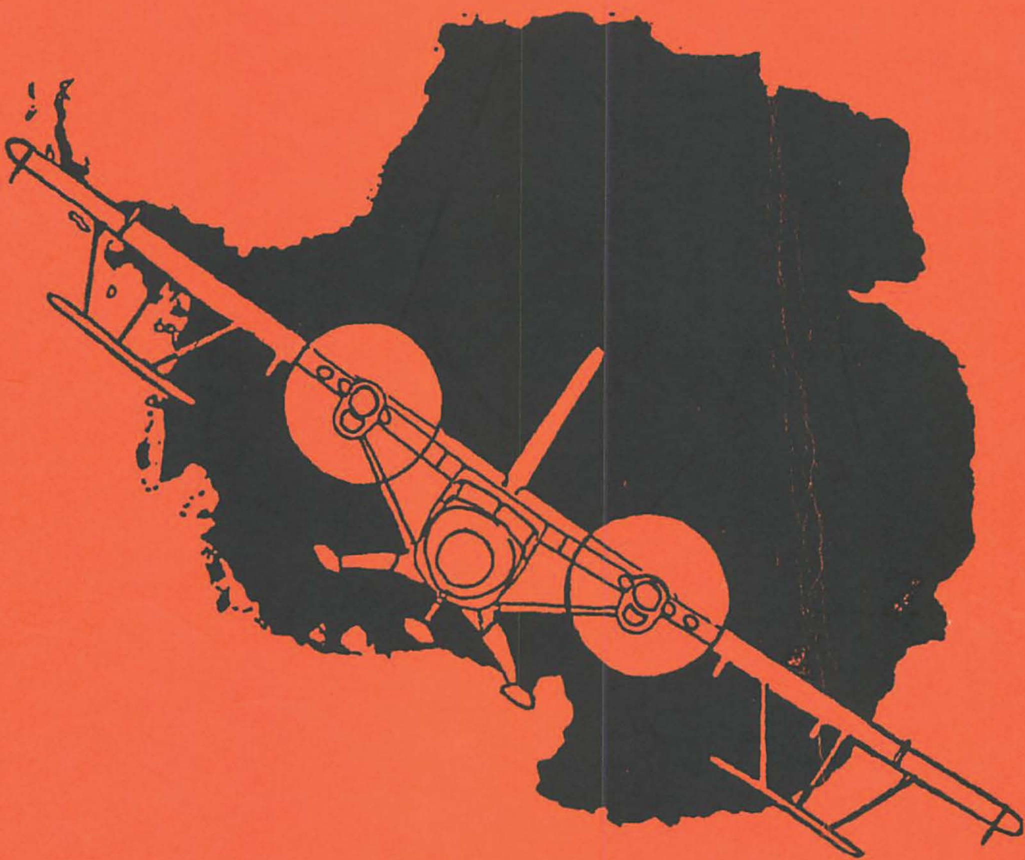
SOAR
(Support Office for Aerogeophysical Research)

Annual Report
1997/98



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Executive Summary

Overview

The Support Office for Aerogeophysical Research (SOAR) is a facility of the National Science Foundation's Office of Polar Programs whose mission is to make airborne geophysical observations available to the broad research community of geology, glaciology and other sciences.

This facility grew out of science programs funded by the National Science Foundation beginning in 1989. The instrumented aircraft presently used by SOAR was also used for the site survey at the Taylor Dome drill site and to collect ice thickness data across the West Antarctic ice streams. The support of these science programs and the increasing number of requests for access to an aircraft led to the concept of an aerogeophysical facility.

SOAR is a multi-institutional facility. The institutions with major responsibilities are the Institute for Geophysics at the University of Texas at Austin, Lamont-Doherty Earth Observatory of Columbia University, and the Geophysics Branch of the U.S. Geological Survey. The central office of the SOAR facility is located in Austin.

This report summarizes the 1997/98 goals and accomplishments of the SOAR facility, its fourth year of operation, and future facility plans.

History

SOAR was chartered on August 1, 1994 via a cooperative agreement between the National Science Foundation and the University of Texas at Austin. The facility goal stated in the agreement is to "develop, maintain and operate a suite of geophysical systems aboard a Twin Otter Aircraft in support of research in Antarctica for five years."

In 1994, SOAR assembled a staff, designed the laboratory areas and deployed personnel and equipment for a thirty-two flight survey 1994/95 field season based out of Byrd Surface Camp. The primary science project supported was a collaborative aerogeophysics program of the University of Texas Institute for Geophysics, Lamont-Doherty Earth Observatory and the United States Geological Survey (CASERTZ/WAIS) over the West Antarctic Ice Sheet. The data acquired during the 1994/95 season also included the preliminary site selection information for the deep ice coring site at the West Antarctic ice divide. For the 1995/96 field season, SOAR completed a successful eighty-eight flight operation again based at Byrd Surface Camp. The science projects supported were the CASERTZ/WAIS aerogeophysics program and the glaciology program of the University of Wisconsin (UW). For the 1996/97 field season SOAR conducted a 58 flight field season completing both the CASERTZ/WAIS and the UW programs. Some preliminary test data for The Ohio State University's Ice Sheet Volume study were also acquired. Details of the goals, accomplishments, finances and timetables of the first three field seasons can be found in the respective SOAR Annual Reports.

Fourth Year Review

Operations and Experiments

The overall experimental goal of SOAR is to meet the scientific needs of its client science projects extending from initial proposal planning through detailed experiment design, data acquisition (field operations), and finally data management (data distribution, archiving and reduction). This year SOAR worked with investigators from six institutions who developed five proposals submitted to NSF for the June 1, 1997 and January 15, 1998 deadlines. Of these five proposals, one now is slated to be flown by SOAR in 1999/00.

For the 1997/98 field season, investigators associated with the five science projects included: Ian Whillans, Beata Csatho and C. van der Veen of The Ohio State University; D.D. Blankenship of UTIG; Bruce Luyendyk of the University of California, Santa Barbara; Christine Siddoway of Colorado College; R. Bindschadler of NASA/Goddard; and R. Bell and W.R. Buck of Lamont-Doherty Earth Observatory. SOAR worked with these investigators to refine and finalize the experiment design for each of the science projects (see Figure 1).

In support of these five science projects, a primary flight target of 56 flights with a bonus goal of 23 flights was planned for the 1997/98 field season (see Table A.1). Thirty-six survey flights were completed in support of these five science projects (see Table A.2). The reduction in the number of flights resulted from a range of factors including weather, inefficiencies associated with operating from a main base with two distant satellite bases, and some issues associated with support at Downstream B. Inefficiencies associated with the use of two satellite bases included 25 transit flights, comprising more than 30% of the SOAR flights documented in the Flight Summary Table (Table A.3). The percentage of planned transects completed for each project (Table A.2) ranged from 97% for the WAG project (Bindschadler), to 6% for the TAM project (Bell, Buck, and Blankenship).

Technology

The technical goal of the facility is to prepare, configure and operate the geophysical and positioning systems aboard the survey aircraft to obtain the highest quality observations consistent with simultaneous operation of these systems. The geophysical instrument suite consists of a gravity meter, magnetometer, laser altimeter, and ice-penetrating radar. Various improvements were made to the aircraft and ground systems since the 1996/97 field season. Achievements this year included development of a single portable base station, acquisition of a computational framework for data reduction and distribution, acquisition and installation of a new cesium magnetometer system, formulating specifications for the coherent radar system in close collaboration with JPL, fabrication of a Digital Acquisition Interface to replace the unit provided by Kenn Borek Air, Ltd., upgrading equipment and porting software to improve the efficiencies of the download and QC process, acquisition of critical spaces for the DGPS and GLONASS/GPS systems, and enhancing the integration of QC between the aircraft, satellite bases, and main base. The principle repair and refurbishment target was the purchase of new laptops for base station operations, and factory evaluation and repair of the proton precession magnetometers.

Logistics

The SOAR facility has large and diverse logistical requirements. In handling these, SOAR was assisted by several organizations. The major needs and assisting organizations were:

- Aircraft Support -- operation and maintenance of the Twin Otter survey aircraft. Aircraft and services were contracted by Antarctic Support Associates (ASA) from Kenn Borek Air, Ltd.

- Field Support -- provided by ASA on-site at Siple Dome and Downstream B.

- Scientific Equipment Support -- the airborne gravity meter was supplied by the Naval Oceanographic Office (NAVOCEANO).

- Cargo Support -- provided by a variety of groups involved in the transport of SOAR equipment coordinated by Lee Degalen for the NSF at Port Hueneme, California.

To meet its aircraft support needs, SOAR requires exclusive use of the specially configured Twin Otter from the beginning of instrument installation to the conclusion of flight operations. Field preparation of the aircraft required 22 days this season, including seven test flights prior to regular survey flying. With the exception of receiving corrections for differential GPS, the aircraft and its subsystems critical to SOAR functioned well and were very reliable.

Field support consists of services provided principally for operation of the field camp. A special SOAR requirement is voice and data communications with North America. Low bandwidth communications were successfully established early in the season. This communications link proved inadequate to support transmittal of data to North America for remote QC review but was adequate for voice and e-mail. The field camp and other field support proceeded smoothly throughout the season at Siple Dome. Delays in the opening of Downstream B and subsequent difficulties to the ground support for the Twin Otter resulted in delays and lost flights.

External support supplying the gravity meter has been required due to the expense of this instrument. The gravity meter, a Bell Aerospace BGM-3, was supplied by NAVOCEANO. UNAVCO provided precise surveying of a number of critical points early in the field season.

Because of the need to transport a complete systems integration laboratory, a computing facility, and the equipment necessary to operate the survey aircraft, SOAR requires a large amount of cargo. A total of 16,670 pounds of cargo was transported to Antarctica in ten shipments plus four pieces of handcarry. The shipping effort went very well this season with all items arriving as needed. The gravity meter had special requirements, including an escort. Again this year the gravity meter and its SOAR escort experienced significant complications and delays during shipment.

<u>Personnel</u>

The core staff of SOAR consists of two directors, a technical coordinator, a science coordinator, a research engineer, an installation engineer, a senior systems analyst, a systems analyst, and an administrative associate. SOAR experienced significant personnel turnover this year. Specifically, both Tom Richter, Technical Coordinator from (1995 - May 1997) and Jeff Williams (Science coordinator from 1994 - June 1997; Technical Coordinator from June 1997 -

March 1998) left SOAR for non-academic jobs. A new Science Coordinator, Sammantha Magsino, and a new Research Engineer, Ryan Biggs, were hired in the Fall of 1997.

Three additional people were temporarily hired for field deployment, and a fourth person was supplied by the United States Geological Survey. Expedition Computing Services (ECS), the field computing subcontractor, provided QC and data archival products in the field with a staff of four, including two senior systems analysts and two systems analysts.

Oversight Committee

The SOAR oversight committee was formed in 1995 and consists of five members of the geophysical and glaciologic communities. The oversight committee did not meet during the 1997-98 year. In the place of the oversight committee, the Three Year NSF review was conducted in Washington. The three person panel conducted an intensive three year review of SOAR activities and provided NSF with a review of SOAR's activities and a summary of future recommendations.

Finances

Expenditures for SOAR during its fourth year (May 1, 1997 to April 30, 1998) are estimated to be $1009K. This compares to $1181K budgeted. The difference is due to a lower expenditure of salaries associated with the turnover of personnel, and savings incurred in the permanent equipment and other-direct-cost line items.

Future Plans

This section reviews issues and plans for SOAR in the upcoming years. Each general topic is fully described in the respective appendices.

Operations and Experiments

The objective for SOAR for the 1998/99 field season is to acquire data for two earth science programs: the Ford Ranges Program in Marie Byrd Land for investigators from the University of California at Santa Barbara and Colorado College; and the Pensacola-Pole corridor of the Transantarctic Mountains Program for investigators at Lamont-Doherty Earth Observatory and University of Texas at Austin. Figure A.1 is a map showing the 1998/99 survey targets (see also Table A.4). A fixed period of time will be dedicated to each of the two earth science projects. The aircraft will be configured at Siple Dome. After test flights are complete, operations will move to South Pole Station, with South Pole operating as the SOAR main base and Downstream B functioning as a satellite base. In mid-December, flight operations will be moved to Siple Dome, with Siple Dome becoming the main base of operations, and the Ford Ranges Camp serving as a satellite base. It is anticipated that up to eighty-three flights will be required with field operations beginning in late October and extending through late-January. Sixteen SOAR personnel and two aircrews will be required to support this work. Five projects are tentatively scheduled for the 1999/00 field season (see Table A.4).

SOAR will continue the reduction of data as requested by the proposals. The data distribution target date is August 1, 1998 for the raw data sets required by some investigators, and November 1, 1998 for the reduced data products required by other investigators (see Table A.5). SOAR is targeting completion of the reduced data products for the 1998/99 field season by the six month post-flight-operations deadline of August 1, 1999.

Technology

Because of the increased scope of SOAR's tasking, upgrades are planned for the data acquisition system and laboratory computer facilities as well as for the geophysical and navigation instrumentation. These improvements include: enhanced QC at the satellite bases in recognition of the insufficient level of QC currently performed at the satellites, improved portable base recording systems to enable efficient transitions between operational areas, acquisition of a spare cesium magnetometer, continuation of the efforts to develop a coherent radar in conjunction with JPL, completion of the spare for the Digital Avionics Interface, assessment of the short-comings in the real-time precise navigation system observed last season, undertaking of a significant revamping of the QC software, updating of the QNX operating system for data acquisition, installation of a functional aircraft intercom system for the passenger compartment, working with Kenn Borek Air to design a complete suite of spare radar antennas and struts, and investing in satellite telephone technology for the instances when radio communications are difficult . Major repair/refurbishment targets include continuing replacement of the aging laptops and acquisition of a spare time-code generator.

Logistics

Future plans for SOAR logistics are guided by the desire to enhance existing arrangements and support new SOAR requirements.

Important items planned for aircraft support are the early field arrival of the survey aircraft next season, sufficient staffing and support equipment for aircraft operations away from the main base for up to seventy-two hours, the use of two aircrews, modification of spare antennas into an operational spare system, assistance in evaluating the high-frequency receivers aboard the Twin-Otter which receive DGPS corrections, the installation of a satellite telephone and assistance in the development of a SOAR safety procedures manual.

The plans for field support include early field arrival, main base operations from both South Pole Station and Siple Dome, satellite base operations at Downstream B and Ford Ranges, and ATS (or better) voice and 10 Mbyte/day data communications.

