase of extreme expansions of the antarctic ice sheets during the late Neogene.
Phillip Bart, Louisiana State University.

Expansions and contractions of the antarctic ice sheets (AISs) have undoubtedly had a profound influence on Earth's climate and global sea level. But the cryosphere in Antarctica is not a single homogenous entity. Science has yet to embrace its three primary components - the East Antarctic Ice Sheet (EAIS), the West Antarctic Ice Sheet (WAIS), and the Antarctic Peninsula Ice Cap (APIC) - into a unified theory. Among these systems may be found differences in ice volume, substratum elevation, ice-surface elevation, and latitude.

Various lines of evidence do show, however, that the extent of ice in all three ice sheets has undergone significant retreats and advances; future episodes appear inevitable. But exactly how and why the ice has fluctuated so is not certain. According to one line of reasoning, the land-based EAIS has been relatively stable, experiencing only minor fluctuations since forming in the middle Miocene; by contrast, the marine-based WAIS has been dynamic, waxing and waning frequently since the late Miocene. A conflicting hypothesis has the ice sheets advancing and retreating at about the same time.

Building on previous seismic-stratigraphic investigations of the continental shelves, we will use high-resolution seismic technology to focus on the frequency and phase of extreme advances of the ice sheets to the continental shelf. The data suggest a couple of useful scientific inquiries:

First, Did extreme advances of the EAIS and WAIS occur across the shelf occur at about the same times and frequencies? This evaluation is possible because the EAIS drains into the western Ross Sea continental shelf (Northern Basin), while the WAIS drains into the eastern Ross Sea (Eastern Basin). Existing regional grids of high-resolution seismic data have been collected, but these are incomplete and cannot be used to determine the stratigraphic correlations from the Northern Basin to the Eastern Basin. We plan to collect high-resolution seismic data (approximately 2,000 line-kilometers) to address this issue.

Second, Did the APIC advance frequently across the shelf? Some investigators have inferred that the APIC advanced across the continental shelf at least 30 times since the middle Miocene. If true, that activity would be an order of magnitude more frequent than advances of the EAIS and WAIS. Others interpret the seismic reflections differently and argue that the advances of the APIC were far fewer. The existing high-resolution seismic grids from the Antarctic Peninsula contain only one regional strike line on the outer continental shelf; we plan to collect high-resolution seismic data (approximately 1,000 line-kilometers) during a January 2002 cruise to the Antarctic Peninsula.

As part of this project, we are integrating our research into a graduate-level course at Louisiana State University and are also developing a pilot outreach program with a Baton Rouge public high school. Responding to scientific standards the Louisiana Department of Education has recently adopted to reflect what ninth through twelfth grade students should be able to do and learn, we are framing an experience to convey the excitement of conducting scientific research as a way to encourage them to pursue earth science at the university level. (GO-154-O)

Advanced Technology for radar sounding of polar ice.
David Morse, University of Texas, Austin

Since its inception in the late 1960's, radar sounding has distinguished itself as perhaps the single most important technique for glaciological work and constitutes a tool in the arsenal of sub-ice geological research. In the 1970s, the Technical University of Denmark (TUD) designed and constructed an ice-penetrating radar based on then state-of-the-art technology. This venerable system has collected the vast majority of all ice-sounding data from the ice sheets of Antarctica and Greenland. During the 1990s, an upgraded digital version of this same radar system (UT/TUD, developed by the University of Texas) was used for extensive ice-thickness-resolution surveys in both West and East Antarctica.

But terrestrial glaciology isn't the only beneficiary of advanced digital radar. Recent interest in the Martian paeleoenvironment and the recognition of possible ice-covered oceans on the Jovian satellites has stimulated research activity in sub-ice detection and characterization problems. One result has been the development of a prototype for an ice-penetrating radar that is a test-bed for sounding of planetary ice bodies. Developed by the Jet Propulsion Laboratory and constructed with the assistance of the University of Kansas, field tests indicate this new radar could help address fundamental questions at the forefront of glacio-geophysical research. Preliminary field tests, however, have revealed some limitations with the current prototype.

To achieve scientific progress on several problems at the forefront of glaciological and glacio-geophysical research, an improved system of radar ice sounding is needed. This project is focused on overcoming these shortcomings by merging components of the JPL/KU radar with the UT/TUD radar into a new "Multi-Institutional Radar Sounder" (MIRS). Targeted improvements are:

• improved ice-column penetration to detect the subglacial interface through thick and/or warm ice, as well as through highly heterogeneous ice;

• improved internal-layer spatial resolution and improved deep-layer detection; and

• the ability to characterize the subglacial interface and, specifically, to identify the presence of water.

We expect MIRS to:

• improve layer resolution and total system sensitivity through pulse compression (relative to the current UT/TUD radar);

• characterize the detected interfaces for material/roughness by preserving the complete shape (both magnitude and phase) of the echo waveform, even as it automatically calibrates the overall system sensitivity; and

• "see through" highly scattered ice - such as the crevassed regions near ice-stream margins or in valley glaciers - in a more powerful way.

We plan field tests that target a wide range of ice-sheet environments, including both hypothesized and established subglacial water bodies underlying the thickest portions of the East Antarctic Ice Sheet during a series of airborne radar surveys to be conducted in the 2001-2002 austral summer. We hope to verify system design and fully establish the capabilities of the MIRS. (GO-167-O)

A target for high-resolution Quaternary and older environmental change records: Site survey for drilling the Mackay Sea Valley, Western Ross Sea.
Ross Powell, Northern Illinois University

Paleoecology is an effort to reconstruct past environments - including the relationships of the biota that inhabited them - as

comprehensively as possible. Scientists have been able to develop fairly high-resolution records of environmental change during the last 1.6 million years (the Quarternary). These studies and models provide a rational basis for predicting the future, and distinguishing natural variability from human-induced changes. We hope to extend the database of high-resolution marine geological records of environmental change that have been established in Antarctica, addressing Quaternary and perhaps even older environmental changes.

We will begin with a detailed site survey of the Mackay Sea Valley (MSV), collecting information to locate the best drill sites, as well as data to help engineers evaluate the drilling and coring systems that will take later samples. MSV extends through Granite Harbor and out to the western Ross Sea, and was formed by erosion associated with early Cenozoic expansion of Mackay Glacier, a major outlet glacier of the East Antarctic Ice Sheet. The valley then began to accumulate sediments, the record of which extends back through the Quaternary and possibly into earlier Late Cenozoic times.

Coring sites in the MSV are excellent targets because:

• they possess the highest resolution record of Quaternary marine environmental change known in the Ross Sea sector, probably due to their great water depth and near shore location, as well as the polar climate;

• the sedimentation regime is one of the most intensely studied coastal settings in Antarctica;

• a preliminary geophysical site survey exists; and

• the sediments appear to have the potential for good chronological control (based on previous piston core work).

These characteristics should enable us to gather high-quality site survey information. This austral summer we hope to provide the data needed for a full assessment of the site's potential for high-resolution records of environmental change in the MSV. If the site yields quality data, we hope eventually to:

• extract a high-resolution (decades to centuries) scale of the Quaternary in the McMurdo Sound area, using multi-proxy techniques;

• correlate the marine-terrestrial data with geological and ice-core records both from local sites and elsewhere in Antarctica (for example, the Dry Valleys and Antarctic Peninsula Quaternary geological records, and the Taylor and Siple Dome ice core records);

• test antarctic variability, using records from the Northern Hemisphere to make cross-hemispheric comparisons;

• determine the age of MSV unconformity - which may well reflect glacial cutting within the MSV by the Mackay Glacier during past Quaternary expansion(s) - and provide constraints on Neogene erosion rates; and

• characterize older Quaternary and/or Neogene(?) sediment below the unconformity, which could potentially provide information on the Pliocene history of the area. (GO-170-O)

Antarctic network of unattended broadband integrated seismometers (ANUBIS).
Sridhar Anandakrishnan, University of Alabama.

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 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.

We have developed a passive seismic network of 11 long-term broadband seismic stations on the 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.