For technical support, the BGM-3 gravity meter will again be needed. Cargo requirements this year should be about the same as last year, but with a more stable plan for gravity meter transport.

Personnel

Personnel targets this year include filling the Technical Coordinator position and an expansion in personnel to enable the implementation of a robust field rotation plan. SOAR plans to increase the core staff by a systems analyst and a research engineer. To accommodate the anticipated departure within this fiscal year of the existing senior systems analyst and the research engineer, we plan on hiring two systems analysts and two research engineers to provide continuity and a smooth transition.

Finances

SOAR planned expenditures ($1257K) for the coming year are anticipated to be approximately the same level as requested in the 1996/97 Annual Report. The 100K increase over the 97/98 expenditures is principally accounted for by the increased personnel costs this year balanced somewhat by the anticipated termination of the ECS contract. Other expenditures should be in line with the 1997/98 expenditures. Some residual funds (approximately $172K) associated with unspent salaries and hardware expenditures reduce the requested amount this year to approximately $1085K.

Cooperative Agreement

A one-year extension to the current Cooperative Agreement must be established to complete the work currently scheduled for the 1999/00 field season.

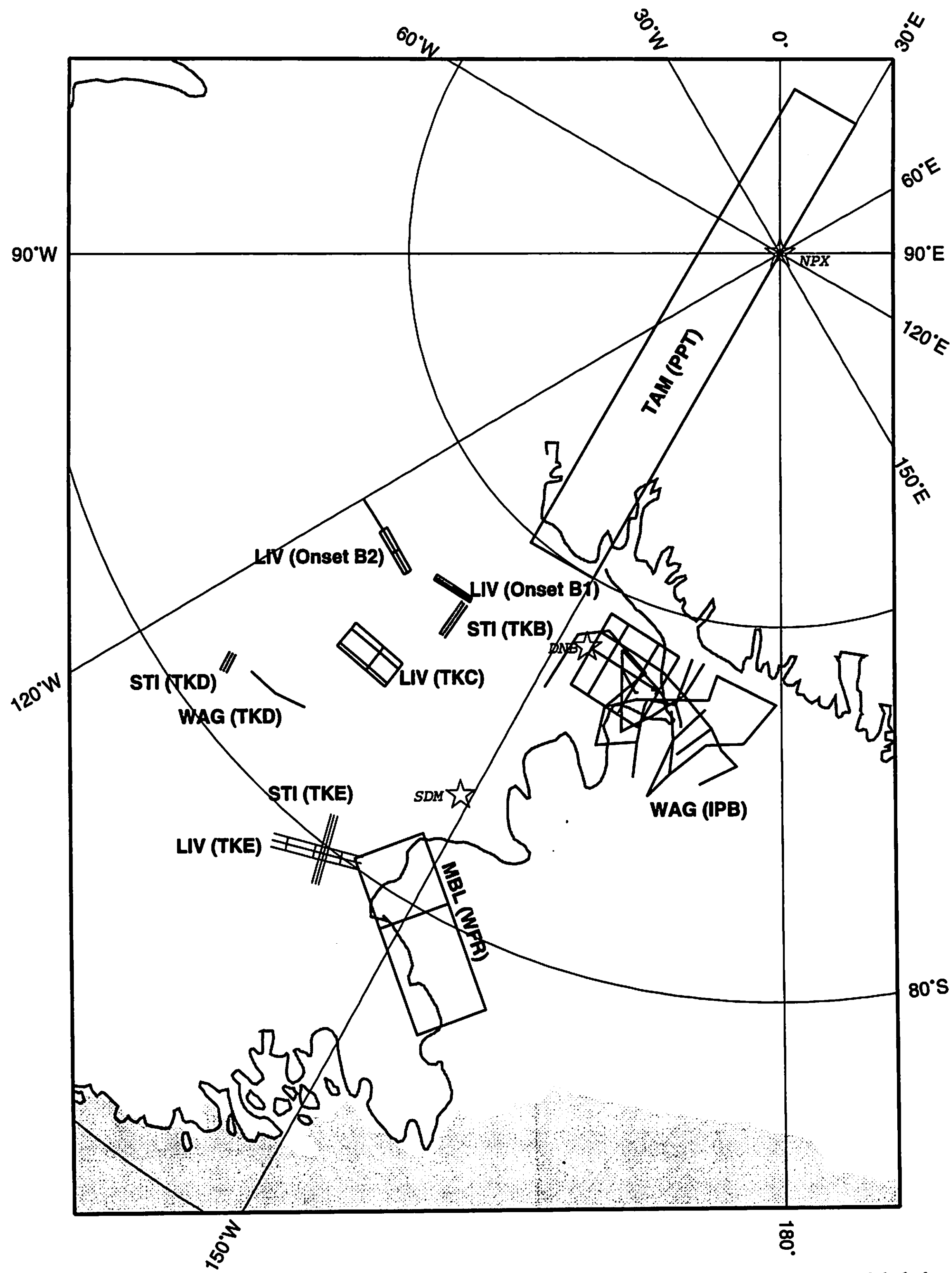

Figure 1 - SOAR survey targets for 1997/98 are shown over West Antarctica. The five experiments are labeled as follows: [1] TAM (PPT) (Transantarctic Mountains, Pensacola-Pole Transect); [2] MBL (WFR) (Marie Byrd Land, Western Ford Ranges); [3] LIV (Laser Ice Volume Experiment, onset of ice streams B1 and B2, as well as the trunks of ice streams B (TKB), C (TKC), and E (TKE)); [4] WAG (West Antarctic Glaciology, ice plain B (IPB) and trunk of ice stream D (TKD)); [5] STI (Shear Transmission at Ice Stream Margins, trunk of ice streams B (TKB), D (TKD), and E (TKE)).

Appendix A: Operations and Experiments
SOAR Annual Report
1997/98

This appendix details SOAR's support to experiments during 1997/98 and SOAR's planned support for 1998/99 and 1999/00. This appendix is divided into the following sections:

I. Project Development - facility support beginning with proposal development and planning and extending through detailed experiment design.

II. Data Acquisition - facility support of data acquisition centered around field activities.

III. Data Management - facility support of data distribution, data reduction and data archiving.

The overall experimental goal of SOAR is to meet the scientific needs of its client science projects extending from initial proposal planning through detailed experiment design, data acquisition (field operations) and finally data management (data distribution, reduction, and archiving).

I. Project Development

Goal

SOAR's project development goal is to provide support for developing proposals with accurate estimates of the SOAR resources required to meet the experimental objectives of the science clients. SOAR's role in project development also includes the detailed experiment design necessary to mesh the experimental goals of the funded science clients with the NSF logistics constraints.

Plan

Individual Investigators

SOAR was to work with individual investigators to clarify SOAR's capabilities for data acquisition and data management as well as to assist them in assessing the SOAR resources needed to meet their science goals.

Project Coordination Role for SOAR

Because of limited NSF resources, a strategy was to be developed to optimize the use of the SOAR platform by providing the maximum amount of data to the largest number of investigators.

International Collaborations

SOAR was to increase efforts to both promote the concept of integrated data acquisition by other aerogeophysical programs in Antarctica and to foster international collaborations to enable the development of scientific programs in logistically difficult regions.

Dissemination of SOAR Capabilities

SOAR was to improve communication of its technical and coordinating capabilities within the Antarctic science community and possibly actively publicize its capabilities beyond the Antarctic science community.

Accomplishments

Individual Investigators

SOAR assisted in the preparation of five proposals requesting use of the facility. The science coordinator served as the point of contact for potential facility users. Based on informal discussions of the investigators' science goals, the facility capabilities, and field logistics requirements, the investigators and SOAR developed draft field plans for the proposed work. SOAR's product to the investigators at this stage was a statement of SOAR resources necessary to support the proposal.

Five proposals were submitted by investigators, representing the following universities:

- Portland State University
- The University of Maine at Orono
- The University of Washington
- The University of Texas at Austin
- Lamont-Doherty Earth Observatory, Columbia University
- Pennsylvania State University

After the NSF proposal review process, the following proposal was funded:

- "Collaborative Research, Universities of Washington and Texas: WAIS Ice Divide Migration" Principle Investigators: E.D. Waddington (University of Washington), D.L. Morse (University of Texas), and D.D. Blankenship (University of Texas).

SOAR continued work with the funded science clients on developing a refined experiment design.

Experiment design refinements on previously funded projects included:

- Working with Ian Whillans and Beata Csatho of the Byrd Polar Research Center of The Ohio State University to finalize survey targets for their "Laser Altimetry for Ice-Sheet Volume-Balance" (LIV) investigation. Coordinates for their survey targets were received by SOAR personnel in mid-October and were modified to their final form during the field season based on independent (UNAVCO) GPS surveys of coffee can sites obtained during the 1997/98 field season. SOAR provided the PIs access to the configured Twin Otter during a field visit to Siple Dome Camp in order to conduct an internal survey of the aircraft.

- Working with Ian Whillans and Cornelis J. van der Veen of the Byrd Polar Research Center of The Ohio State University to finalize survey targets for their "Stress Transmission at Ice-Stream Shear Margins" investigation (STI). New target coordinates based on independent (UNAVCO) GPS surveys of coffee can sites were obtained during the 1997/98 field season which SOAR incorporated into the survey design.

- Working with Bruce Luyendyk of University of California, Santa Barbara and Christine Siddoway of Colorado College to modify survey designs for their proposal entitled "Air-ground study of tectonics at the boundary between the Eastern Ross Embayment and Western Marie Byrd Land" (MBL).

- Working with R. Bell and W. Roger Buck of Lamont-Doherty Earth Observatory, and D.D. Blankenship of The University of Texas at Austin to modify and refine the survey target for their "Collaborative Research: Contrasting Architecture and Dynamics of the Transantarctic Mountains" investigation (TAM), specifically the Pensacola-Pole transect.

Project Coordination Role for SOAR

To optimize the use of the SOAR platform by providing the maximum amount of data to the largest number of investigators SOAR capabilities were presented to several scientific communities including:

- The portion of the WAIS community interested in developing an integrated science plan for the Pine Island Bay drainage system at a WAIS workshop in September 1997.
- The geologic community developing future plans for studies of the Transantarctic Mountains at The Ohio State University in September 1997. Discussions arising from this workshop presentation resulted in a letter of intent to use the SOAR aircraft for a major field campaign to support the geologic studies from Carol Finn (USGS) and John Goodge (SMU).

International Collaborations

SOAR's role in international collaborations has been twofold, first to encourage the wide adoption of the integrated data acquisition and secondly to develop coordinated logistical efforts.

The last year has seen increasing adoption of the integrated aerogeophysical strategy by other Antarctic programs. The British Antarctic Survey continues to pursue the goal of simultaneous acquisition of gravity, magnetics and radar data. The Italians have recognized the concept as an important long term objective, and the Alfred Wegener Institute has also developed an integrated aircraft for polar applications. The German effort has focused on mapping in Queen Maud Land in support of the European Ice Coring Program (EPICA).

Development of international logistics as a mechanism of strengthening science programs has been pursued as part of the Transantarctic Mountains program for Bell, Buck, and Blankenship. Coordinated logistics support for the Transantarctic Mountains program over the Wilkes Basin was positioned at the "Italian Mid-point" over the last year. The midpoint, located roughly midway between McMurdo and Dome C, will be used as a "satellite" base of operations for survey flights in the Wilkes corridor. Development of this midpoint will permit a significant extension in the scientific program which could not be easily supported from the National Science Foundation alone.

Dissemination of SOAR Capabilities

SOAR established a web site (http://www.ig.utexas.edu/soar). The site provides SOAR background information, upcoming field season information and guidance on proposal development.

Issues to Address

Individual Investigators

Field programs were not finalized prior to deployment to the field. Experiment design must be finalized before field work begins.

Project Development in Light of Limited NSF Resources

In light of limited NSF resources, continued strategic planning should be developed to optimize the use of the SOAR platform and logistics by providing the maximum amount of data to the largest number of investigators.

Interagency Coordination

Development of new instrumentation and new broad science programs increasingly requires interagency coordination. NASA interest in Antarctic programs and instrumentation is the prime example.

Future Targets

Individual Investigators

SOAR will continue to work with individual investigators to clarify SOAR's capabilities for data acquisition and management and to assist investigators in assessing the SOAR resources needed to meet their science goals. This will include finalizing an experiment design prior to entering the field.

Project Development and International Collaboration

Because of limited NSF resources, continued work toward optimizing the use of the SOAR platform by providing the maximum amount of data to the largest number of investigators will take place. Several avenues are emerging for coordinated US and international project development including the upcoming Chapman Conference on the West Antarctic Ice Sheet (September 1998) and possibly the planned Lake Vostok Workshop in the Fall of 1998. The Chapman conference will include discussion of future efforts in the Pine Island Bay region with both British and German scientists. The Lake Vostok effort may involve international collaboration as the European interest in the region continues to be strong

Interagency Coordination

During the past year a number of discussions have emerged between SOAR and NASA, in particular, in terms of the development of a next generation radar system and in terms of NASA programs in Antarctica, including Lake Vostok and a grounding line survey. No definitive plan has emerged from these discussions. As NASA develops the agency's long term plan for Antarctica, especially with remote sensing and ground truth targets, it will be critical that NSF and SOAR closely coordinate their efforts with NASA.

II. Data Acquisition

Goal

SOAR's data acquisition goal is to meet the experimental needs of the science clients by providing simultaneous observations of gravity, magnetics, ice-surface topography and subglacial topography. When the prime experimental objective is a subset of these data sets, SOAR aims to maintain the data quality of the secondary data sets wherever possible without compromising the primary data sets required by the science clients.

Plans

The SOAR 1997/98 operations plan was based upon three new concepts introduced in the 1996/97 Annual Report including:

- *Dedicated Projects.* Fifty-five flights per season are allocated to "dedicated projects" which are primary goals for the season.
- *Bonus Projects.* Approximately twenty additional flights are allocated to "bonus projects." This gives a season flight total of about seventy-five.
- *Bases of Operation.* Support is provided each season from a "main" base and a number of designated "satellite" bases. A main base supports aircraft configuration and provides normal camp support facilities. A satellite base may provide fuel, a geophysical base station, limited QC capability, and berthing.

During the 1997-98 season, SOAR's objectives were to complete the following surveys, using Siple Dome as the main base of operations (SOAR acronyms are in parentheses; see Figure 1 and Table A.1):

- "Laser Altimetry of Ice-Sheet Volume-Balance" (LIV), Whillans and Csatho;
- "Collaborative Research: Contrasting Architecture and Dynamics of the Transantarctic Mountains (TAM)" Pensacola-Pole Transect (PPT), Bell, Buck, and Blankenship;
- "Stress Transmission at Ice-Stream Shear Margins" (STI), Whillans and van der Veen;
- "West Antarctic Glaciology - V" (WAG), Bindschadler.

SOAR also planned to devote four flights of the 1997-98 season to the Western Ford Ranges (WFR) portion of Luyendyk and Siddoway's project:

- "Air-ground study of tectonics at the boundary between the eastern Ross Embayment and western Marie Byrd Land, Antarctica: Basement geology and structure, and influences on West Antarctic glaciation" (MBL).

Table A.1
SOAR Field Plan for 1997/1998

Experiment	Primary	Bonus	Bases
TAM (PPT)	28		NPX, DNB
LIV	11		SDM, DNB
WAG	9		DNB
STI	4		DNB
MBL (WFR)	4	23	SDM
Totals:	**56**	**23**	= **79**

NPX = South Pole Base
DNB = Downstream B
SDM = Siple Dome
WFR = Western Ford Ranges

<u>Science Observers</u>

SOAR requested each project be limited to a single science observer, rather than supporting a science observer from each project institution. For 1997/98, this would have reduced the maximum number of possible science observers from six to five. SOAR developed a schedule for science observers, attempting to place them in the field during the flying for their specific project while minimizing the impact on SOAR operations. SOAR planned to provide e-mail support for the science observers, but no additional computing or engineering support.

Accomplishments

SOAR completed 37 survey flights which included 99 transects in support of all five science programs (Tables A.2 and A.3). Scheduling delays getting SOAR into Siple Dome dropped the number of flights possible to 56, representing only the dedicated flights of our initial estimate. The discrepancy between the number of planned flights and the number of actual flights is due to a combination of factors including:

- poorer than anticipated weather
- reduced efficiency working out of the Downstream B satellite base
- delays in the setup of Downstream B
- problems with the ground power unit provided at Downstream B.

Table A.2
Project Completion Summary

Project	Flights Planned	Flights Completed	% of Planned Flights Completed	Transects Planned	Transects Completed	% of Planned Transects Completed
WAG	9	15	160	58	56	97
STI	4	2**	~50	9	6	66
LIV	11	12**	~100	26	25	96
MBL (WFR)	4	4	100	10	8	80
TAM (PPT)	28	4	14	50	4	8
Season Total	**56**	**37**	**66**	**153**	**99**	**65**

** LIV and STI shared 3 flights.

Table A.3
Flight Operations Summary (1997/98 field season)

Flight Number*	Take Off Date (GMT)	Take Off Time (GMT)	Flight Duration (h:mm)	Transects	Originating Base	Project or Purpose
TF01	12/1/97	20:15	2:06		SDM	Radar Test
TF02	12/6/97	21:25	2:55		SDM	Full Test
TF03	12/8/97	01:12	2:16		SDM	Full Test
TF04	12/9/97	01:35	2:23		SDM	Full Test
TF05	12/11/97	03:41	3:37		SDM	Full Test
TF06	12/12/97	03:12	2:12		SDM	Full Test
F01	12/15/97	18:52	3:12	9	SDM	LIV
TF07	12/16/97	19:23	2:16		SDM	Full Test
F02	12/17/97	00:45	2:29	2	SDM	MBL
F03	12/18/97	18:41	3:12	2**	SDM	MBL
F04	12/19/97	02:04	3:17	3	SDM	LIV
F05	12/19/97	18:52	3:17	2**	SDM	MBL
F06	12/20/97	18:45	1:31	0**	SDM	LIV
F07	12/21/97	01:03	3:43	3	SDM	MBL
F08	12/29/97	01:15	2:57	2	SDM	LIV
TR	12/31/97	23:39	1:08		SDM	SDM to DNB (DNB setup)
TR	1/1/98	01:22	1:08		DNB	DNB to SDM
F09	1/2/98	13:12	1:30	1†	SDM	SDM to DNB
TR	1/2/98	16:20	1:15		DNB	DNB to SDM
TR	1/3/98	19:00	1:00		SDM	SDM to DNB
F10	1/3/98	22:38	1:31	1	DNB	WAG
F11	1/4/98	02:34	3:58	5	DNB	WAG
F12	1/4/98	18:50	4:24	6	DNB	WAG
F13	1/5/98	01:46	3:03	3**	DNB	WAG
TR	1/5/98	05:45	1:10		DNB	DNB to SDM
TR	1/5/98	14:26	1:15		SDM	SDM to DNB
F14	1/5/98	16:35	2:47	1**	DNB	WAG
TR	1/5/98	20:48	1:13		DNB	DNB to SDM
F15	1/6/98	13:22	1:28	4	SDM	LIV
TR	1/7/98	18:59	1:12		SDM	SDM to DNB
F16	1/7/98	20:59	3:20	5	DNB	WAG
F17	1/8/98	02:33	3:47	5	DNB	WAG
TR	1/8/98	20:00	1:05		DNB	DNB to SDM
TR	1/9/98	13:42	1:17		SDM	SDM to DNB
F18	1/9/98	18:15	4:03	5	DNB	WAG
F19	1/9/98	23:35	3:30	3**	DNB	WAG
TR	1/10/98	03:47	1:13		DNB	DNB to SDM
TR	1/10/98	13:46	1:10		SDM	SDM to DNB
F20	1/10/98	15:28	3:20	3	DNB	WAG
TR	1/10/98	19:46	1:09		DNB	DNB to SDM
TR	1/11/98	00:43	1:08		SDM	SDM to DNB
F21	1/11/98	02:35	2:25	5	DNB	WAG

Table A.3 (Continued)
Flight Operations Summary (1997/98 field season)

Flight Number*	Take Off Date (GMT)	Take Off Time (GMT)	Flight Duration (h:mm)	Transects	Originating Base	Project or Purpose
F22	1/11/98	18:18	4:21	10	DNB	WAG
F23	1/12/98	00:34	3:54	5	DNB	LIV and STI
TR	1/12/98	05:17	1:09		DNB	DNB to SDM
TR	1/12/98	11:43	1:14		SDM	SDM to DNB
F24	1/12/98	13:36	3:06	3	DNB	WAG
F25	1/12/98	17:57	1:50	1**	DNB	WAG
TR	1/12/98	20:35	1:10		DNB	DNB to SDM
F26	1/14/98	21:22	4:17	5	SDM	LIV and STI
F27	1/15/98	02:52	2:54	2	DNB	LIV
TR	1/15/98	13:20	1:10		SDM	SDM to DNB
F28	1/15/98	15:04	3:42	5	DNB	WAG
F29	1/15/98	20:06	2:52	5	DNB	LIV
TR	1/16/98	00:35	1:18		DNB	DNB to SDM
F30	1/17/98	01:08	3:35	2	SDM	STI
TR	1/17/98	11:58	1:07		SDM	SDM to DNB
F31	1/17/98	13:41	4:11	4	DNB	LIV
F32	1/17/98	19:04	4:26	4	DNB	LIV
TR	1/18/98	00:30	1:09		DNB	DNB to SDM
TR	1/19/98	01:17	1:05		SDM	SDM to DNB
F33	1/19/98	02:42	1:50	0**	DNB	TAM
F34	1/19/98	18:15	3:46	3	SDM	LIV
F35	1/20/98	01:01	4:06	3	SDM	LIV and STI
TR	1/24/98	18:00	1:16		SDM	SDM to DNB
F36	1/24/98	19:50	3:18	1	DNB	TAM
F37	1/25/98	1:55	3:13	1	NPX	TAM
TR	1/25/98	05:55	1:09		NPX	DNB to SDM
TR	1/25/98	19:25	1:10		SDM	SDM to DNB
F38	1/25/98	21:15	3:05	1	DNB	TAM
F39	1/26/98	02:15	3:24	1†	NPX	NPX to DNB
TR	1/26/98	06:49	1:14		DNB	DNB to SDM

* TF denotes test flight; F denotes survey flight; TR denotes transit flight
** Truncated due to weather
†Transit data acquired, not dedicated to project
Total survey time: 120 hours
Total transit flight time: 35 hours
Total test flight time: 17 hours

Surveys were flown from three bases, with Siple Dome as the main base and Downstream B and South Pole serving as satellite bases. The WAG survey relied upon Downstream B as a satellite base. STI and LIV surveys relied upon both Siple Dome and Downstream B as bases. MBL relied upon Siple Dome as a base. Late in the season, South Pole as well as Downstream B were used as satellites for the TAM (PPT) survey. The inefficiencies in Downstream B operations resulted from constraints on aircraft maintenance and flight day length for the pilot and copilot as well as communication and support restrictions at Downstream B. These issues are addressed in detail in the Logistics Appendix.

Science Observers

Four science observers representing three projects were in the field while SOAR was configuring the aircraft. They were able to view initial test flights, but were not in the field during survey flights. SOAR provided e-mail support for the science observers while at Siple Dome.

Issues to Address

Science Observer

SOAR has a policy of a single science observer per field project. Three official science observers were scheduled to visit the SOAR field facility. There were four observers, representing three projects, in the field for some part of the field season. Though the three scheduled observers were in the field during the setup phase of operations, work with them went smoothly. Their presence was unobtrusive and beneficial. The fourth observer, however, "dropped in" to observe SOAR's work as a second science observer for a single project. The introduction of this "drop in" science observer ultimately reduced the efficiency of SOAR operations.

Multiple Operating Areas

The flexibility of a satellite base in the survey area was not fully realized in practice. This was due in part to the daily maintenance scheduling for the aircraft, and in part to the long duty day introduced by use of the satellite base. In light of the experience gained during the 1997/98 field season, the satellite base concept should be reexamined and possibly modified. The following issues must be addressed in order to realize the full benefits of the satellite base concept:

- "Leap frogging" from one satellite base to another, or transits to a satellite base in order to fly a survey area (representing 35 hours of flight time for 1997/98).

- Aircraft certification required the Twin Otter be checked out by the Borek mechanic at the beginning of every duty day. This constrained field operations from the satellite base if an overnight stay was necessary.

- SOAR operations must become more mobile. During the 1997/98 season, overnight stays at Downstream B were necessary. Surveying out of Downstream B, in some cases, was possible following an overnight stay, but communications with Siple Dome, flight planning, and data archiving difficulties hindered survey operations. A more mobile operation would alleviate many of these problems during future operations when overnight or extended stays are required at satellite bases.

Project Completion

Due to tight schedules and survey areas which are logistically difficult, completion of all tracklines requested in funded projects may become increasingly difficult. SOAR requires input from the NSF as to when a project should be considered "complete."

Future Targets

Field Plan

During the 1998/99 season, SOAR will focus on completing the remainder of the Pensacola-Pole Transect (TAM (PPT); Bell, Buck and Blankenship) and Marie Byrd Land (MBL; Luyendyk and Siddoway). Figure A.1 is a map showing the locations of these survey targets. Both of these projects will have a dedicated time frame in which to be completed. Should these projects be completed prior to their fixed dates, SOAR will be in a position to survey any remaining transects from the 1997/98 field season. Table A.4 gives planned flights for the 1998/99 field season, as well as a projected schedule for the 1999/00 season.

Operational Bases for 1998/99

The Twin Otter will be configured and tested at Siple Dome (SDM) at the beginning of the season. As we will be using both South Pole and Siple Dome as primary bases of operations, we will install parallel base infrastructures at both sites while the aircraft is being configured and tested at Siple Dome. Operations will shift to South Pole Station (NPX) at the beginning of December; NPX will be used as the first primary base of survey operations and Downstream B (DNB) will be the satellite base. The survey target for this portion of the field season will be the TAM/Pensacola-Pole Transect (PPT) survey. Surveying will continue in the TAM (PPT) corridor until a predefined date, at which time operations will return to SDM to begin work on the MBL survey.

The Ford Ranges camp will serve as a satellite base for the MBL survey. This arrangement of focusing operations from a single primary operational base and a single satellite base at a time will avoid "leap frogging" and "double-deep" satellites.

Satellite bases must be able to support ground power needs of the aircraft and accommodate the crew for up to three days of operation and up to a potential five days of occupation in case of poor weather conditions. Each satellite base must be in full operation when SOAR is scheduled to survey the area the satellite supports. The sequential nature of the field season schedule means that only one satellite base will be in use by SOAR at any given time during the 1998/99 season.

Science Observers

SOAR requests each project be limited to a single science observer. This implies SOAR will only support two science observers in the field during the 1998/99 field season. Minimizing the number of science observers will be critical as the main base of operations shifts from Siple Dome during installation and initial testing to South Pole during the TAM (PPT) work and finally back to Siple Dome again during the MBL effort. SOAR will develop a schedule for these science observers that attempts to place them in the field during the flying for their specific project while minimizing the impact on SOAR operations. The SOAR priority will be to accomplish the season's flight program even if the appropriate science observer is not present. SOAR will provide e-mail support for the science observers, but no additional computing or engineering support will be available. Some mechanism must be put in place to discourage additional "drop-in" science observers for a single project.

Project Completion

NSF, SOAR, and possibly SOAR's oversight committee, need to develop a definition of "project completion." A number of models exist, ranging from the commercial aerogeophysical definition which requires every requested line to be flown with excellent data quality, to the marine science community definition, which is generally the number of dedicated ship days in the field. A definition of project completion for SOAR is now necessary due to full schedules for the next two seasons and the potential for significant weather restrictions during the Marie Byrd Land operations.