This year we will remove all of the stations and return the equipment to the United States. (GO-180-O)

Aeolian processes in the McMurdo Dry Valleys, Antarctica.
Nicholas Lancaster, Desert Research Institute.

The McMurdo Dry Valleys provide a unique natural laboratory where scientists can study some fundamental processes in nature. Geomorphology, for example, is the study of landforms and the processes that shape them; for example, particles (sand, dust, snow, etc.) blown by the wind across a characteristic terrain. Wind-shear-stress partitioning analysis can create models to predict how such wind-borne particles, en route to a surface, may be affected by intervening elements that possess a certain roughness - boulders, in the case of the McMurdo Dry Valleys. On-going studies of such regions (that is, sparsely vegetated to unvegetated rough surfaces) should provide models relevant to other arid areas on Earth and on Mars, as well as a range of rocky desert and sand sheet sites.

Using novel instrumentation (Irwin Sensors) that was recently developed and has been tested in field and laboratory wind tunnel experiments, we will conduct studies of boundary layer winds and surface shear stress at four to six locations. This work will contribute to the testing and improvement of existing theoretical models for shear-stress partitioning. We hope the research will lead to the development of an improved and universally applicable model for estimating sediment transport by wind on surfaces that are covered by varying densities of non-erodible roughness elements. (GO-183-O)

Ferrar basaltic tuff-breccias formed by direct eruption: Evaluating a Hypothesis.

David Elliot, Ohio State University.

Gondwanaland was one of the supercontinents, part of which was destined in Mesozoic times to break off and move to the geographic south pole as Antarctica. As the land mass broke up during a major magmatic event, voluminous basaltic magmas were erupted at the surface and intrusive sills and dikes were emplaced at depth within the underlying sedimentary sequence. The record of this process in Antarctica shows extrusive rocks that include thick tuff-breccias (coarse pyroclastic rocks), believed to have formed by subsurface explosive interaction of basaltic magma and water in aquifers. This clash of media with dramatically different temperatures is known as phreatomagmatic process.

In modern rift settings, volcanic fields are commonly found, where rising magmas interact explosively with water in aquifers or at the surface. The volcanic fields in parts of Antarctica, however, are unique. Compared to other well-documented examples, these basaltic pyroclastic rocks differ in terms of areal extent and thickness of deposits, depth of magma/water interaction, and dominance of basaltic tuff-breccia. We expect study of the paleovolcanology of these rocks to yield important new information on the origins and emplacement mechanisms of tuff-breccia deposits, as well as and on the evolution of volcanic fields in which tuff-breccias form a significant component.

To better describe the processes involved in forming these exceptionally thick tuff-breccias, we hope to:

• document the three-dimensional architecture of the basaltic pyroclastic rocks;

• establish the depth of magma/water interaction; evaluate aquifer recharge;

• establish the nature and extent of the volcanic field and its paleovolcanologic setting; and

• evaluate the hypothesis that these tuff-breccias are the result of direct eruption from volcanic vents.

Building on reconnaissance work, we expect the results of this study to have broad implications for understanding how phreatomagmatic processes form tuff-breccias, and the tectonic settings in which it occurs. Results are also expected to develop the paleovolcanologic setting of the Transantarctic Mountains during the Jurassic. (GO-290-O)

High precision GPS survey support.
Bjorn Johns, University NAVSTAR Consortium (UNAVCO).

UNAVCO provides year-round support for scientific applications of the Global Positioning System (GPS) to U.S. Antarctic Program, supported and managed by the National Science Foundation's Office of Polar Programs. 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, providing 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. (GO-295-O)

Chemical weathering in Taylor Valley streams: Sources, mechanisms, and global implications.
W. Berry Lyons, Ohio State University, and Brent McKee, Tulane University.

Geochemists study the process of "chemical weathering" - whereby rocks and minerals are transformed into new, fairly stable chemical combinations, primarily by such chemical reactions as oxidation, hydrolysis, ion exchange and solution. Silicate hydrolysis is another such process, which may have an impact on the global climate by consuming carbon dioxide (CO_2), an important greenhouse gas. Generally scientists have concentrated on more temperate climates to examine chemical weathering, because two of its most significant drivers are warmth and humidity.

However, recent data suggests that chemical weathering can and does occur in polar desert streams. At around 78°S, a number of ephemeral streams in Taylor Valley, Antarctica, that are associated with dry-based glaciers flow for 4 to 10 weeks each year. Solutes produced from chemical weathering such as major cations, minor elements (for example, rubidium, cesium, lithium, strontium, and barium), bicarbonate, and dissolved reactive silica, as well as isotopes ($^{87}Sr/^{86}Sr$) have been found here. Although the mechanism/process of weathering is unknown, we hypothesize that the high chemical weathering rates that have been computed derive either from the high coincidence of freezing/thawing cycles and/or the unusual hydrologic behavior of the hyporheic zone in these streams.

Building on the initial work of the McMurdo Dry Valleys Long Term Ecological Research team and others, we hope to better establish weathering rates and weathering mechanisms by examining the cryogenic processes whereby physical weathering may influence chemical weathering. To establish what materials are being weathered, we will analyze the suspended matter (in streams from the Lake Bonney basin in Taylor Valley and the Onyx Valley in Wright Valley) for their bulk chemistry and then compare these data to rock types in the valleys. To better ascertain solute sources, we will focus on uranium series geochemistry. Using major rock types from the Taylor and Wright valleys, we will also conduct laboratory experiments to establish how microfracturing from freeze-thaw cycles may affect chemical weathering.

All of the data will be used to draw analogies to historic weathering regimes on Earth during colder, drier, climatic eras.

Seismic and stratigraphic data acquisition and integration for Cenozoic tectonic and paleoenvironmental analysis in McMurdo Sound.
David Harwood, University of Nebraska, Lincoln.

Because it is perenially covered by ice, Antarctica presents a challenge to geologists looking back to Cenozoic times - strata of that age are accessible primarily through drill cores. To resolve the depositional context of the soil and to select the best potential drill sites, good seismic data are necessary.

Over the last 20 years of drilling experience, much has been learned through such projects as the Deep Sea Drilling Project (DSDP), Ocean Drilling Project (ODP) and via the fast-ice and on-land drilling of the Dry Valley Drilling Project (DVDP), McMurdo Sound Sediment and Tectonic Studies (MSSTS), Cenozoic Investigations of the Ross Sea (CIROS) and Cape Roberts Project drill holes. ANDRILL, the latest international drilling effort, has just begun.

This project includes a geological field team sponsored by Antarctica New Zealand (the New Zealand national antarctic program) and the Institute of Geophysical and Nuclear Sciences of New Zealand. The American component of the team will focus on the McMurdo Sound area, using drilling technology proven in the Cape Roberts Project. During the 2001-2002 austral summer, we will survey sites in the three ANDRILL target areas and collect new seismic information to address tectonic, basin history, and paleoenvironmental questions. Each country will be responsible for acquiring seismic data in specific target areas - United States in the New Harbor region, New Zealand at Windless Bight, and the United Kingdom on the southern end of the McMurdo Ice Shelf.

Beyond the requisite site survey work, the seismic data should help address questions regarding:

• the geometry of sedimentary sequences, which should provide insight on competing theories of the development of the Victoria Land Basin, as well the uplift history and possible causes of the adjacent Transantarctic Mountains;

• the contrasting stratigraphic history recorded in the Ferrar and Taylor valleys; and

• whether the McMurdo Dry Valleys landscape has experienced a stable cold, polar climate for the last 20 million years.

The new seismic information will also put existing drill core data into a broader stratigraphic framework. The spirit of international collaboration developed through the Cape Roberts Project and continuing with ANDRILL will result in scientific exchange during the follow-up studies of all three target areas. The 12 drill holes already established in the McMurdo Sound/Dry Valleys region, combined with new seismic data to be acquired (by this project, from research ships and from future drill holes) will make this region a nexus for correlating future chronostratigraphic data on the antarctic continental shelf.