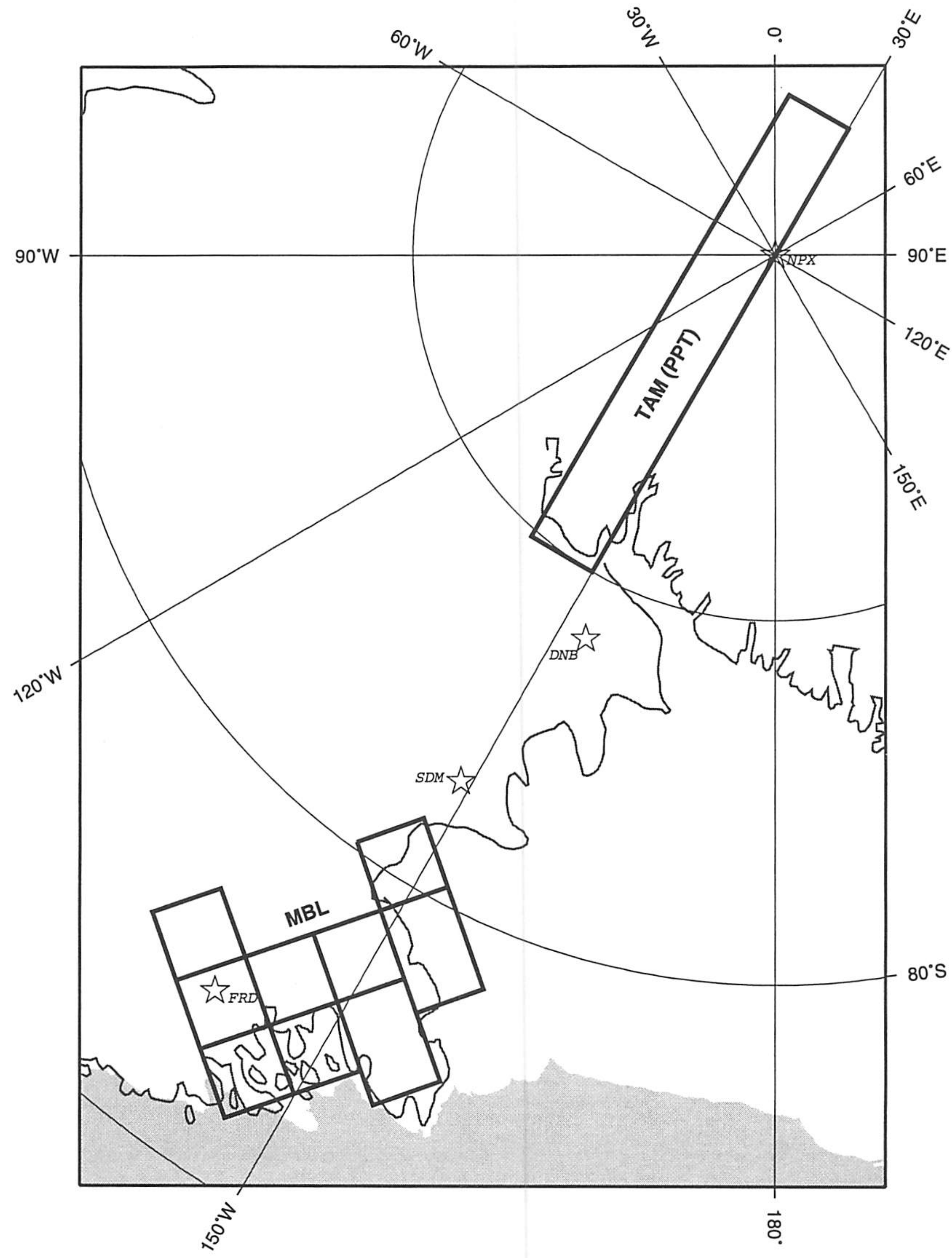

Figure A.1 - SOAR survey targets for 1998/99 are shown over West Antarctica. The two targets are outlined with blocks: [1] TAM (PPT) (Transantarctic Mountains, Pensacola-Pole Transect), [2] MBL (Marie Byrd Land). Main and satellite bases are marked with stars: NPX (South Pole Station), DNB (Downstream B), SDM (Siple Dome Camp), and FRD (Ford Ranges Camp).

Table A.4

SOAR Field Plan for 1998/99

Experiment	Main Base	Satellite Base	Number of Flights
TAM (PPT)	NPX	DNB	24
MBL	SDM	FRD*	59
Total Flights:			83

SOAR Field Plan for 1999/00

Experiment	Main Base	Satellite Base	Number of Flights
Divide	SDM	Byrd/UPD	7
LIV	SDM	DNB	11
STI	SDM	Byrd/UPD	2
WAG	SDM	Byrd/UPD	1
TAM (Robb Glacier)	MCM		2
TAM (Wilkes Basin)	MCM	Italian Midpoint	16
TAM (Dome C Ext.)	Italian Midpoint	Dome C	12
Total Flights:			51

*Ford Ranges Camp

III. Data Management

Goal

SOAR's data management goal is to efficiently distribute, reduce, and archive the data acquired using the SOAR aircraft.

Plans

Data Distribution

SOAR was to continue to provide raw data products for each geophysical and positioning data stream when needed. The target date for distribution of data collected is, in general, six months after the end of flight operations.

Data Reduction

SOAR was to have established an in-house data reduction capability starting in time to process the 1997/98 field data. The intention is to provide transect data products for the geomagnetic and gravity fields as well as surface and bed elevation.

SOAR was to hire and train two specialists this year to reduce 1997/98 data as soon as it is available. One data reduction specialist was to focus on morphology data, i.e., ice surface measurements and ice-penetrating radar. The morphology specialist would train with the UTIG ice sheet morphology science program. The second specialist was to focus on navigation, magnetics and gravity data. This specialist would train primarily with the LDEO potential field group, with some assistance from the USGS magnetics program. Minimal funds were requested for the CASERTZ/WAIS science investigators to support the training of these specialists. The targeted hiring date for these specialists was August 1, 1997, to permit six months of training prior to the arrival of data in February, 1998. A small budget for additional personnel to assist in the reduction of the 1997/98 data, beginning in February, 1998, was included. A computational framework for these efforts was also budgeted.

Data Archiving

SOAR directors were to begin the process of arranging for archival of SOAR data products by an independent agency.

Accomplishments

Data Distribution

SOAR completed distribution of data from the 1996/97 field season to the CASERTZ/WAIS and UW investigators. The data products provided were raw digital data and hard copy quality control plots. The raw digital data were distributed by June 1, 1997. The paper QC plots were distributed in August, 1997.

Data Reduction

SOAR hired and trained two specialists beginning in the fall of 1997, as required by the revised budget for 1997/98, in order to provide transect data products for the geomagnetic and gravity fields as well as surface and bed elevation. A morphology specialist was hired and trained at the UTIG facility. A potential fields specialist was hired and trained at the LDEO facility. Suitable computational frameworks for SOAR morphology and potential fields data reduction were established at UTIG and LDEO, respectively.

Data Archiving

The National Snow and Ice Data Center has submitted a proposal to NSF that includes data archival for SOAR ASCII data products (e.g., laser ranges, avionics and GPS positions) appropriate for glaciology.

Issues to Address

Data Reduction

A plan must be developed to completely transfer the data reduction process to SOAR, or establish a stable long-term subcontracting arrangement to secure this capability.

Data Archiving

SOAR needs to follow through on the plan to acquire an independent agency to archive SOAR data products.

Future Targets

Data Distribution and Reduction

SOAR will continue to provide raw data products for each geophysical and positioning data stream when needed. Quality control and raw data products from the 1997/98 field season will be delivered to the appropriate science clients or SOAR reduction facility by August 1, 1998. Reduced data will be distributed to the science clients by November 1, 1998, meeting the oversight committee target of nine months after the completion of the field work. A summary of the SOAR data distribution and reduction tasking is represented in Table A.5. SOAR will consult with its oversight committee regarding future options for maintaining SOAR's data reduction capabilities.

Table A.5
Data Management and Tasking

Data Product	Raw	Transect Morphology	Transect Geopotential	Map
Client				
TAM	♦	♦	♦	
WAG		♦		
LIV	♦	♦		
MBL		♦	♦	
STI		♦		

Data Archiving

SOAR is continuing to have discussions with NSIDC and NGDC on the archiving of the SOAR ASCII data. SOAR reduced products, including gravity, magnetics, ice surface and bedrock topography clearly will be archived at one of these institutions. The major outstanding issue is the archiving of the binary radar data. The British continue to benefit from radar data collected in the 1970's; US researchers in 20 years should have the same access to the binary SOAR radar data. This large data volume (60-90 Gigabytes/season) does not easily fit into either NSIDC or NGDC data archiving schemes but is becoming increasingly feasible as mass storage becomes cheaper. We recommend that NSIDC, as part of the effort to archive the US Antarctic Program's glaciology data, include resources for archiving the binary radar data.

Appendix B: Technology
SOAR Annual Report
1997/1998

This appendix focuses on the facility's technical goals, plans, accomplishments, outstanding issues and future targets.

Goal

The SOAR technical goal is to prepare, configure and operate the geophysical and positioning systems aboard the survey aircraft to obtain the highest quality observations consistent with simultaneous operation of these systems. This technical goal includes providing base station facilities and a computational framework for data reduction. The geophysical observations are gravity, magnetics, laser altimetry, and ice-penetrating radar sounding. The positioning observations are GPS (including post-processed differential carrier-phase), precision pressure altimetry, and inertial navigation.

Plans

The plans for major technical improvements during the fourth year of facility operations were the following:

Satellite Base Equipment

SOAR intended to develop a pair of portable base stations with the following capabilities in priority order: GPS observations, acquisition system downloading (with some QC) and geomagnetic field operations.

Computational Framework for Data Reduction and Distribution

SOAR was to acquire a dedicated workstation with peripherals for the potential fields/GPS data reduction site, and for the surface and subsurface morphology data reduction site.

Cesium Airborne Magnetometers

SOAR was to acquire and integrate cesium airborne magnetometers into the aircraft instrument package and continue investigating adding a three-component magnetometer capability.

Coherent Radar

A general specification in developing coherent radar capability was to be developed.

Digital Avionics Interface

SOAR intended to fabricate or obtain two functional replacements for the existing interface to the aircraft avionics package (the DAI 1200).

Data Acquisition Efficiency

To address the inefficiencies and vulnerabilities of the field download and QC network, a UNIX workstation and PC were to be acquired. Additionally, the existing radar QC programs were to be ported to the Solaris operating system.

Precision Navigation

SOAR was to acquire spares for the DGPS and GLONASS/GPS systems and continue the development of robust precision navigation for the aircraft.

Integrated QC

SOAR was to provide for an integrated QC process across the three platforms of aircraft, satellite base, and main base by the following methods:

- Upgrade the aircraft's QC systems (mostly software) to provide, at each station, real-time monitoring of data along with trend displays for each data stream.
- Incorporate checks of downloaded data integrity and consistency at the satellite base as currently implemented for the main base systems; K&RS processing of GPS data and the plotting of magnetics base station data was to be possible at the satellite bases.
- Upgrade QC at the main base.

Repair and Refurbishment

In order to keep equipment functioning and up-to-date, SOAR targeted:

- Repair and refurbish the network of laptop computers used for operation and monitoring of aircraft and base station data acquisition.
- Purchase one Ashtech Z-12 GPS receiver and pursue borrowing the remaining GPS receivers from SOAR's home institutions (UTIG and LDEO) to cover its geodetic GPS needs.

Accomplishments

Satellite Base Equipment

A single portable base station was developed with the capability of making GPS and geomagnetic field observations, conducting acquisition system downloading, and running base station QC. The station consisted of a workstation, two Ashtech GPS receivers, and a proton precession magnetometer. The magnetometer was housed in a "mag hutlet" which included the housing unit, solar panels, and batteries. The "mag hutlet" worked well to protect and power the magnetometer. A second satellite base has not yet been assembled.

Computational Framework for Data Reduction and Distribution

SOAR acquired two dedicated workstations with peripherals for each of the two SOAR data reduction sites. Workstations were acquired for the SOAR potential fields group at LDEO, and the SOAR morphology group at the UTIG facility.

Cesium Airborne Magnetometers

The Geometrics 813 Proton Precession magnetometer used during the previous field seasons was upgraded to an 823 optically-pumped cesium vapor magnetometer and successfully integrated with the other airborne systems. In addition to the increased reliability, the 823 system is lighter and more robust in the presence of high gradient fields. Very few data dropouts occurred with the 823 system. SOAR postponed acquisition of a second 823 system to make funds available for data reduction, and is monitoring developments in the three component magnetometer field.

Components for a spare winch, used to spool the airborne magnetometer bird cable, were manufactured and a new winch is being constructed.

Coherent Radar

To make funds available for data reduction, SOAR reduced by half, the radar specification effort. SOAR engineers, however, have begun discussions with NASA's Jet Propulsion Laboratory (JPL) concerning coherent radar specification, design, and development, and the prospects are good for SOAR to achieve its ice-penetrating radar goals through a cooperative relationship. JPL is developing a prototype ice-penetrating radar as a testbed for a radar to be built for the Europa orbiter. The system is a 500 watt peak power chirped system with center frequencies of 40, 60, and 80 MHz, and a 15 MHz bandwidth. Chirp and down-conversion signals are synthesized from a digital signal generator employing a numerically controlled oscillator. Transmission is through a single antenna, although dual channel receivers and recording allow for great flexibility in data post-processing. Figure B.1 shows a block diagram describing the prototype ice-penetrating radar.

Digital Avionics Interface

Components for a spare digital avionics interface (DAI) were acquired but a second functional replacement for the DAI 1200, as specified in the last year's report, has not yet been obtained.

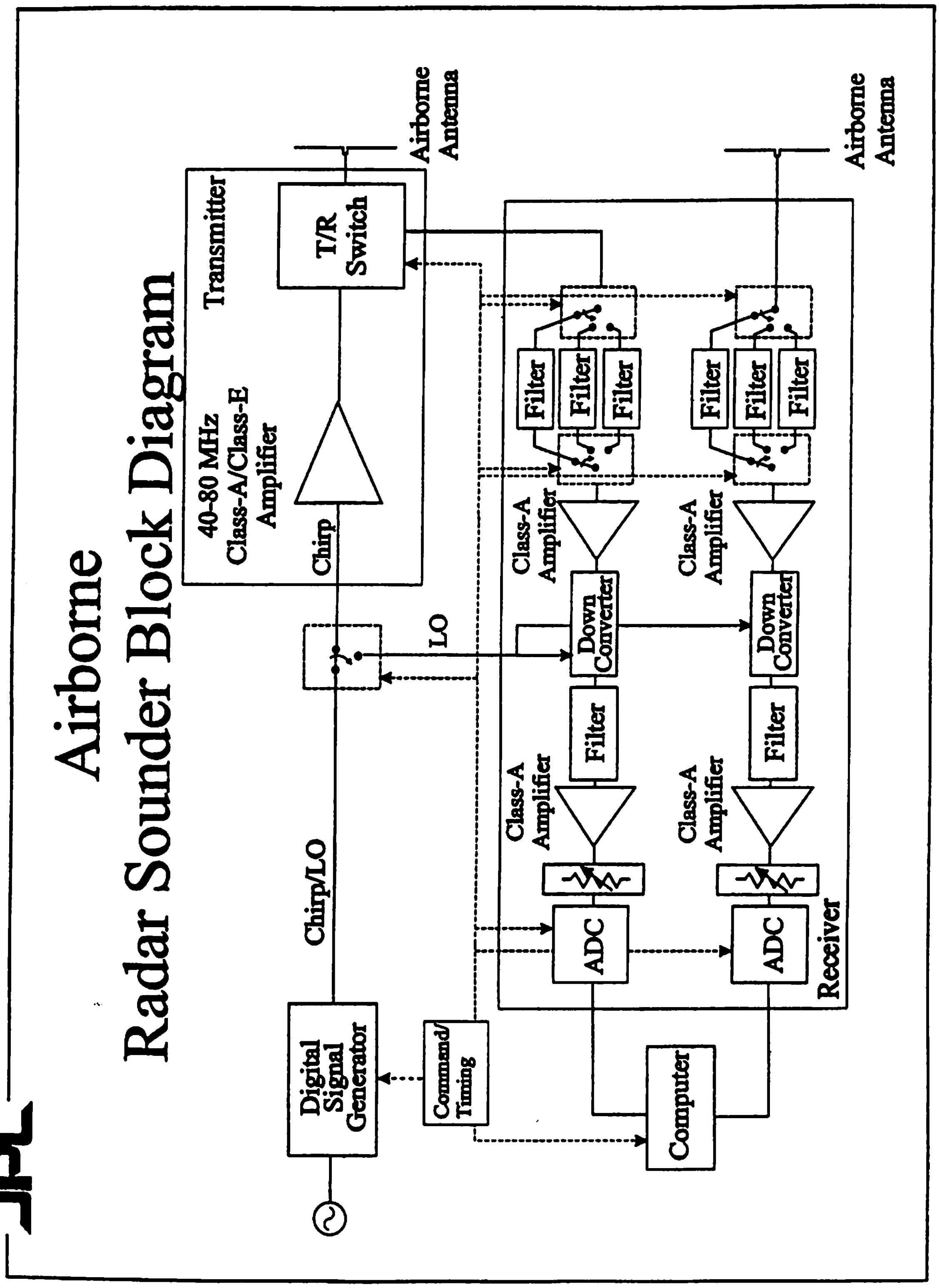

Figure B.1 - Block diagram of the JPL testbed radar.

Data Acquisition Efficiency

In order to increase efficiency of the data download and QC process, SOAR purchased a UNIX workstation and PC. The radar QC program was ported to the Solaris operating system.

Precise Navigation

SOAR acquired critical spares for the DGPS and GLONASS/GPS navigation systems. A spare high power HF amplifier for DGPS was not acquired in order to free up funds for data reduction.

The HF transmission link for DGPS corrections did not function nearly as well as during the 1996-97 field season. The audio tones were typically heard but were successfully decoded only a small fraction of the time. In spite of this, the Twin Otter aircraft was able to maintain the experimental navigation target of ± 22.5 meters of the planned flight lines for most of the transects using the GLONASS/GPS navigation system.

The GLONASS/GPS navigation system was further integrated into SOAR's equipment with the purchase and installation of a stand-alone receiver. GLONASS/GPS navigation has advantages over standard GPS navigation, including better positioning accuracy (from no intentional degradation), as well as more available satellites and higher inclination orbits more suitable for polar navigation. This system, including an improved antenna, worked well when used with the existing TrimFlight navigation system.

SOAR's goal of ± 22.5 meters may not have been met when surveying near the South Pole. All of our commercial GPS navigation systems behaved erratically as the Twin Otter approached the pole.

Integrated QC

In order to provide a more integrated QC process across the three platforms of aircraft, satellite base, and main base, the following were accomplished:

- To improve continuous real-time monitoring of digital radar data on the aircraft, software was developed and a dedicated flat panel display was installed for the radar operator's use.

- In order to maintain the integrity and consistency of data downloaded at Downstream B, QC software and hardware were installed at the base site. A subset of the QC programs were sufficient to determine if the flight instruments were downloaded properly. Since the only portable QC platform was located at Downstream B, no data checks were possible during our two visits to South Pole Station. Instead, data were brought back to Siple Dome Camp to be downloaded and checked.

- QC software at the main base was upgraded. Changes in the data breakout software were made resulting in a system about four times faster than the original. These changes were necessary to accomplish download and QC on the more modest satellite base computer. Numerous changes were made to the QC package to accommodate new data streams (i.e., the cesium magnetometer and Trim Flight), multiple base stations, new operating systems, scaling factors, and non-grid survey lines.

<u>Repair and Refurbishment</u>

In order to keep equipment functioning and up-to-date:

- SOAR purchased four new laptop computers used mainly for base station operations. One laptop was used as a primary X-term display for the computer workstation at Downstream B, two laptops were used at South Pole Station for logging GPS data, and the remaining laptop served as a spare. No repairs or upgrades were made on the remaining laptops already in use by SOAR, though their usefulness as reliable field machines is at an end after three years of heavy use.

- The purchase of new GPS receivers was postponed to free funds for SOAR data reduction. The GPS receivers brought to the field were borrowed from LDEO and the University of Maryland. Additional GPS support at South Pole Station was provided by the USGS.

Issues to Address

To achieve future experimental objectives, the following technical issues need to be addressed:

<u>Base Equipment</u>

The QC capacity at satellite bases was inadequate. In order to increase speed and efficiency while running base station QC, SOAR needs to revisit the hardware needs of the satellite base QC platform. Additionally, because of the nature of operations planned for the 1998/99 field season, SOAR must develop more portable QC systems. Maintaining equal QC capabilities at all main bases and satellites is essential as SOAR operations move from base to base.

Similarly, equal but portable, base recording equipment (magnetics and GPS) must be maintained for both main and satellite bases. Also, all of the portable proton precession magnetometers for base recording failed at one time or another during base recording last season, even after complete refurbishment before the field season.

Cesium Airborne Magnetometers

SOAR must address the issue of a spare cesium magnetometer for the aircraft.

The parts manufactured for the spare magnetometer bird winch need to be assembled and fully checked out prior to deployment to the field.

SOAR currently owns one magnetometer bird and is using a second bird on loan from the USGS as a spare. The USGS is willing to hand over ownership of the second bird to SOAR. Ownership of the second magnetometer bird should be resolved.

Coherent Radar

The JPL radar needs to be compared with existing ice-penetrating radar systems, including SOAR's incoherent 60 MHz pulsed continuous wave radar in Antarctica and the University of Kansas' coherent 150 MHz chirped radar in Greenland. As part of this process, SOAR needs to determine which radar design best meets the needs of projects requiring SOAR-collected radar data. An agreement needs to be reached allowing the use of SOAR's airborne platform for the Antarctic testing of the JPL system and a means of transfer in technology from JPL to SOAR needs to be established.

Digital Avionics Interface

The acquired components for the spare DAI must be assembled and tested.

Precision Navigation

SOAR must determine why the decoding of DGPS HF transmissions at the TrimFlight was unsuccessful for most of the season. This needs to be resolved in order to restore DGPS navigation ability by the 1998/99 field season.

SOAR must review the GPS data acquired near the pole to determine how far from our experimental target of $\pm$ 22.5 m of the survey line we were as we approached the pole. SOAR also must determine how to remove these ambiguities in navigation as the Twin Otter approaches the pole.

Integrated QC

In order to provide a more integrated QC process across the three platforms of aircraft, satellite base, and main base, the following must be considered:

- With the increasing variety of SOAR experiments, the existing QC code is proving inflexible.
- The subset of QC software used at satellite base camps was inadequate.

Repair and Refurbishment

- SOAR is currently using eight Versa laptop computers, all purchased in the first and second years of operation. These laptops have been failing consistently and repair support is no longer practical.
- The True-Time time code generator (TCG) in the aircraft has no drop-in replacement. The current spare is used as the base station TCG.

Acquisition System

The version of the QNX operating system used for the acquisition systems is out of date and will not be supported much longer.

Aircraft Intercom System

The aircraft intercom system in the passenger compartment of SJB is unreliable. Communication between the pilots and instrument operators is essential to the overall safety in the air as well as enabling coordination among SOAR's instrument operators.

Future Targets

Base Equipment

In order to increase portability of the QC platforms at main and satellite bases, SOAR will design and build two stand-alone "plug-and-play" QC platforms. These will be rack mounted, include flat panel displays and printers, and have digital linear tape and 4mm DAT tape archiving capabilities. In designing this system, SOAR will review current and projected future hardware needs of the platform in light of increasing speed and efficiency of running base station QC. Existing workstations for QC will become the spares pool for the "plug-and-play" system.

Similarly, in order to make the base station monitoring equipment more portable and easier to install, SOAR will develop three rack mounted "plug-and-play" base monitoring stations. These will include three GPS receivers (including a spare), a new base station magnetometer, and all necessary logging hardware. Laptops will be replaced with "lunchbox" style computers which combine a flatpanel display and a small, rugged chassis with full desktop functionality. Spare critical components for the "plug-and-play" base monitoring stations will also be part of the rack mounted systems.

Data Reduction

SOAR will purchase discs, tape drives and printers to replace those on loan from science groups. The purchase of these peripherals was postponed in 1997/98 to realize the cost advantages of advancing technology.

Magnetometers

SOAR plans to acquire a spare cesium magnetometer for the aircraft.

Parts for the spare magnetometer bird winch will be assembled and sent to Kenn Borek Air, Ltd. for installation and full check-out prior to deployment to the field.

Ownership of the second magnetometer bird currently on loan from the USGS will be resolved.

Coherent Radar

Meeting the final objective of actually procuring the best coherent radar hardware will require implementing a method of technology transfer from JPL to SOAR, and/or the use of a subcontractor to produce a hybrid of the various designs. SOAR will continue to fly its existing system through the 1999/00 field season, while working with JPL on the specification and testing of coherent radar technology. This technology will be compared with coherent systems at SOAR and the University of Kansas. Three months of Research Engineering resources (and some travel) will be allocated to these tasks.

SOAR will request that NSF and SOAR begin a dialog with NASA regarding field testing and transfer of JPL's coherent radar technology. Field testing of any jointly developed coherent radar system would occur during the 1999/00 field season.

Digital Avionics Interface

SOAR will assemble and test the spare DAI, and construct a second functional replacement for the Borek DAI 1200.

<u>Precision Navigation</u>

The experimental target for aircraft navigation is to fly within 22.5 meters of the planned flight line. This target is driven by current radar pulse width and processing considerations. In an attempt to resolve this past season's DGPS corrections problems, SOAR will utilize a wider frequency shift modulation method to allow for easier tuning. Also, in continuing the development of robust precision aircraft navigation, SOAR will investigate transmitting GLONASS/GPS corrections to the aircraft. Having both DGPS and GLONASS/GPS systems should provide adequate navigation under varied ionospheric conditions and survey flight plans. SOAR will also investigate GPS navigation using the y-code for the 1999/00 field season.

SOAR will review the erratic GPS data collected as the Twin Otter approached the pole. SOAR will determine the navigation system's limits by simulating a GPS NMEA stream for near pole conditions. SOAR will also evaluate the necessity of a coordinate shift to keep the INS on the aircraft operating near the pole. It will be necessary for SOAR to work closely with our navigation system manufacturers to develop a solution to this problem.

<u>Integrated QC</u>

In order to provide a more integrated QC process across the three platforms of aircraft, satellite base, and main base, the following need to be accomplished:

- SOAR will evaluate the existing QC code and determine which sections must be rewritten in order to achieve maximum flexibility. Four and one-half months of systems analyst time will be allocated to the rewrite.

- The new "plug-and-play" concept for QC (described above under "Base Equipment") will provide identical QC platforms for the main and satellite bases. QC and data archive procedures at the satellite base stations will be identical to those at the main base to maintain data integrity.

- Complete implementation of SOAR's original specifications for real-time monitoring of data at each position on the aircraft will occur prior to the 1998/99 field season. This upgrade will provide user friendly monitoring of data from each instrument in real time along with trend displays of each data stream. SOAR is allocating four and one-half months of systems analyst resources to implement the software specifications.

Repair and Refurbishment

SOAR will replace both NEC Versa laptop and Apple Powerbook computers before next season. In the aircraft, most or all laptops will be replaced with rack mount computers and flat panel monitors, providing a more rugged and reliable computer which will be easier to upgrade in the future. Additional laptop computers must be purchased to replace the four-year-old Apple models currently used in the field for logistics and inventory management.

SOAR will acquire additional spares for the True-Time time code generator and digital avionics interface (DAI).

SOAR will send its laser altimeters for factory refurbishment and will continue to borrow the necessary Ashtech Z-12 GPS receivers (6) from SOAR host institutions (LDEO and UTIG).

Acquisition System

SOAR will upgrade the QNX operating system currently used for data acquisition to a new version which supports current hardware. A new windowing system will be acquired.

Aircraft Intercom System

SOAR will purchase a stand-alone intercom and noise-canceling headset system. This system will be mounted directly on the racks, and have a single cable interface to the Twin Otter.

Satellite Telephones

SOAR will acquire three low-earth-orbit satellite telephones to maintain communications between bases and the aircraft during periods of inadequate HF communications (see Appendix C).

TUD Antennas

In order to have a complete set of ready-to-install spare radar antennas and struts (see Appendix C), SOAR will engineer the modifications required for existing antennas. These plans will be passed to Kenn Borek Air, Ltd. for implementation. Two months of Research Engineering resources will be allocated to this task.

Appendix C: Logistics
SOAR Annual Report
1997/98

This appendix details the logistical support aspects of the facility's 1997/98 field season. It is divided into the following sections:

I. Aircraft Support - facility interactions with the aircraft contractor Kenn Borek Air, Ltd.

II. Field Support - facility interactions with Antarctic Support Associates (ASA).

III. Technical Support - facility interactions with organizations providing equipment and service directly to SOAR, specifically, the University Navigation Consortium (UNAVCO) and the Naval Oceanographic Office (NAVOCEANO).

IV. Cargo Support - facility interactions with NSF and ASA cargo systems.

I. Aircraft Support

This section discusses the facility's goals, plans, accomplishments, issues to be addressed, and future targets as they pertain to the interactions with this contractor and the survey aircraft.