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GLACIOLOGY

Johnathan Thom (in black) of the University of Wisconsin at Madison and Doug MacAyeal (in red) of the University of Chicago install on the large tabular iceberg B-15A a tower with instruments that will relay position, temperature, wind speed, pressure and humidity to a satellite. Scientists will be able to track the conditions on and around the iceberg as it makes its way through the waters of Antarctica. *(NSF photo by Josh Landis)*

Ice is the defining characteristic of Antarctica, indisputably. The entire continent (with a few exceptional areas such as the McMurdo Dry Valleys and some lakes and mountains) is covered by a "sheet" of ice that has been laid down over eons, if the term sheet can be used to describe a dynamic mass several thousand meters (m) thick, larger than most countries, rising over 2,000 m above sea level (peaking in an ice dome in the east nearly twice that high), and heavy enough to depress the bedrock beneath it some 600 m. Actually there are two sheets - the much larger East Antarctic Ice Sheet that covers the bedrock core of the continent and, beyond the Transantarctic Mountains, the smaller, marine-based West Antarctic Ice Sheet that overlays a group of islands and waters.

The Glaciology Program is concerned with the history and dynamics of the antarctic ice sheet; this includes research on near-surface snow and firn, floating glacier ice (ice shelves), glaciers, ice streams, and continental and marine ice sheets. These species of ice facilitate studies on ice dynamics, paleoenvironments (deduced from ice cores), numerical modeling, glacial geology, and remote sensing. Some current program objectives include:

• correlating antarctic climatic fluctuations (from ice core analysis) with data from arctic and lower-latitude ice cores;

• integrating the ice record with the terrestrial and marine records;

• investigating the physics of fast glacier flow with emphasis on processes at glacier beds;

• investigating ice-shelf stability; and

• identifying and quantifying the relationship between ice dynamics and climate change.

History and evolution of the West Antarctic Ice Sheet, Marie Byrd Land.
Charles F. Raymond, University of Washington.

The West Antarctic Ice Sheet (WAIS) has been an object of intense study for years, yet much remains to be specified about its evolution and dynamics - and therefore its possible futures. Almost certainly, those potential futures are vital to the Earth's global climate and its ocean systems. Because its base consists of a series of archipelagos, the WAIS is a marine ice sheet. The Siple Coast Ice Stream system is a principal dynamic process by which the ice sheet drains ultimately into the Ross Sea. This seaward movement runs primarily

through the Byrd subglacial trough, its flanks defined by the Ellsworth Mountains; such movement will usually leave behind tell-tale scars in the ice.

This project focuses on scar-like features in this region; some are well known, other margin scars are poorly constrained and need better dating, and still other as-yet unvisited scars require primary identification and exploration. 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 them more exactly within the region's known topography.

Our goal for these initial data is a better description of the recent history of the Siple Coast glaciers, and a more coherent account how they were configured. For this, we will use low-frequency radio-echo sounding (RES) and high-frequency ground-penetrating radar (GPR) profiles to image internal layers and measure the depths of buried crevasses or disrupted layering. These depths, seen in the context of accumulation rates determined from shallow ice cores, will provide "shutdown" ages for when the margin features ceased actively flowing; that is, times after which they could not have formed. The field data should allow us to develop simple ice-flow models - for the margins and inter-ice stream ridges - during active shearing and after shutdown. One primary output of such models would be closer estimates than we have at present of the initial elevation of a given scar, and the corresponding ice-stream elevation, at the time of shutdown. (II-163-O)

Ice dynamics, the flow law, and vertical strain at Siple Dome.
William Harrison, University of Alaska, Fairbanks.

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 dominates and must be quantified in order to calibrate dynamic models of ice flow. Our project - a collaboration between the Universities of Alaska, Washington, and California, San Diego - is measuring the vertical strain rate (as a function of depth) at two sites on Siple Dome, Antarctica. We hope to develop a better analysis of the ice core than was possible from recent coring sites in central Greenland.

We are in the final of four years, using two relatively new, high-resolution systems to measure the core in hot-water drilled holes. These data, coupled with a determination of the flow-law, are used 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; an improved model should emerge. This model will provide a context in which to interpret the ice core drilled at Siple Dome - both the thicknesses of the annual layers (as indicative of annual accumulation rates) and the borehole temperatures.(II-164-O)

High precision borehole temperature measurements at Siple Dome, Antarctica, for paleoclimate reconstruction and ice dynamics studies.
Edwin D. Waddington and Gary D. Clow, University of Washington.

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; also to improve estimates of the pore close-off ages in the past, which should in turn provide a more accurate 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.

In the austral summer of 2001-2002, we begin two other aspects of the project, in collaboration with the U.S. Geological Survey (USGS).

(1) Borehole fingerprinting - vertical strain, firn compaction, and firn depth-age scales. This 2-year project will develop a new method for measuring vertical strain rates in firn. Such measurements in the firn can help to:

• describe the dynamics of firn compaction (a key factor in determining ice age/gas age difference estimates for ice cores);

• determine ice advection for borehole paleothermometry models; and

• date the shallow sections of ice cores, where ambiguities in chemical dating or counting annual layers compromise traditional dating methods.

Borehole fingerprinting has the potential to improve measurements of vertical strain in firn holes. Preliminary work, using an improvised logging system at Siple Dome, showed a series of optically bright and dark zones as the tool was moved up or down the hole. We will use a video logging tool to create a unique "optical fingerprint" of variations in the optical properties of the firn (with depth), as well as to track the movement and deformation of the features of this fingerprint.

(2) High-resolution borehole paleothermometry. We are also developing and testing digital probes for high-precision temperature measurements in boreholes in polar ice sheets. These measurements are key to obtaining calibrated paleotemperature records in the

polar regions. The current state-of-the-art system is the USGS Polar Borehole Temperature Logging System (PBTS), which uses analog probe technology coupled with an electronic package at the ice sheet surface. Strong winds encountered in the field, however, can disturb the recording electronics. Probes that transmit digital signals up the cable would not be affected by these surface conditions and are more likely to provide quality data and improve the efficiency of field operations.

We are adapting a recently designed digital probe for use with the PBTS system in cold temperatures in ice-core drilling fluids. These probes streamline both the hardware and the procedures required for the current analog system. This austral summer, we will calibrate these new digital probes alongside the currently used sensors and test them at Siple Dome. We expect to describe this working borehole temperature-logging system in the *Journal of Glaciology*, gaining insight on the new digital probes, how the system compares to current technology, and the new research opportunities that digital probes can offer. (II-171-O)

Construction and operation of biospectrologger in a borehole in polar ice.
Buford Price, University of California, Berkley.

Microbes adapted to oligotrophic, low-temperature environments - lakes that lack plant nutrients and usually contain plentiful amounts of dissolved oxygen without marked stratification - are found in glacial ice, frigid lakes, in permafrost, and in cold, deep ocean water and sediments. Of these various sinks, polar ice contains the lowest concentrations of such microbes (from a few hundred to about 10^4 cells per cubic centimeter), which were probably transported by wind into the atmosphere, precipitated with snow, and compacted into ice. The great majority of these are dormant or dead.

Trying to cultivate microbes recovered from such ice cores is a hit-or-miss proposition, yielding colony-forming units in only a fraction (between about 10^{-4} to 10^{-2}) of dormant cells. Chemical, physical and biological models indicate that as many as 10^3 microbes per cubic centimeter are able to extract sufficient energy from acids (confined in narrow liquid veins in otherwise solid ice) to survive for a few thousand years or a smaller population for a correspondingly longer time. No search has yet been carried out for living bacteria in such liquid veins.

We plan to construct and operate a biospectrologger at Siple Dome, Antarctica, during the 2001-2002 field season as part of an ongoing borehole logging program at that site. Such an optical device has already been developed and tested for measuring dust in polar ice, but we will explore whether the same general principle can be expanded to study microbes and biomolocules - as a function of depth - in glacial ice. (IO-122-O)

Iceberg drift in the near-shelf environment, Ross Ice Shelf, Antarctica.
Douglas MacAyeal, University of Chicago.