The Twin Otter survey aircraft, flight crew, and maintenance support in the field were provided by Kenn Borek Air, Ltd. of Calgary, Canada.

Goal

SOAR's principle aircraft support goal is to receive the survey aircraft from the contractor optimized to SOAR's specifications for use as an aerogeophysical platform, and after configuration and testing by SOAR personnel, operate it safely and reliably in the field during the survey period.

Plans

To meet its aircraft support goal for the 1997/98 field season, the following items were identified in pre-season planning:

Safety Procedures Manual

Kenn Borek Air was to provide assistance to SOAR in the development of a safety procedures manual based on documentation available through the International Airborne Geophysical Safety Association (IAGSA).

Satellite Base Operations

Borek Air was to assure the availability of the support equipment and other accommodations necessary to allow operations for seventy-two hours at each satellite base (NPX and DNB) without returning to the SOAR main base at Siple Dome.

Repair or Replacement of Aircraft Autopilot

Borek Air was to repair or replace the aircraft autopilot to ensure the altitude hold requirement of ± 12 meters is met, with response tuning capability in the field.

On-site Spares

Borek Air was to obtain on-site spares, engineering diagrams, and manuals for critical contractor supplied systems (INS, autopilot; assistance to SOAR in construction of new DAIs) and implement a plan for quick delivery of replacement aircraft parts (see Table C.1, Equipment To be Supplied by Kenn Borek Air, Ltd.).

Spare Radar Antennas and Struts

Borek Air was to construct a complete set of ready-to-install spare radar antennas and struts. Existing spares were to have been adapted and new ones fabricated as needed.

Pre-deployment Site Visit to Kenn Borek Air, Ltd.

SOAR personnel were to conduct a pre-deployment site visit to Kenn Borek Air, Ltd. to inspect aircraft fabrications and modifications and verify SOAR specifications (see Table C.1).

HF Receiver and Antenna Interfaces for DGPS Data

Borek Air was to establish HF receiver and antenna interfaces for passing DGPS correction data to the SOAR precision navigation equipment. Additionally, the GLONASS/GPS antenna used for precision navigation was to be mounted in such a way as to allow servicing in the field.

Two Flight Crews

Two flight crews (four pilots) were to be available for three flights a day, from early November, 1997 through January, 1998.

Delivery of the Twin Otter to Siple Dome

Borek Air was to deliver the Twin Otter directly to Siple Dome Camp from the contractor facility in Calgary.

Accomplishments

This section focuses on the aircraft support accomplishments during the fourth year of the facility operations.

Safety Procedures Manual

SOAR has obtained and reviewed available documentation of recommended safety procedures from the International Airborne Geophysical Safety Association (IAGSA).

SOAR has instituted the policy of conducting a Risk Assessment of survey areas in mountainous regions taking account of the topography of the area and the climb rate of the Twin Otter at specific elevations. SOAR has completed, and utilized in the field, a Risk Assessment of the TAM/Pensacola-Pole Transect with the assistance of Borek pilots.

Table C.1
Equipment Supplied by Kenn Borek Air, Ltd.

Equipment	Specifications
GPS positioning*	CA code with latitude and longitude (±0.1 minute) available over an RS-232 port.
Inertial Navigation*	Litton LT-92R or equivalent with all raw binary output available for SOAR interfacing.
Pressure Altitude*	0.5m pitot boom and Paroscientific 1015a or equivalent with pressure (±0.1 mbar) over a range of 600-1100 mbar, available over an RS-232 port.
Outside Air Temperature*	Temperature (±1°C) over a range of -40 to +25°C available for SOAR interfacing.
Autopilot †	Roll, pitch and pressure altitude stabilized with all controls available to both pilot and copilot. Altitude hold performance must attain ±12 meters maximum excursions with the capability of tuning responses in the field.
Antenna system refurbishment and cable raceway in wings	For user-supplied radar antennas to be mounted beneath wings; includes flight preparation/relamination of user supplied antennas and struts, including modification and/or fabrication of spares.
Securing mechanisms and viewing window	For the "bird" containing the magnetometer sensor that is to be towed on a 30m retractable cable, and laser ranger finder which is mounted in viewport.
Auxiliary Power Units †	28V at 10 kW. One APU is required at the main base and each of the satellite bases.
Precision Navigation Equipment Interfaces	HF radio† with audio line output and antenna to receive DGPS correction signal.
Radar Altimeter*	Altitude above surface (±0.5m) over a range of 0 to 500m, available for SOAR interfacing.
Digital Avionics Interface (DAI) *	RS-232 data interfacing to SOAR will be by DAI 1200 made available to SOAR for reproduction.
Low Earth Orbit (LEO) Satellite Communications	A satellite telephone system compatible with SOAR supplied ground units must be acquired and installed.

*Engineering diagrams and manuals must be available in the field for these avionics systems.
†Spare parts, engineering diagrams, and manuals must be available in the field for these systems.

Satellite Base Operations

SOAR was required to stay overnight at DNB on multiple occasions. Accommodations at DNB were marginally adequate for a multiple night stay of the aircraft and SOAR crew. The planned three-flight per day operations from Downstream B were not possible due to the length of the pilots' flight day, and to aircraft certification requirements. These certification requirements necessitated inspection of the Twin Otter by a Borek mechanic at the beginning of every duty day. The absence of a Borek mechanic at both Downstream B and South Pole increased the number of transit flights, and represented a significant limitation in satellite base operation this field season.

Repair or Replace Aircraft Autopilot

Altitude oscillations, apparently due to autopilot feedback circuits, were observed in previous seasons. No large systematic altitude oscillations were noticed during the 1997/98 season, indicating the autopilot was calibrated and operating within SOAR specifications.

On-site Spares

Spares for the INS and autopilot were located on the other Borek Twin Otter in Antarctica. Borek has loaned SOAR the DAI currently used so that it may be duplicated.

Among the items to be supplied by Borek Air were three auxiliary power units (APUs; 28V, 10 kW). One APU was located at the main base, and one for each of the satellite bases. Borek initially supplied two APUs for SOAR use, located at South Pole Station and Siple Dome Camp. A third APU was eventually supplied for Downstream B. The APU at Downstream B did not function due to a faulty relay, while the APU at pole was never tested. Without a functioning APU at Downstream B, the Twin Otter was unable to sit idle for more than an hour, and could not be shut down. The Borek mechanic was transported to Downstream B via Twin Otter to repair the APU. These difficulties in positioning and servicing the APUs delayed SOAR survey operations.

Spare Radar Antennas and Struts

A complete set of ready-to-install spare radar antennas and struts were not ready for the 1997/98 field season. In the case of a failure of the primary radar antenna and strut system, SOAR could not complete its field objectives.

Pre-deployment Site Visit to Kenn Borek Air, Ltd.

Three SOAR personnel traveled to Calgary to conduct a pre-deployment inspection of aircraft fabrications and modifications and to verify SOAR specifications as listed in Table C.1. The radar antenna cables were installed during the visit.

HF Receiver and Antenna Interfaces for DGPS Data

HF receiver and antenna interfaces were set up to pass DGPS correction data to the SOAR precision navigation equipment. For an undetermined reason, the receiver on the aircraft could not pick up DGPS data sent from Siple Dome Camp, although the system was configured identically to the previous season when it was used successfully.

For ease of servicing, the GLONASS/GPS antenna was installed on top of the fuselage with the other GPS antennas rather than on the vertical tail fin. The new GLONASS/GPS antenna used during the 1997/98 season did not require a separate preamplifier nearby, simplifying installation and maintenance.

Two Flight Crews

A single flight crew was at Siple Dome from mid-November and was joined by a second flight crew in mid-December. Two flight crews were available to SOAR until the final week of the flight season. The absence of two flight crews at Siple Dome during the last week of the field season ended SOAR's capability to conduct three flight per day operations.

Delivery of the Twin Otter to Siple Dome

Kenn Borek Air, Ltd. delivered the Twin Otter to Siple Dome by the time SOAR arrived at camp (November 13).

Issues to Address

Safety Procedures Manual

There is limited access to IAGSA resources without IAGSA membership.

SOAR would like Kenn Borek Air, Ltd. to take an active role in developing the Safety Procedures Manual.

Satellite Base Operations

In order to ensure up to seventy-two hours of operation from a satellite base, the following must be addressed:

- How best to meet the requirement that the plane be inspected by a Borek mechanic at the beginning of every duty day.
- The necessary aircraft support equipment must be located at the satellite base, including a functioning APU.
- The flight crew was, in general, unwilling to spend the night at a satellite base unless return to the main base was impossible due to weather conditions.

Spare Radar Antenna and Struts

Borek Air did not provide spare radar antennas and struts.

HF Receiver and Antenna Interfaces for DGPS Data

SOAR needs to work with Borek to evaluate why the DGPS signal was not routinely received on the plane.

Two flight crews

Borek Air provided two flight crews for 90% of the 1997/98 survey period. Logistical constraints, such as aircraft certification requirements and the absence of a second flight crew for the last week of the field season, prevented SOAR, in general, from obtaining the operational target of three-flights per day.

Winch Power Cable

The winch power cable on the Twin Otter is faulty and needs to be repaired. The winch failed during a flight this year, and the magnetometer was pulled in by hand. A temporary fix in the field was implemented without removing rack mounted instrumentation, but a more substantial failure might require disassembling the racks.

Intercom

Kenn Borek Air, Ltd. provided an intercom system, but the system functioned poorly and was inadequate for safe survey operations.

Satellite Telephone

The International Airborne Geophysical Safety Association (IAGSA) recommends that all survey aircraft be equipped with a satellite telephone.

Future Targets

Safety Procedures Manual

SOAR plans to join the IAGSA and strongly recommends Kenn Borek Air, Ltd. also join. Development of the Safety Procedures Manual should occur jointly between SOAR and Borek.

SOAR will produce a Risk Assessment of the Marie Byrd Land survey area with the assistance of Kenn Borek Air, Ltd.

Satellite Base Operations

In order to assure up to three flight-days of operation, or five days of residence at a satellite camp, Kenn Borek Air, Ltd. must:

- be able to comply with aircraft certification requirements at the satellite base,
- supply necessary aircraft support equipment,
- be willing to spend multiple nights away from the main base camp.

Aircraft Autopilot

Borek should continue to maintain the ability to repair or replace the aircraft autopilot to ensure the altitude hold requirement of +/- 12 meters is met (with the capability for response tuning in the field).

On-site Spares and Aircraft Repairs

Borek should maintain on-site spares of the critical contractor supplied systems and implement a plan for quick delivery of replacement aircraft parts (see Table C.1, Equipment To Be Supplied by Kenn Borek Air, Ltd.). Of particular interest are available spares for the INS and autopilot. Special attention should be given to repairing the power cabling for the magnetometer winch prior to deployment.

Spare Radar Antenna and Struts

SOAR will engineer a new strut design for the existing antennas currently configured for an LC-130. This design should be implemented by Kenn Borek Air, Ltd. A visit by SOAR personnel to Calgary is planned to assure that this work is completed.

Pre-deployment Site Visit to Kenn Borek Air, Ltd.

A pre-deployment site visit to Kenn Borek Air, Ltd. by SOAR personnel is planned in order to inspect aircraft fabrications and modifications and to verify SOAR specifications (see Table C.1, Equipment To Be Supplied by Kenn Borek Air, Ltd.).

HF Receiver and Antenna Interfaces for DGPS Data

SOAR needs to work with Kenn Borek Air, Ltd. to ensure the HF receiver and antenna interfaces used to pass DGPS correction data to the SOAR precision navigation equipment is functioning adequately for the 1998/99 field season.

Two flight crews

Two flight crews (four pilots), including the personnel required for daily aircraft inspections at satellite bases, should be available to complete an 83 survey flight season lasting from early November 1998 through January 1999. The planned flight rate is three per day.

Delivery of the Twin Otter to Siple Dome

Kenn Borek Air, Ltd. should deliver the Twin Otter to Siple Dome Camp directly from the contractor facility in Calgary.

Intercom

Kenn Borek Air, Ltd. needs to provide assistance in installing SOAR supplied intercoms. Installation and testing should take place in Calgary prior to the start of the 1998/99 field season.

Satellite Telephone

With the completion of the Iridium low earth orbit satellite constellation, satellite telephone coverage is available for all of Antarctica. An Iridium telephone should be installed in the survey aircraft for use during periods of unreliable HF communications.

II. Field Support

Field support includes services provided by ASA to the facility principally for operations of the field camp. This section focuses on these services.

Goals

The goals of the SOAR field support efforts primarily are to ensure that the field camp is set up to optimize configuration and safe operation of the survey aircraft, and secondarily, to minimize the time and resources necessary for field setup and maintenance.

Plans

Siple Dome Camp and Satellites

SOAR targeted the use of Siple Dome Camp as the SOAR main base with satellite bases at Downstream B and South Pole Station.

Establishment of ATS Voice and Data Communication

SOAR requested the establishment of ATS (or better) voice and data communications links at the field site prior to the arrival of SOAR field personnel with a detailed plan for upgrading to 10 megabytes per day throughput to allow monitoring of QC products in North America.

Flight Following Capabilities

SOAR required the implementation of flight following capability, with hourly updates from three locations during flight operations: Siple Dome, Downstream B, and South Pole Station.

Alternate Landing Sites

Maintenance of two alternate landing sites with fuel caches positioned at least seventy-five kilometers and no more than 200 km away from each base of operations was required. When possible, the other SOAR bases could fill this role on a mutually supporting basis.

Camp Medivac Policy

In order to address field camp medivac policies encountered during the 1996/97 field season, a policy was implemented for SOAR personnel to communicate medical problems to the SOAR senior personnel in the field. SOAR requested the camp medical personnel inform both the camp manager and the SOAR senior personnel of developing medical problems for SOAR personnel.

Accomplishments

Siple Dome Camp and Satellites

SOAR personnel occupied Siple Dome Camp from November 13, 1997, through January 31, 1998. Logistical constraints delayed the start of SOAR's field season. The SOAR science jamesway was left at Siple Dome the previous season, and rebuilt this year. Facilities to support the planning, maintenance and survey activities were available. Other camp facilities were available when needed to support aircraft configuration, testing and flight operations. After completion of flight operations on January 28, two days were required for deconfiguring the aircraft and packing equipment. In general, ASA personnel at Siple Dome did a good job of supporting SOAR operations throughout the season.