Icebergs command a lot of attention. The Titanic disaster at sea illustrates only one important reason. Such a massive piece of glaciology on the move is a process that scientists would like to have better models for. One theoretical benefit entails harnessing the extraordinary freshwater volume of large tabular icebergs - possibly even harvesting it - as a natural resource of potential economic value, especially for water-poor regions of the earth. And though feasibility studies of towing icebergs to such areas in need have largely been dismissed as science fiction, it is tantalizing to realize that tabular icebergs commonly travel thousands of miles as a result of natural processes. Might a better understanding of the behavior and dynamics of icebergs one day lead to such a boon of human economic and social value?

The recent calving of an extraordinarily large iceberg (designated B-15) from the Ross Ice Shelf presents a unique opportunity to measure the processes - such as wind-driven and thermohaline currents, tides, sea ice, and winds - that control the drift of large tabular icebergs. Such an event rarely occurs within the logistical reach of the U.S. Antarctic Program, so this is an 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.

In this second year of our investigation, we plan to:

• deploy three geodetic-quality GPS receivers (provided by UNAVCO) on iceberg C-16 for about 7 weeks, at the vertices of an equilateral triangle (with one-kilometer legs) somewhere near the center of C-16.

• install 2 AWS/GPS tracking stations (that is, standard meteorological "towers" about 20 feet tall) at two of the three vertices of the equilateral triangle (referenced above) and to retrieve in late January geodetic-quality GPS receivers that were installed in December.

• try to locate iceberg B-15a, and service and upgrade three AWS/GPS tracking stations currently deployed there.

The data we expect from these instruments should constrain parameters that will improve the models of iceberg drift, as well as our ability to predict calving events and the subsequent iceberg drift trajectories. (IO-190-O)

Deglacial chronology of the northern Scott Coast from relative sea-level curves.
Brenda Hall, University of Maine.

A key unresolved question in antarctic glaciology concerns the stability of the marine-based West Antarctic Ice Sheet (WAIS). Marine-based means that (unlike the base of the East Antarctic Ice Sheet sitting on a lithospheric plate) the substratum for the WAIS is a series of archipelagoes, such that the sheet at its relatively fixed position is grounded on the continental shelf - in the northwestern Ross Sea Embayment off the northern Scott Coast - with plate boundaries nearby. As deglaciation began after the last glacial maximum (LGM), the WAIS eventually became unmoored. Scientists believe this was likely the first area of the shelf to become free of grounded ice. Learning how and when (and in what sequence) this has occurred in the past is a critical step for isolating the mechanisms (sea level, climate, ocean temperature, and internal dynamics) that control WAIS dynamics.

Thus the northern Scott Coast is of particular interest to researchers looking for mechanisms that may have triggered the key stages of deglaciation. But an important first step is to better constrain the age of structures where the inquiry is focused. The Barbados coral record suggests the initial retreat from the Ross Sea Embayment may have begun as early as 17,000 years ago. In contrast, recent glacial geologic mapping and relative sea-level work from the southern Scott Coast suggests that deglaciation here is more recent,

during the Holocene (the last 11,000 years), with southward grounding-line migration past Ross Island shortly before 6,500 years ago [carbon-14 (^{14}C) dating]. This chronology suggests that rising sea level could not have driven grounding-line retreat to the Siple Coast, because deglacial sea-level rise essentially would already have occurred by mid-Holocene.

To begin to resolve this conflict, one deficiency in the southern Scott Coast work might be corrected. Those data cannot differentiate among the possible triggering mechanisms because they come from 450 kilometers south of the LGM grounding-line position. We will try to overcome this by constructing relative sea-level curves on a transect along the northern Scott Coast. We hope to get the ages for this work from accelerator mass spectrometer ^{14}C dates of seal skins and shells within raised beaches. These curves should tell us when the grounded ice from the northwestern Ross Sea Embayment cut loose. (IO-196-M)

Characterizing the onset of ice stream flow: A ground geophysical field program.
Sridhar Anandakrishnan, University of Alabama.

Ice streams of the Ross Sea Embayment are the principle force by which the interior West Antarctic Ice Sheet (WAIS) is drained, moving vast quantities of ice rapidly to the front of the Ross Ice Shelf, where they are calved off as icebergs. These ice streams provide a buffer between the interior ice and the floating ice shelves. For antarctic ice streams on the Siple Coast, the transition from no-sliding (that is, all internal deformation) to motion dominated by sliding is defined as the "onset-region." To fully understand (and adequately model) the WAIS, we must have a better understanding of this onset region, which means learning the reasons for their fast flow and the factors controlling their current grounding-line, margin and head positions. The lateral margins of the ice streams are also a transition that needs better explanation.

Hypotheses on controls of the location of the onset region range from the "purely-glaciologic" to the "purely-geologic." Until the basal boundary conditions - roughness, wetness, till properties - are specified, and a good subglacial geologic map that shows the distribution, thickness, and properties of the sedimentary basins is drawn, ice sheet models will remain incomplete.

These parameters can be estimated from seismic, radar and other geophysical methods. We will study the transition region of ice stream D in detail with this coupled geophysical experiment. We will also select other locations on ice streams C & D to study, compare, and contrast conditions with the main site on ice stream D. Site-selection for the main camp will be based on existing radar, GPS and satellite data, as well as input from the modeling community. (IO-205-O)

Glacial history of Ridge AB.
Howard Conway, University of Washington.

Scientists do not fully understand a basic aspect of the stability of the West Antarctic Aice Sheet - how the configuration and activity of the drainage system is changing. Ridge AB provides a key area of study because:

• While previous studies of inter-stream ridges in West Antarctica have revealed much information about the history of the surrounding ice streams, there remains an "information-hole" in the southern sector of the ice sheet. We believe a targeted study of Ridge AB will reveal new information about recent changes in the configuration and activity of Ice Streams A and B.

• Geologic evidence from Reedy Glacier indicates that ice near Ridge AB was about 700 meters (m) thicker during the last glacial maximum. This helps constrain the magnitude of thinning that has occurred through the Holocene and opens the possibility of linking the history of the West Antarctic Ice Sheet to the geologic record in the Transantarctic Mountains.

We plan to first map spatial variations of internal layering, buried crevasses, surface velocity, and accumulation rate, using high- and low-frequency radar systems, GPS surveying methods, and short (20 m) firn cores. These diagnostic measurements will be put into ice-flow models to infer the glacial history of Ridge AB and the surrounding ice streams. The history will be interpreted in the context of the histories that are emerging from the other inter-ice stream ridges, as well as the geologic evidence from Reedy and other outlet glaciers in the Transantarctic Mountains. We hope these explorations will enhance scientific understanding of the evolution of the WAIS drainage system.(IO-210-O)

Deposition of HFC degradation product trifluoroacetate in antarctic snow and ice.
Joseph McConell, Desert Research Institute.

Pursuant to the 1987 Montreal Protocol and the 1995 Clean Air Act in the United States, the threat to global ozone posed by migration into the atmosphere of chlorofluorocarbons (CFC) has led to the release into the biosphere of some worrisome substitutes. One of these, trifluoroacetate (TFA), is a highly persistent, atmospheric degradation product of the halogenated ethane derivatives (HCFC, HFC).

As this class of chemicals is now in widespread industrial use, there is growing concern that TFA will accumulate in aquatic ecosystems. Extant data on the pre-industrial (background, or baseline) concentration of TFA in meteoric and surface waters, including antarctic ice, are ambiguous; thus the impact of anthropogenic TFA on these background concentrations is hard to specify. Ice core records, however, can provide a useful proxy for background and thus enable models to be developed for anthropogenic TFA deposition.

Our primary objective is to use ice cores and snow pits at South Pole to develop a record of TFA deposition for the last millenium, focused especially on the past 20 years. This pre-industrial to present record of TFA in near-surface snow and ice at South Pole and in West Antarctica will be unique. It should elucidate the origin, transport, and fate of this contaminant over Antarctica and - possibly - the globe. More generally, it enhances the context for assessing potential impacts on antarctic ecosystems from the natural and anthropogenic sources, by providing vital data on the regional and long-range movement, and the eventual fate, of contaminants. (IU-123-O)

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INTERNATIONAL TRANS-ANTARCTIC SCIENTIFIC EXPEDITION (ITASE)

From its original formulation in 1990, the International Trans-Antarctic Scientific Expedition (ITASE) has coordinated the efforts of scientists from several nations to collect and interpret a continent-wide array of environmental parameters. This cooperative endeavor is geared to produce an improved description and understanding of environmental change in Antarctica over approximately the last 200 years. These original ITASE scientific objectives have been adopted as key science initiatives by both the International Geosphere-Biosphere Program (IGBP) and the Scientific Committee on Antarctic Research (SCAR).

In 1996 an NSF workshop was held to develop a Science and Implementation Plan for the United States contribution to ITASE (called "U.S. ITASE"). Because of the long-standing U.S. research effort in West Antarctica, U.S. ITASE chose to focus its activities there. At the U.S. ITASE workshop, participants developed a multi-disciplinary research plan that integrates different approaches to environmental research. The primary scientific lenses through which West Antarctica is being examined are meteorology, remote sensing, ice coring, surface glaciology, and geophysics. The plan has four phases:

• In Phase 1 meteorological modeling and remote sensing was used to plan sampling strategies in support of U.S. ITASE's major objectives.

• Phase 2 initiates ground-based sampling over four study areas (corridors). Notwithstanding the broad spatial sampling of West Antarctica that was proposed, the logistic requirements for this sampling are modest and highly efficient.

• Phase 3 will continue ground-based sampling at a limited number of key sites where monitoring is required.

• Phase 4 follows through with data interpretation and modeling.

The United States component of ITASE (which has established a wide range of general scientific objectives) is trying to refine answers to the following questions:

• At what rate is the mass balance changing over West Antarctica?

• How do the major oceanic and atmospheric circulation systems(for example, ENSO) influence the moisture flux over West Antarctica?

• How and why does climate (that is, temperature, accumulation rate, atmospheric circulation) vary over West Antarctica on seasonal, inter-annual, decadal and centennial scales?

• What is the frequency, magnitude, and effect (local to global) of any extreme climate events recorded in West Antarctica?

• What is the impact of anthropogenic activity (for example, ozone depletion, science work, airborne pollutants) on the climate and atmospheric chemistry of West Antarctica?

• How much has biogeochemical cycling of sulfur, nitrogen and carbon, as recorded in West Antarctica, varied over approximately the last 200 years?

Radar studies of internal stratigraphy and bedrock topography along the U.S. ITASE traverse.
Robert W. Jacobel, Saint Olaf College.

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 immediate information (to those working in the field) on ice thickness and the structure of internal layers. 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 (m); it can detect near-surface crevasses. Our radar system is most sensitive at depths below 60 m and is able to depict deep bedrock and internal geological layers deep into the ice. (IU-133-O)

Science Management for U.S. ITASE.
Paul A. Mayewski and Mark S. Twickler, University of New Hampshire.

The Science Management Office (SMO) coordinates the effort developed for U.S. ITASE, the broad aim of which is to develop an understanding of the last 200 years of west antarctic climate and environmental change. ITASE is a multidisciplinary program integrating 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. They also establish and operate the logistics base that supports ground-based sampling in West Antarctica. (IU-153-A)

U.S. ITASE Glaciochemistry.
Paul A. Mayewski and Loren D. Meeker, University of New Hampshire.

Among the research targets for scientists in U.S. ITASE are the impact of anthropogenic activity on the climate and atmospheric chemistry of West Antarctica and the variations in biogeochemical cycling of sulfur and nitrogen compounds over the last 200 years.

Begun during the 1999-2000 austral summer, this 5-year project focuses on 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. These data can also 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. (IU-153-B)

Snow and firn microstructure and transport properties: U.S. ITASE.
Mary R. Albert and Robert E. Davis, U.S. Army's Cold Regions Research and Engineering Laboratory.

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; that is, how heat, vapor, and chemical species in air are incorporated into snow and firn. Since many of the snow and firn properties will also affect how radiation behaves across different parts of the electromagnetic spectrum, such field measurements provide a valuable baseline profile against which to range complementary efforts that use 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. ITASE traverses in West Antarctica. We provide field measurements of snow and firn properties near the surface (down to 2 meters), 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 same properties and for their microstructure. Ultimately, we will develop a transport model to elucidate the nature of the air/snow/firn exchange and the firnification process at the various sites along the U.S. ITASE traverse. (IU-155-O)

Hydrogen peroxide, formaldehyde, and sub-annual snow accumulation in West Antarctica: Participation in west antarctic traverse.
Roger C. Bales, University of Arizona.

Atmospheric photochemistry leaves valuable traces in snow, firn and ice; it has been verified that the efficiency of atmosphere-to-snow transfer, and the preservation of hydrogen peroxide and formaldehyde, are both strongly related to temperature and also 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. 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.The study of atmospheric chemistry requires good estimates of the inter-annual patterns of snow accumulation at sub-annual resolution in the pits and cores.

We will measure the concentration of seasonally dependent species (including hydrogen peroxide, nitrate and chloride) on all samples. Supplemented by stable isotope and ionic analyses done by others, these data will provide a highly resolved accumulation record. We will then use a recently developed, physically based, atmosphere-to-snow transfer model in order to elucidate the photochemistry that led to the concentrations in the snow/firn.

These snow chemistry data will also shed light on the interannual variability of snow accumulation over a wide area of West Antarctica. In addition, data we develop on current atmospheric levels of hydrogen peroxide, higher peroxides such as methylhydroperoxide, and formaldehyde will constrain model boundary conditions and the state of photochemistry in the austral summer. (IU-158-O)

Mass balance and accumulation rate along U.S. ITASE routes.
Gordon S. Hamilton, University of Maine.

The polar ice sheets - and the snow falling on them - are both 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 U.S. ITASE seeks to improve this understanding.

This 5-year project, which is beginning its third year, 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 compare the vertical velocity of ice (obtained from precise global positioning system surveys of markers buried 5-20 meters deep in the surface firn) with the local, long-term, average snow accumulation rate that has been derived from ice-core stratigraphy. Earlier work demonstrates that very precise rates of thickness change can be measured using this technique.

We are also studying spatial variations in accumulation rates, probing the link between snow accumulation and surface topography. Continuously operating, autonomous instruments will be deployed at several closely spaced sites that have very different slope gradients. The instruments will record snow accumulation, wind speed and direction, and firn compaction and temperature. These results will enable us to test hypotheses of 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 certain distance up-glacier, of the core site. Changes in surface topography along this flow line will lead to apparent accumulation rate variations in the ice-core record. By studying local ice dynamics (for example, horizontal velocities, surface slope) around each ice core site, we will be able to better understand why the accumulation rate varies in the core records. (IU-178-O)

The physical properties of the U.S. ITASE ice cores.
Debra Meese, U.S. Army Cold Regions Research and Engineering Laboratory.

Our objective is to examine, measure and analyze the visual stratigraphy, physical, and structural properties of the U.S. ITASE ice cores spanning the last 200 years of snow accumulation in Antarctica.

• First, visual stratigraphy; this will delineate the annual layer structure for dating purposes and determine (to as great a depth as possible) the accumulation variability over the full length of a stratigraphically dated core.

• Second, depth-density profiles; the rate of snow and firn densification depends on both the in-situ snow temperature and the rate at which the snow is deposited. These data will be used to derive average snow accumulation rates for those sites where annual layer structure is difficult to decipher, or where stratigraphic analysis fails altogether.

• Third, the 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 gap that exists in the mean annual temperature data between -31° and -50°C. Crystal size data can also be used (in conjunction with ice loads based on density profile measurements) to extract mean accumulation rates for those sites where stratigraphic dating of cores proves difficult or impossible to accomplish along the ITASE traverse routes; this is likely to occur at the sites where temperature is the lowest, and snow accumulates the least. (IU-193-O)

Stable-isotope studies at West Antarctic U.S. ITASE sites.
Eric Steig, University of Pennsylvania; James White and Christopher Shuman, University of Colorado-Boulder, Institute of Arctic and Alpine Research.

As participants in U.S. 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 on the calibration of the isotope/climate relationship on a site-by-site basis.