Downstream B satellite base was to have been ready for use early in the season, but logistical constraints and weather did not allow an LC-130 to deliver necessary equipment and personnel from Siple Dome Camp to Downstream B. After the cancellation of numerous LC-130 flights to Siple Dome, personnel and small, absolutely essential items were transported to

Downstream B via Twin Otter, so that operations out of Downstream B could begin. The bulk of SOAR's equipment and supplies were eventually delivered via LC-130. Given the limited number of ASA personnel stationed at Downstream B, ASA provided adequate support for SOAR operations.

South Pole Station served as a second satellite base and was used for the last four flights of the season. There were some coordination difficulties obtaining magnetic base station measurements from South Pole for those flights. Multiple lines of communication regarding the magnetic base station support resulted in some confusion. These problems would likely have been worked out if SOAR had continued flying out of South Pole. Personnel at South Pole Station responsible for setting up and acquiring GPS data effectively communicated with SOAR regarding SOAR's requirements and conscientiously supplied the needed data and shipped all SOAR data and equipment directly to McMurdo at the end of SOAR's flight operations.

Establishment of ATS Voice and Data Communication

ASA provided equipment and personnel to set up an ATS voice and data communications link at the field site, and were working on its implementation by the time SOAR personnel reached Siple Dome. SOAR assisted in the setup and provided some of the equipment. The amount of data passing daily through Siple Dome averaged about 330 Kbytes of e-mail. SOAR was not able to send QC data products to North America.

Flight Following Capabilities

Communication was consistent and reliable between the in-flight Twin Otter and McMurdo and South Pole Stations. However, communications with Downstream B from Siple Dome Camp were often problematic and required relaying messages through McMurdo or South Pole stations. This caused numerous delays in transmission of information vital to flight operations. Communication delays often caused delays in the flight operations themselves.

Siple Dome camp received hourly weather reports from McMurdo and South Pole Station. Due to the limited number of ASA personnel at Downstream B, hourly weather reports were only available when requested from Siple Dome Camp.

Alternate Landing Sites

Downstream B served as an alternate landing site for most of the LIV and WAG flights.

The WAG (TKD) and STI (TKD) transects were not flown because of unreliable weather and their distances from both Siple Dome Camp and Downstream B.

Camp Medivac Policy

There were no serious medical problems involving SOAR personnel during the season. A PICO employee required a medivac ultimately provided by the utility Twin Otter. SOAR senior personnel were not informed of a possible medical emergency and the proposed plans to use the fully configured Twin Otter for the medivac.

Issues to Address

To maintain and improve the efficiency of aircraft configuration and flight operations, as well as to ensure that flight operations are conducted safely, a number of issues need to be addressed including:

Satellite Base

SOAR's goal of three flights a day cannot be met with the current level of support provided at the satellite camps. In order to achieve our flight operational goal, increased support, especially in the areas of radio communications and food preparation, is required for each satellite base. Additionally, berthing at Downstream B was marginally adequate for extended stays and must be improved for continued safe flight operations out of the satellite base.

Establishment of Higher Bandwidth Voice and Data Communication

Voice communications are critical for installing and maintaining the complex technical systems on the SOAR aircraft. A clear new priority is data transmission at the 10 megabyte per day level. At this level, QC products, or subsets of the raw data, can be sent back to North America for inspection. Voice communication at the level of service provided by ATS continues to be necessary, but a higher bandwidth of data communications is required to support transmission of QC products to North America.

Voice Communications Between Camps

Voice communications between Siple Dome Camp and Downstream B were difficult for two reasons:

1. Downstream B did not have adequate manpower to continuously monitor radio communications.
2. Radio transmissions were often very poor between the main and satellite base.

Communications were often relayed from McMurdo or South Pole Station. Hourly weather updates were immediately relayed, but messages regarding flight operations and planning were often delayed by hours, causing delays in flight operations.

Access to Reliable Weather Forecasts

Weather forecasts and hourly weather reports were received at Siple Dome Camp from Downstream B, McMurdo, and South Pole Station, but did not provide adequate information about weather over survey areas.

Camp Medivac Policy

A suitable camp medivac policy does not exist. The fully configured Twin Otter is entirely inappropriate for medivac use. The fully configured aircraft has a limited range, and open field landings are difficult with the radar antennas installed.

Gravity meter transport

Transport of the gravity meter continues to be difficult and time consuming, requiring several weeks of SOAR personnel effort. While waiting for transport from McMurdo to Siple Dome Camp, the gravity meter was separated from its escort, palletized, and left unplugged overnight. It was then "freight-trained" upon arrival at Siple Dome Camp. More attention must be paid to avoid significant damage to the instrument.

Future Targets

Satellite Bases

SOAR will require satellite base station support for up to three days of flight operations or five days of occupation. This includes adequate radio communications, support in food preparation (during flight operations), and berthing appropriate for regularly scheduled aircraft operations.

Flight Following

SOAR will require a flight following capability with hourly updates from four locations during flight operations: South Pole Station, Siple Dome, Downstream B, and the Ford Ranges.

Establishment of Higher Bandwidth Voice and Data Communication

This season, SOAR requires voice communication at the level of service provided by ATS, and a higher bandwidth of data communications suitable to support transmission of QC products to North America. SOAR generates approximately four megabytes of QC products per flight. There are approximately 400 megabytes of raw data generated per flight. Because of the narrow ATS bandwidth, QC transmission to North America is impossible, and camp e-mail is a burden. If the bandwidth could be expanded to the 10 megabyte per day level, QC transmission would be possible and camp e-mail would no longer be a burden on SOAR personnel. The expanded data rate can not be supported by ATS-3. Other satellite systems now in use in Antarctica (GOES, LES, or TDRS) can be used with small additional effort.

Voice Communications between Operational Bases

Reliable communication between the satellite and main bases of operation is critical. The current radio support is inadequate due to the distance between these operational bases. SOAR will purchase Iridium satellite phones for all main bases and satellites. An additional phone must be installed in the Twin Otter.

Access to Reliable Weather Forecasts

SOAR requests two complete Weatherfax systems: one for Siple Dome Camp, and one for the active satellite camp. SOAR would like ASA to provide a trained observer for each Weatherfax. SOAR will attempt to arrange for University of Wisconsin Department of Meteorology to provide 12 hour forecasts of the region over which SOAR will be flying.

Alternate Landing sites

Maintenance of two alternate landing sites per survey area (four total), with fuel caches positioned at least 75 km and no more than 200 km away from each base of operations is required. When possible, the other SOAR bases can fill this role on a mutually supporting basis. New fuel caches will need to be installed.

Camp Medivac Policy

SOAR requests camp medical personnel inform the camp manager and SOAR senior personnel of any developing medical situation which may require emergency use of the fully configured Twin Otter. We reiterate that the fully configured survey aircraft is entirely inappropriate for medical evacuations.

Gravity Meter Transport

The path for gravity meter transport must be reevaluated with the objective of identifying significant risk for damage. At the present, the field offload represents the most significant apparent risk.

III. Technical Support

This sections covers the interactions of the SOAR facility with other organizations providing technical support. Technical support was provided for the gravity meter and the geodetic GPS receivers.

A. Gravity Meter

Goal

The goal of SOAR is to secure reliable access to a state-of-the-art gravity meter designed for airborne applications.

Plans and Accomplishments

The plan for the 1997/98 field season was to obtain and operate the BGM-3 gravimeter modified for airborne use owned by the Naval Oceanographic Command (NAVOCEANO) for the period from late October to February, 1998. This device was picked up from a NAVOCEANO ship on October 26, 1997 and returned to Bay St. Louis on February 27, 1998.

Issues to Address and Future Targets

Transportation of the gravity meter is somewhat difficult with its need to be powered constantly and to have an escort. The instrument is fragile and some care must be taken during transport. This issue is fully addressed in the succeeding Cargo Section.

In order to support the next field season SOAR plans to obtain the gravity meter for the period from October 25, 1998, through March 1, 1999.

B. GPS Systems for Precise Positioning

GPS technology is utilized by SOAR in two different ways: as a real-time tool to allow accurate airborne navigation along a pre-determined flight path, and to precisely determine the aircraft's position for post-mission data reduction. This section addresses this latter use of GPS, as a precise geodetic positioning system.

Goal

The goal of SOAR for precise positioning is to gain reliable access to the GPS equipment best suited for routine sub-meter position determination of the survey aircraft.

Plans and Accomplishments

This year, SOAR again used both Ashtech Z-12 and Turborogue GPS receivers. For reliability, the two receiver types operated in parallel in the aircraft and on the ground. Multiple receivers of each type were used to prevent data loss due to individual receiver failure.

SOAR required seven Ashtech Z-12 receivers to equip the aircraft, main base, and two satellite bases. SOAR intended to purchase one receiver and borrow the remainder from SOAR host institutions. SOAR did not purchase any receivers but obtained six receivers from the Lamont-Doherty Earth Observatory. The remaining receiver was on loan from the University of Maryland.

SOAR targeted coordination with existing GPS operators at South Pole Station for the 1997/98 field season. SOAR had extensive communication with USGS personnel and South Pole technicians in order to combine GPS equipment already present at South Pole Station with our own equipment. This effort resulted in SOAR augmenting South Pole's base station GPS equipment. The SOAR/USGS/ASA GPS coordination went smoothly.

SOAR planned to, and assumed custody and maintenance responsibilities of the two OPP Turborogue receivers in the UNAVCO pool. UNAVCO surveyed SOAR antenna sites, runway thresholds, and the laser calibration range.

Issues to Address

After reviewing our base station requirements for the 1998/99 season, SOAR must obtain nine Ashtech Z-12 receivers.

Future Targets

SOAR needs nine Ashtech Z-12 receivers to equip the aircraft, main and two satellite bases. For the upcoming season, SOAR intends to borrow all nine receivers from the SOAR host institutions.

SOAR encourages Polar Programs to continue fostering a relationship with UNAVCO to ensure continuing excellent technical development and support. SOAR will require static positioning of its GPS receivers at Siple Dome Camp and South Pole Station, as well as runway thresholds and laser calibration ranges.

SOAR will evaluate coordination with existing GPS operators at South Pole Station for the upcoming field season.

IV. Cargo Support

This section reviews the cargo support provided to the facility by ASA. A significant quantity of cargo must be moved annually from the SOAR central office in Austin, Texas, to the field site in a timely manner. To date it has been necessary for much of this equipment to be returned to North America quickly so data distribution activities could begin soon after the field season.

Goal

The SOAR cargo goal is to move equipment to the field site in a manner which supports the timetable for configuring and operating the survey aircraft and associated ground support facilities.

Plan

1. SOAR estimated the 1997/98 cargo requirements would be similar to estimated amounts for the 1996/97 field season, plus a small (<1000 lb.) increase to accommodate equipment for the satellite bases. Handcarry amounts should also be similar.

2. SOAR targeted working with ASA to arrange acceptable commercial transport for the gravity meter to Christchurch, and back to North America from Christchurch.

Accomplishments and Events

Cargo Shipping

Cargo deployment accomplishments are shown below in two tables. Table C.2 describes the amount of cargo in each of the SOAR 1997/98 shipments. Table C.3 describes the timing of these cargo shipments.

Gravity Meter Shipping

As it is each year, shipping the gravity meter was a high profile and resource intensive process. The "live" gravity meter sensor weighs 325 pounds including its shipping container. The complete system included three additional boxes totaling 375 pounds for a total gravity meter weight of 700 pounds.

Problems were encountered in transporting the gravity meter both to and from Antarctica this year. On the way down, the Air Guard flight departing from Travis Air Force Base in California was delayed due to bad weather conditions in Hawaii. To avoid these delays it was necessary for the gravity meter and escort to board an Air Guard flight en route to Richmond, Australia. On the way back, the gravity meter and escort incurred delays once again in Hawaii. On February 18, the gravity meter and escort were transported via a non-stop commercial airline into Dallas/Fort Worth Airport. SOAR was concerned that further delays in Hawaii would have jeopardized their compliance of the loan agreement with NAVOCEANO to have the BGM-3 returned to Stennis Space Center by February 28.

Table C.2
Cargo Summary

Shipment Number	Number of Pieces	Total Weight (lbs)	Volume (ft^3)
1 (Kilo Air Shipment)	1	500	59
2 (Kilo Air Shipment)	17	4712	494
3 (Kilo Air Shipment)	9	1664	137
4	13	1794	168
5	10	2124	193
6	15	2427	236
7	13	2088	170
8	4	1253	100
9	1	92	9
10	1	16	2
Total	84	16670	1568

<u>Handcarry</u>

In addition to the cargo denoted in the Tables C.2 and C.3, certain items were required to be hand carried from North America to Antarctica because of their late availability, critical importance or immediate need upon arrival. SOAR personnel hand carried only four pieces (200 lbs) down this year.

The number and weight of hand carried items taken into the field continues to show significant decreases. We attribute this to better planning and a concerted effort to discourage hand carried items. Several time sensitive items hand carried in the past (the gravimeter items not requiring an escort and borrowed GPS receivers) were retrograded via commercial air.

Table C.3
Cargo Timetable

Shipment Number	Date Departed Austin, TX	Arrival Dates		
		Port Hueneme	Christchurch	McMurdo
1	18 Jul	25 Aug	15 Sep	24 Nov
2	22 Aug	25 Aug	15 Sep	24 Nov
3	26 Aug	29 Aug	15 Oct	24 Nov
4	17 Sep	19 Sep	22 Oct	24 Nov
5	01 Oct	03 Oct	22 Oct	24 Nov
6	14 Oct	20 Oct	24 Oct	24 Nov
7	22 Oct	24 Oct	29 Oct	01 Dec
8	30 Oct	03 Nov	22 Nov	01 Dec
9	25 Nov	26 Nov	29 Nov	08 Dec
10	17 Dec	18 Dec	22 Dec	26 Dec

New Shipping Containers

Six medium sized Hardigg cases (16 ft^3) were bought to accommodate new equipment purchases and the decrease in the number of hand carried items. Several more wooden boxes were "retired" again this year as SOAR continues to "phase out" its supply of old and unreliable cases.

Issues to Address

To optimize resources during the next field season, the following issue must be addressed:

Gravity Meter Shipping

Changing transportation arrangements for the gravity meter increases the chances that the system will undergo an expensive failure or that it will become separated from its escort. Lengthy delays in gravity meter transport cause significant additional costs.

Future Targets

SOAR's cargo requirement for next year is estimated to be approximately the same as last year. Handcarry amounts should stay about the same.