Our objectives are to

• obtain detailed oxygen-18, deuterium, deuterium-excess, and stratigraphic histories in snowpits at most or all of the U.S. ITASE coring sites;

• provide direct calibration of the isotope/climate relationship at each site, through a combination of direct (automatic weather stations) and indirect (passive microwave satellite) temperature measurements;

• obtain isotope profiles covering the last 200 years; and

• use the results to provide climate histories at high temporal and broad spatial resolution across West Antarctica for the past two centuries.

These climate histories should provide the context to test relationships that have been proposed among isotopes, moisture source conditions, synoptic scale climatology, and site-specific meteorological parameters. They will also enhance our ability to interpret isotope records from older and deeper antarctic ice cores. (IU-193-O)

High-resolution radar profiling of the snow and ice stratigraphy beneath the U.S. ITASE traverses, West Antarctic Ice Sheet.
Steven Arcone, U.S. Army Cold Regions Research and Engineering Laboratory

Ice core measurements provide historical profiles of snow accumulation and chemistry only at the point where the core was drilled, which - along the U.S. ITASE traverses - is every 100 kilometers (km). Subsurface radar, by contrast, provides reflection profiles of continuous horizons, generally related to density and chemistry contrasts; but their continuity strongly suggests that they are isochronal (that is, demonstrate regularity of period). 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 centimeters, and records reflections from a depth in firn of about 60 meters (m). During the first year of U.S. ITASE, we tracked some horizons for distances of more than 190 km and found depth variations as great as 22 m over a 5-km stretch. The variations are caused by surface topography, which affects local accumulation rates and ice movement.

We are also using a wide range of 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 develops spatially averaged, historical accumulation rates; these can be correlated with GPS data to find the effects of topography upon local accumulation rates. In addition, the radar is also being used for advanced crevasse detection. (IU-311-0)

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INFORMATION ON TELECOMMUNICATIONS EQUIPMENT AND SCHEDULES FOR THE YEAR 2001-2002

COUNTRY United States of America
STATION McMurdo
CALL SIGN NGD

ADDRESS FOR CORRESPONDENCE ON THIS INFORMATION:

OFFICE OF POLAR PROGRAMS
NATIONAL SCIENCE FOUNDATION
ARLINGTON, VA 22230

LATITUDE 77°55'S **LONGITUDE** 166°39'E

TRANSMITTERS				RECEIVERS				REMARKS
TYPE	FREQUENCY BANDS	TYPES OF TRANSMISSION AND POWER	FREQUENCY SELECTION (CRYSTAL VFO, etc.)	TYPE	FREQUENCY BANDS	TYPES OF RECEPTION AVAILABLE	FREQUENCY SELECTION (CRYSTAL VFO, etc.)	
AN/FRT-83	2-30 MHz	1K08F1B, 3K00J3E 1K24F1B, 100H0A1A 1KW	SYNTHESIZED					
CM-200VT CM-200UT	116-149.95 MHz 225-399.95 MHz	6K00A3E, 10W 6K00A3E, 10W	SYNTHESIZED SYNTHESIZED	CM-200VR CM-200UR	116-149.95 MHz 255-399.95 MHz	6K00A3E 6K00A3E	CRYSTAL CRYSTAL	
AN/LST-5C	225-399.995 MHz	30K0F3E/20W	SYNTHESIZED	AN/LST-5C	225-399.995 MHz	30K0F3E	SYNTHESIZED	
RT-100	2-30 MHz	100H0A1A, 3K00J3E 100W	SYNTHESIZED	RT-100	2-30 MHz	100H0A1A, 3K00J3E	SYNTHESIZED	
RT-7000	2-30 MHz	100H0A1A, 3K00J3E	SYNTHESIZED	RT-7000	2-30 MHz	100H0A1A,3K00J3E	SYNTHESIZED	
AN/PRC-1099	2-30 MHz	100H0A1A, 3K00J3E, 20W	SYNTHESIZED	AN/PRC-1099	2-30 MHz	100H0A1A, 3K00J3E	SYNTHESIZED	
AN/LST-5C	225-399.95 MHz	30K0F3E/20W	SYNTHESIZED	AN/LST-5C	225-399.995 MHz	30K0F3E	SYNTHESIZED	
SR-210	1.6-30 MHz	100H0A1A, 3K00J3E 150W	CRYSTAL	SR-210	1.6-30 MHz	100H0A1A, 3K00J3E	CRYSTAL	
DRAKE TR-7	2-30 MHz	100H0A1A, 3K00J3E	VFO	DRAKE TR-7	2-30 MHz	100H0A1A, 3K00J3E	VFO	
CUBIC T4150	1.6-30MHz	100H0A1A, 3K00J3E 1KW	SYNTHESIZED	CUBIC LCR2000	1.6-30 MHz	100H0A1A, 3K00J3E	SYNTHESIZED	
INMARSAT A TERMINAL	L BAND		VFO	INMARSAT A TERMINAL	L BAND			
NASA TDRSS EARTH STATION	KU BAND		SYNTHESIZED	NASA TDRSS	KU BAND		SYNTHESIZED	
USES INTELSAT EARTH STATION	C BAND		SYNTHESIZED	USES INTELSAT EARTH STATION	C BAND		SYNTHESIIZED	
NASA MGS	S, SKU BAND		SYNTHESIZED	NASA MGS	S, KU BAND		SYNTHESIZED	

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INFORMATION ON TELECOMMUNICATIONS EQUIPMENT AND SCHEDULES FOR THE YEAR 2000-2001

COUNRY United States of America
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ARLINGTON, VA 22230

LATITUDE 77°55'S **LONGITUDE** 166°39'E

ANTENNA		FACSIMILE		TELEPRINTER		REMARKS	
TYPE	AZIMUTH (IN DEGREES OR OMNI)	INDEX OF COOPERATION	DRUM SPEED	TYPE	SPEED (bauds)		LIST OF AVAILABLE FREQUENCIES
RHOMBIC RHOMBIC RHOMBIC	088T T 088T T 146T T	9165L/AE I of C N/A	120/240 (scans per minute vice rpm)	KPDT-3 (MOD-40)	75	US-14 ANTARCTIC BROADCAST/RATT WORKING	2650, 4872, 5810, 6397, 8092, 11004, 16321.5
RHOMBIC	220T T			KPDT-3 (MOD-40)	50-75	US-17 ITERNATIONAL ANTARCTIC COMMON	4771.5, 7996.5, 9007.5, 11554.5
7 CONICAL MONOPOLES	OMNI T	9271D/H/AE I of C N/A	120/240 RPM	KPDT-3 (MOD-40)	75	US-4 SHIP SHORE*	2026.4, 2717.4, 3248.4, 8298.4, 12345.4, 12357.4
ROSETTE ARRAY	DIRECTIONAL R					US-5 LONG RANGE AIR TO GROUND*	4719.5, 5727.5, 6709.5, 9034, 11257.5, 13252.5
END-FIRE ARRAY	088T T						
CONICAL MONOPOLE	OMNI T/R			KPDT-3 (MOD-40)	75	US-6 AIR TO GROUND WEATHER*	10641, 12222, 14700
						US-9 AIR TO SHIP*	3103.5, 5697.5
RHOMBIC	088T/146T/220T				75	US-15 ANTARCTIC SHIP TO SHORE*	4242, 8420, 12630
						US-16 ANTARCTIC BROADCAST/RATT WORKING*	2572, 4147.4, 6225.4, 6365.5, 7340, 7750, 8298.4, 8678, 9073, 11156, 12098, 12457, 133551.5, 14805, 16860, 16529.4
						AA-1 DISTRESS AND CALLING SAR*	2183.4, 3023.5, 4127, 8364
						USB-2*	2717.4

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LATITUDE 77°55'S **LONGITUDE** 166°39'E

ANTENNA		FACSIMILE		TELEPRINTER		REMARKS	
TYPE	AZIMUTH (IN DEGREES OR OMNI)	INDEX OF COOPERATION	DRUM SPEED	TYPE	SPEED (bauds)		LIST OF AVAILABLE FREQUENCIES
7 METER DISH	VARIABLE					BI TDRSS (NASA)	KU BAND
11 METER DISH	VARIABLE					BI USES	C BAND
2 METER DISH	VARIABLE					BI INMARSAT	L BAND
10 METER DISH	VARIABLE					MCMURDO NASA MGS	S,KU BAND
CONICAL MONOPOLE	OMNI DIRECTIONAL					BI HF RCV	1.6-30 MHz
LOG PERIODIC	146					BI HF RCV PALMER	1.6-30 MHz
RHOMBIC	88					BI HF RCV CHCH	1.6-30 MHz
RHOMBIC	266					BI HF RCV POLE	1.6-30 MHz

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ARLINGTON, VA 22230

LATITUDE 77°55'S **LONGITUDE** 166°39'E

	GMT		FREQUENCIES USED		CIRCUIT CONDUCT				REMARKS
STATION WORKED	OPEN	CLOSE	TRANSMITTING	RECEIVING	TYPE OF EMISSION (See ccir 432) (X)	TYPE OF TRAFFIC	SX OR DX	SIDE BAND	
SOUTH POLE	OCT-- ON MAR-- 2000-- DAILY SUN-	--NOV CALL --OCT --2130 LESS DAY	2650 5810 6397 8090 11004 4872	7340 - P&SP 7750 - P&SP 9073 - P&SP 13551.5 - P&SP	1.24F1	ALL SYNOPS HOURLIES (AS REQUIRED) TERMINAL	DX		
			11554.5 9032 13252.5	11554.5 9032 13252.5	3A3J 3A3J	VOICE VOICE	SX SX		
PALMER	SAME AS ABOVE		SAME AS ABOVE	SAME AS ABOVE	SAME AS ABOVE	SAME AS ABOVE	SAME AS ABOVE		
INMARSAT COASTAL EARTH STATION SANTA PAULA, CA	TIME OPEN 18 HR. PER DAY. START AND STOP CHANGES WITH PERCESSION OF SATELLITE.		1.636.-1.654 GHz	1.535-1.543 GHz		VOICE/DATA/ FACSIMILE			

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INFORMATION ON TELECOMMUNICATIONS EQUIPMENT AND SCHEDULES FOR THE YEAR 2001-2002

COUNTRY United States of America
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ARLINGTON, VA 22230

LATITUDE 90° S **LONGITUDE** ____

TRANSMITTERS				RECEIVERS				REMARKS
TYPE	FREQUENCY BANDS	TYPES OF TRANSMISSION AND POWER	FREQUENCY SELECTION (CRYSTAL VFO, etc.)	TYPE	FREQUENCY BANDS	TYPES OF RECEPTION AVAILABLE	FREQUENCY SELECTION (CRYSTAL VFO, etc.)	
MACKAY MSR 8000D	1.6-30 MHz 10 Channel	3K00J3E 6K00A3E 100HA1A 1KW	SYNTHESIZED	MACKAY MSR 8000	1.6-30 MHz	3K00J3E 6K00A3E 100HA1A	SYNTHESIZED	
ICOM 735	1.6-30 MHz 20 Channel	3K00J3E 6K00A3E 100HA1A 100W	SYNTHESIZED	ICOM R70 ICOM IC-735	0.1-30 MHz 0.1-30 MHz	3K00J3E 6K00A3E 100HA1A	VFO VFO	
Motorola Maxar Transceiver	135.5-149.3 MHz 4 Channel	16F3/20W	CRYSTAL	Motorola Maxar Transceiver	135.5-149.3 4 Channel	15K00FZD	CRYSTAL	ATS-3, not in use
REPCO Exciter	149.282	4F3/1W	CRYSTAL	Hamtronics	135.57 MHz	4F3	CRYSTAL	ATS-3
Kenwood TM-721 Transceiver with Mirage/KLM Amplifier	130-150 MHz 430-460 MHz	F3/300W	SYNTHESIZED	Kenwood TM-721 Kenwood R-5000	130-150 MHz 0.1-30 MHz	15K00F2D 3K00J3E 6K00A3A 100HA1A	SYNTHESIZED VFO	ATS-3
Kenwood TH25	140-150 MHz	F3 / 3W	SYNTHESIZED	Kenwood TH25	140-150 MHz	F3	SYNTHESIZED	
ABA Transmit.	1.5-5.26 Hz	90K00G2W/50W	SYNTHESIZED	ICOM-735	0-30 MHz	4F4, 6A3B, 6A9B		
Kenwood TH45	440-450 MHz	F3 / 3W	SYNTHESIZED	Kenwood TH45	440-450 MHz	F3	SYNTHESIZED	
RITRON	450 MHz	F3 / 7W	CRYSTAL	RITRON	450 MHz	F3	CRYSTAL	

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ANTENNA		FACSIMILE		TELEPRINTER		REMARKS	
TYPE	AZIMUTH (IN DEGREES OR OMNI)	INDEX OF COOPERATION	DRUM SPEED	TYPE	SPEED (bauds)		LIST OF AVAILABLE FREQUENCIES
RHOMBIC	167 T T/R					HF COMMUNICATIONS	0-30 MHz
RHOMBIC	167 T T/R					HF COMMUNICATIONS	0-30 MHz
SLOPING V	64 T T/R					HF COMMUNICATIONS	0-30 MHz
CONICAL MONOPOLE	OMNI R					ANTARCTIC BROADCAST	0-30 MHz
CONICAL MONOPOLE	OMNI T/R					HF COMMUNICATIONS	0-30 MHz
TRI BAND	STATES T/R					BACK UP HF	1.6-30 MHz
TRI BAND	STATES T/R					BACK UP HF	1.6-30 MHz
TRI BAND	STATES T/R					BACK UP HF	1.6-30 MHz
CIRCULAR POLAIZED YAGI	VARIABLE T/R					LES 9	L BAND
CIRCULAR POLARIZED YAGI	VARIABLE T/R					ATS-3	L BAND
4 METER DISSH	VARIABLE T/R					GOES3	C BAND
2 METER DISH	VARIABLE T/R					TDRSS	KU BAND

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INFORMATION ON TELECOMMUNICATIONS EQUIPMENT AND SCHEDULES FOR THE YEAR 2001-2002

COUNRY United States of America
STATION Amundsen-Scott South Pole
CALL SIGN NPX **LATITUDE** 60°S **LONGITUDE** _____

ADDRESS FOR CORRESPONDENCE ON THIS INFORMATION:

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	GMT		FREQUENCIES USED		CIRCUIT CONDUCT				REMARKS
STATION WORKED	OPEN	CLOSE	TRANSMITTING	RECEIVING	TYPE OF EMISSION (See ccir 432) (X)	TYPE OF TRAFFIC	SX OR DX	SIDE BAND	
MCMURDO	OCT – MAR 24 hrs. daily MAR – OCT Daily less local Sunday		7340 7750 9073 10235 13551.5 15564	2650 4872 (Alt.) 5810 (Alt.) 6397 (Alt.) 8090 11004 17361.5	3K00J3E	ALL TELETYPE TRAFFIC, 74.2 BAUD (75 BAUD) 100 WPM 850 Hz SHIFT			
MCMURDO PALMER	OCT – MAR 24 hrs. daily MAR – OCT Daily less local Sunday		4770.0 7995.0 9032 11553.0	4770.0 7995.0 9032 11553.0	3K00J3E	VOICE - INTERSTATION		USB SUPPRES -SED CARRIER	
MCMURDO PALMER	OCT – MAR 24 hrs. daily MAR – OCT as required		9032 13251.0 11255.0 4718.0 5826.0 6708.8	9032 13251.0 11255.0 4718.0 5826.0 6708.8	3K00J3E	VOICE - AIRCRAFT		USB SUPPRES -SED CARRIER	
MCMURO PALMER	AS REQUIRED		2182 8364 3023 121.5 MHz 243.0 MHz 282.8 MHz	2182 8364 3023 121.5 MHz 243.0 MHz 282.8 MHz	3K00J3E 3K00J3E 3K00J3E 3K00J3E 3K00J3E 3K00J3E	DISTRESS AND CALLING/SEARCH AND RESCUE		USB USB USB AM AM AM	
LOCAL AIR/GROUND	ON CALL ONLY OCT – FEB 15TH		360.2 MHZ 134.1 MHZ	360.2 MHz 134.1 MHz	6K00A3E	VOICE (APPROACH CONTROLS – GCA)			

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INFORMATION ON TELECOMMUNICATIONS EQUIPMENT AND SCHEDULES FOR THE YEAR 2001-2002

COUNTRY United States of America
STATION Palmer
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ADDRESS FOR CORRESPONDENCE ON THIS INFORMATION:

OFFICE OF POLAR PROGRAMS
NATIONAL SCIENCE FOUNDATION
ARLINGTON, VA 22230

LATITUDE 64°46'S **LONGITUDE** 64°05'W

TRANSMITTERS				RECEIVERS				REMARKS
TYPE	FREQUENCY BANDS	TYPES OF TRANSMISSION AND POWER	FREQUENCY SELECTION (CRYSTAL VFO, etc.)	TYPE	FREQUENCY BANDS	TYPES OF RECEPTION AVAILABLE	FREQUENCY SELECTION (CRYSTAL VFO, etc.)	
GX23205 STANDARD MARINE	156-162 MHz 55 CHANNEL	16K0F3E/25W	SYNTHESIZED	STANDARD MARINE	156-162 MHz 55 CHANNEL	16K0F3E	SYNTHESIZED	MONITOR Ch16 & 27
SUNAIR LINEAR AMP GSL-1900A	1.6-30 MHz	3K00J3E/1 KW		SUNAIR GSB-900DX TRANSCEIVER	1.6-3.0 MHz	3K00J3E 3K00J1D	SYNTHESIZED	AX.25
SUNAIR GSB-900DX TRANSCEIVER	1.6-30 MHz	3K00J3E, 3K00J1D 100W	SYNTHESIZED	ICOM R 70	0.1-30 MHz	3K00J3E	SYNTHESIZED	
MOTOROLA MSR-2000	161.950 MHz	16F3/112W	CRYSTAL	MOTOROLA MSR-2000	157.350 MHz	16F3	CRYSTAL	CARRIER ACCESS REPEATER
MOTOROLA MICOR	149.195 MHz CH 2 149.163 MHz CH 6A 149.283 MHz CH 6B 149.245 MHz CH 4	16F3/375W	CRYSTAL	MOTOROLA MICOR	135.575 MHz CH 2 135.543 MHz CH 6A 135.663 MHz CH 6B 135.625 MHz CH 4	16F3	CRYSTAL	ATS-3
NERA Saturn Bm	1636.5 MHz 1645.0 MHz	F9	SYNTHESIZED	NERA Saturn Bm	1535.0 MHz to 1543.5 MHz	F9	SYNTHESIZED	INMARSAT TERMINAL
Univ. of Miami LES-9 Transceiver	303.350, 303.375, 303.450, 303.475 MHz	16F/20W	SYNTHESIZED	Univ. of Miami LES-9 Transceiver	249.550, 249.575, 249.650, 249.675 MHz	16F3	SYNTHESIZED	LES-9
Kenwood TS450S Transceiver	2-30 MHz	100H0A1A, 3K00J3E 100W	SYNTHESIZED	Kenwood TS450S	2-30 MHz	100H0A1A, 3K00J3E	SYNTHESIZED	Amateur Radio
Kenwood TS922A Linear Amplifier	2-30 MHz	100H0A1A, 3K00J3E 1KW	SYNTHESIZED					

NSF FORM 1172B (4-82)

INFORMATION ON TELECOMMUNICATIONS EQUIPMENT AND SCHEDULES FOR THE YEAR 2001-2002

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NATIONAL SCIENCE FOUNDATION
ARLINGTON, VA 22230

LATITUDE 64°46'S **LONGITUDE** 64°05'W

ANTENNA		FACSIMILE		TELEPRINTER		REMARKS	
TYPE	AZIMUTH (IN DEGREES OR OMNI)	INDEX OF COOPERATION	DRUM SPEED	TYPE	SPEED (bauds)		LIST OF AVAILABLE FREQUENCIES
SLOPING "V"	340					HF (long distance)	2-30 MHz
CONICAL MONOPOLE	OMNI					HF (local ops.)	2-30 MHz
J-POLE (2)	OMNI					VHF (local ops.)	155-163 Mhz
CROSS POLARIZATION YAGI	ATS-3 SATELLITE 3150					DUAL ARRAY VOICE TRANSMIT	149.195, 149.220, 149.245, 149.249 MHz
CROSS POLARIZATION YAGI	ATS-3 SATELLITE 3150					DUAL ARRAY VOICE RECEIVE	135.555, 135.575, 135.600, 135.625 MHz
CROSS POLARIZATION YAGI	LES-9 SATELLITE 3140					DUAL ARRAY DATA TRANSMIT	303MHz
CROSS POLARIZATION YAGI	LES-9 SATELLITE 3140					DUAL ARRAY DATA RECEIVE	249MHz
HF YAGI (TRI-BAND)	ROTATABLE					AMATEUR/MARS/HAM	14, 21, 28 MHz
PARABOLIC DISH	IMMARSAT SATAELLITE					MARISAT, VOICE, DATA, TELEX	1.5-1.6 GHz
860' RHOMBIC	1950					HF primary, MCMURDO + POLE, VOICE + RATT	2-30 MHz design center = 11,553 kHz
COAXIAL	OMNI					VHF LOCAL AIR-GROUND	116-135 MHz
VHF MARINE WHIP	OMNI					VHF Marine Repeater Primary & Secondary for local boating ops.	155-163 MHz
5 ELEMENT COAXIAL	OMNI					VHF MARINE BASE	155-163 MHz

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ANTENNA		FACSIMILE		TELEPRINTER		REMARKS	
TYPE	AZIMUTH (IN DEGREES OR OMNI)	INDEX OF COOPERATION	DRUM SPEED	TYPE	SPEED (bauds)		LIST OF AVAILABLE FREQUENCIES
ENCLOSED MONOPOLE	OMNI					NOAA ARGOS relay for J-275	401.650 MHz
ENCLOSED 1.2M STEERABLE DISH	STEERABLE					TERA SCAN WEATHER DATA RX FOR T-312 (Receive)	1689, 2252.2 MHz

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LATITUDE 64°46'S **LONGITUDE** 64°05'W

	GMT		FREQUENCIES USED		CIRCUIT CONDUCT				REMARKS
STATION WORKED	OPEN	CLOSE	TRANSMITTING	RECEIVING	TYPE OF EMISSION (See ccir 432) (X)	TYPE OF TRAFFIC	SX OR DX	SIDE BAND	
MCMURDO SOUTH POLE	DEC-- 1100 Dai- MAR-- 1100 Daily Satur-	-MAR 0000 ly --OCT 0000 less local day	4771.5 7996.5 (Primary) 11554.5 (Primary)	4771.5 7996.5 8975.5 11554.5	3A3J	VOICE - INTER-STATION		USB SUPPRES -SED CARRIER	
MCMURDO SOUTH POLE	AS REQUIRED		9032 (Primary) 13252.5 (Second.) 11256.5 (Tertiary) 4719.5 (Alt. 5727.5 on 6709.5 call) 9034	9032 13252.5 11256.5 4719.5 5727.5 6709.5 9034	3A3J	VOICE - AIRCRAFT		USB SUPPRES -SED CARRIER	
MCMURDO SOUTH POLE	AS REQUIRED		2182 8364 3023.5	2182 8364 3023.5	3A3J	DISTRESS AND CALLING/SEARCH AND RESCUE		USB	
ROTHERA	1130 1730 2330 DAI	1135 1735 2335 LY	3186 (Second.) 4553 (Primary)	3186 4553	16F3 3A3J	WEATHER SYNOPTIC GROUPS		USB USB USB	
COPACABANA, SEAL IS., CAPE SHERIFF	OCT- 0000 Z DAI	MAR 0030 Z LY	4125 (Primary) 4131 (Secondary)	4125 4131	3A3J	VOICE		USB	