Shipping Containers

SOAR will investigate the acquisition of custom cases for the two magnetometer "birds" as well as the Henry Radio Amplifier. The custom cases will replace wooden cases currently being used. New nine-inch storage tubs and eight medium Hardigg cases will also be purchased.

Gravity Meter Transport

SOAR recommends commercial transport of the gravity meter and its escort from Dallas to Hawaii, and military transport from Hawaii onward. Similarly, the gravity meter and its escort should return by military escort through to Hawaii, and commercial transport back to Dallas.

Appendix D: Personnel
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This appendix covers the goals, plans, accomplishments, outstanding issues and future targets for SOAR personnel.

Goals

The SOAR personnel goals are to staff the facility with a stable core of highly qualified technical people and to maintain a flexible management structure that allows the core personnel to be easily augmented during periods of peak activity.

Plan

The personnel plan for the fourth year of SOAR activities focused on the following:

Data Reduction

SOAR targeted hiring two full-time data reduction specialists. The persons were to begin a six month training period in late summer 1997 and be fully prepared for the arrival of the 1997/98 data in early 1998.

Technical

SOAR was to task the current research engineer with evaluating the specifications for coherent radar. A new engineer was to be hired and trained.

Administrative

SOAR targeted adding one month of support by an administrative associate to the year's personnel budget.

Field

1. SOAR targeted implementing a two year extension to the existing contract with Expedition Computing Services (ECS) to supply QC and data archival products in the field. The statement of work for ECS was to be expanded to include the responsibility of optimizing the architecture of the download and QC computer network.

2. The basic staff level to support survey operations during the 1997/98 field season was estimated to be 13, assuming six core SOAR personnel, three augmented SOAR personnel, and four ECS employees. The two SOAR directors were to be available at critical times in the field to assist with operational transitions, bringing the personnel total to fifteen. One SOAR person would be stationed at Downstream B. SOAR planned to investigate training one of the support staff to operate the SOAR base equipment at South Pole Station to minimize SOAR's impact on station activities.

3. SOAR targeted implementation of a personnel rotation policy to prevent loss of personnel due to lengthy field deployments in multiple years. An eight week field season is the target for experienced SOAR personnel. An employee's first season would be considered a training period and subsequently be a full season. Each subsequent season will be limited to approximately eight weeks. This plan was to be realized without increased staffing levels due to enhanced efficiencies in flight operations.

Accomplishments

<u>Data Reduction</u>

SOAR hired and trained two data-reduction specialists to reduce the 1997/98 raw data. A potential fields specialist was hired to work at the LDEO facility, and a morphology specialist was hired to work at the UTIG facility.

<u>Technical Activities</u>

The existing SOAR research engineer was tasked with evaluating the specifications for the coherent radar. A new research engineer was hired to assume most of the tasking of the former engineer.

<u>Administrative</u>

Though specified in last year's annual report, it was not necessary for SOAR to increase administrative support in the 1997/98 personnel budget.

<u>Field Activities</u>

1. SOAR negotiated a two year extension to the existing contract with Expedition Computing Services (ECS). With some shortfalls, ECS provided QC and archival products in the field and played a part in optimizing the architecture of the download and QC computer network.

2. Survey operations during the 1997/98 field season were supported by 13 people, including six core SOAR personnel, three augmented SOAR personnel, and four ECS employees. A SOAR director was in the field during the installation and test flight stage, bringing the personnel total to 14. One SOAR person was stationed at Downstream B as a base station operator. No SOAR personnel were stationed at South Pole Station.

3. SOAR began implementation of a personnel rotation policy to prevent the loss of key personnel due to lengthy field deployments in multiple consecutive years. Ultimately, SOAR was able to rotate only augmented personnel. The core SOAR employees

participated in the entire field season. Additional staff were not specifically hired to accommodate personnel rotation.

To augment the core staff for the field season the following positions were temporarily filled:

- Augmented Installation Engineer - Don McNair.
- Augmented Research Engineer - Matt Peters.
- Augmented Field Assistant - Vicki Langenheim, employed by the USGS, participated under the USGS subcontract to SOAR.
- Augmented Field Assistant - Lena Krutikov.

The core SOAR personnel in the field and North America were:
Co-director - Don Blankenship (Ph.D. Geophysics, 1989, University of Wisconsin-Madison) has 13 austral summers of field experience in Antarctica, nine as chief scientist including the Corridor Aerogeophysics of the Southern and Eastern Ross Transect Zone (CASERTZ) surveys and the four SOAR field seasons. His efforts there have concentrated on aerogeophysics and seismology. Blankenship was in Antarctica during the installation and test phase of operations.

Co-director - Robin Bell (Ph.D. Geophysics, 1989, Columbia University) has spent three austral summers in Antarctica as chief scientist for the CASERTZ surveys and two austral summers doing long-range aerogeophysics over the Weddell Sea. Her work has been in marine and airborne geophysics with an emphasis on gravity measurements.

Technical Coordinator - Jeff Williams (M.S. Geophysics, 1995, University of Texas at El Paso) served as Science coordinator since shortly before SOAR's first season, and assumed the responsibilities of Technical Coordinator from June, 1997 until March, 1998. His background includes advanced studies in applied geophysics and service as a U.S. Air Force officer and test director for airborne life-support systems. The Technical Coordinator's primary responsibilities include the day-to-day operation of the SOAR facility. Williams was in Antarctica the entire 1997/98 field season and resigned from SOAR upon returning from the field to accept a position in the oil industry.

Technical Coordinator - Tom Richter (M.S. Electrical Engineering, 1993, University of Texas at Austin) served two field seasons with SOAR as Technical Coordinator until returning to active duty in the military in June, 1997. In the past, he was a pilot and an operational test director for aircraft systems for the U.S. Navy.

Science Coordinator - Sammantha Magsino (M.S. Geology, 1994, Florida International University) joined SOAR shortly before the 1997/98 field season. Her background is in geophysical hazardous waste site evaluation and volcano studies. The Science Coordinator's primary responsibilities include interaction with SOAR science clients and data distribution. Magsino was in Antarctica the entire 1997/98 field season.

Senior Research Engineer / Installation Engineer - Ken Griffiths (B.S. Electrical Engineering, 1968, Duke University) is a Research Engineer with the Institute for Geophysics who acts as installation engineer for SOAR. Griffiths has participated in more than ninety marine, land and airborne geophysical field programs including all four SOAR field seasons. Griffiths has both developmental and operational responsibilities for geophysical and navigational systems. Griffiths was in Antarctica the entire 1997/98 field season.

Senior Systems Analyst - Scott Kempf (M.S. Computer Science, 1992, University of Wisconsin-Madison) also moved to SOAR from CASERTZ where he had spent a year programming database applications for underway geophysics. His background at the University of Wisconsin includes experience in systems architecture, programming tools and assembly language applications as well as six years as a network administrator. His primary responsibilities include software development for data acquisition, data distribution and data reduction.

Systems Analyst - John Gerboc (M.S. Systems Science, 1991, State University of New York at Binghamton) joined SOAR prior to its first field season. His previous experience was in software development for vision and airborne systems. While a software engineer at IBM Federal Systems Division, he participated in a number of aircraft based field projects. While with SOAR, he has participated in all field programs with operational responsibility for data acquisition and data distribution. Gerboc was in Antarctica the entire 1997/98 field season.

Research Engineer - Ryan Biggs (B.A. Physics, 1997, University of Texas at Austin) joined SOAR just prior to the 1997/98 field season. His experience includes work as a research assistant in plasma and nuclear physics. His primary responsibilities with SOAR include integration of aircraft instrumentation, and he served as one of the radar and data acquisition system operators. Biggs was in Antarctica the entire 1997/98 field season.

Data Reduction Specialist - David Morse (Ph.D. Geophysics, 1997, University of Washington) joined SOAR in February, 1998 to oversee the reduction of the morphology data sets (i.e., ice-penetrating radar and laser altimetry). He has substantial experience in ground-based radar and GPS studies of ice sheet dynamics. He also has experience reducing airborne radar and laser altimetry data collected by the CASERTZ project over Taylor Dome in East Antarctica, as well as over the West Antarctic ice streams.

Data Reduction Specialist - Robert Arko (M.S. Computer Sciences, 1997, Columbia University) joined SOAR in October, 1997 to oversee the reduction of the potential field data sets. He has been involved in the design and implementation of the airborne gravity reduction process at LDEO, and has worked closely with the USGS on magnetic data reduction. He has substantial experience in GPS studies, including Antarctic field work, as well as experience in support of other Marine Geology and Geophysics database and visualization programs.

Administrative Associate - Wilbert King (B.S. Economics, 1995, University of Texas at Austin) was selected for this position because of his familiarity with computer oriented administration. He has substantial experience with the management of administrative databases as well as University of Texas budgeting. His responsibilities for SOAR include information management and logistics coordination.

The temporary personnel added to augment staffing for the field deployment this year were:

Research Engineer (augmented) - Matt Peters (Ph.D. Electrical Engineering, 1994, The Ohio State University) joined SOAR immediately upon completion of his Ph.D. His doctoral research focus was on antennas and wave propagation for airborne applications. One of the early engineers on the CASERTZ project, he assisted in field preparations and participated in two CASERTZ field seasons. Peters has participated in all four SOAR field programs and has primary operational responsibility for geophysical systems. He was in Antarctica for the installation and test phases of operation during the 1997/98 season.

Installation Engineer (augmented) - Don McNair, a retired geophysical technician at the Geophysics Branch of the USGS with over twenty years of geophysical field experience, was hired to assist with field logistics and equipment setup. He participated in all previous SOAR field programs. McNair was in Antarctica during the installation stage of operations.

Field Assistant (augmented) - Vicki Langenheim (M.S. Geology, 1989, University of California at Berkeley) is a geophysicist with the USGS where she uses potential field data to solve tectonic problems. This year, she flew with SOAR as a potential fields instrument operator on the plane, and supported base station instrumentation. This was her fourth field season with SOAR. Langenheim was in Antarctica for the flight operations phase of the season.

Field Assistant (augmented) - Lena Krutikov (B.A. Geology, 1997, Colgate University) recently graduated and has experience as a Staff Scientist with Southwest Research Institute where she assisted with geophysical data collection and analysis. She joined SOAR during the 1997/98 field season to assist in base station data acquisition at Siple Dome. Krutikov was in Antarctica for the flight operations phase of the field season.

The personnel who worked under the Expedition Computing Services contract to supply computer data products in the field were:

Senior Systems Analyst - Mark Maybee (Ph.D. Computer Science, 1994, University of Colorado-Boulder). His background includes over ten years of research experience in software engineering as well as substantial systems programming experience. He has participated in all four SOAR field programs. Maybee was in Antarctica during the installation and test phase of operations.

Senior Systems Analyst - Dwight Melcher (B.S. Applied Mathematics and Computer Science, 1986, University of Colorado-Boulder). He has over nine years experience with UNIX, programming languages and system administration. Melcher participated in the 1995/96 and 1996/97 SOAR field programs.

Senior Systems Analyst - Eric Robison has over seven years experience as a systems and network administrator. He participated in the last three SOAR field programs. Robison was in Antarctica during the flight operations phase of the season.

Systems Analyst - Geoff Phelps (B.A. Geology, 1990, University of California at Berkeley). His background includes eight years with the USGS and extensive experience with GIS systems and UNIX system administration. This was his second season with ECS and SOAR. Phelps was in Antarctica during the flight operations phase of the season.

Systems Analyst - John Mark Tepper (M. Phil. Mechanical Engineering, 1994, Hong Kong University of Science and Technology). His work experience includes developing windshear warning systems, ocean surveying using GPS and other instruments, and work on global atmospheric projects. This was his first season with ECS and SOAR. Tepper was in Antarctica for the entire 1997/98 field season.

Issues to Address

Technical

SOAR must address its new and changing personnel needs. SOAR does not currently have a technical coordinator. Additionally, SOAR must be prepared to anticipate turnover in engineering and systems analyst positions. Equipment modifications and necessary software modifications also require the addition of personnel to the core SOAR staff.

Administrative

SOAR's North American support needs will increase as SOAR begins receiving daily QC and data products from the field. The increased level of communication between the field program and North America will necessitate a lab manager whose responsibilities will include logistical and information management and coordination of QC products in North America.

Field Activities

1. ECS was responsible for providing personnel to supply QC and data archival products in the field. With some shortfalls, ECS met their contractual obligations. The continued role of ECS in providing field personnel in addition to delivering QC and data archival products may be problematic due to other professional commitments of the ECS principals. The issue of finding qualified personnel to supply computer data products in the field remains critical for the upcoming season. SOAR is in the process of evaluating the role of ECS in future SOAR operations in light of new ECS limitations.

2. SOAR's field personnel rotation plan must be fully implemented in the upcoming seasons. The personnel rotation plan is necessary to maintain the established levels of safety and productivity without significant staff turnover. Long field seasons are slated for the upcoming years due to the high demand for SOAR resources.

3. Personnel must be available for the upcoming field season to install and operate the aircraft, main bases (Siple Dome, South Pole Station), satellite bases (Downstream B, Ford

Ranges), and monitor SOAR activities at Siple Dome while SOAR operates out of South Pole Station.

Future Targets

Overall Staffing Levels

To meet the technical objectives of the SOAR program and to improve SOAR's ability to retain personnel through numerous field seasons an overall increase in personnel has been necessary. This year's budget also includes engineering costs for the coherent radar specification, antenna strut design, and upgrades to both in-flight and base station quality control software. We do not anticipate substantial reductions in personnel costs in future years.

Technical

1. SOAR will hire a replacement Technical Coordinator to assume responsibility of day-to-day operation of the facility. This position is budgeted at six months in recognition of the difference between the departure date of J. Williams and the date on which the position will be filled.

2. SOAR intends to hire two new engineers to fill its need for additional full-time engineering support. One of these new hires will serve to augment and eventually replace an engineer currently on staff who will be returning to graduate studies. The new positions are budgeted at nine and seven months, respectively, to reflect realistic hiring dates. One of these engineers will be tasked with the design of the spare antenna system.

3. SOAR intends to hire two new systems analysts to take responsibility of streamlining QC software and to maintain SOAR's data acquisition systems. The senior systems analyst will train to eventually replace SOAR's current senior systems analyst. The other systems analyst will be responsible for many of the activities previously supported by ECS. The new position is budgeted at nine months to reflect a realistic hiring date while the replacement position is included within the ongoing support at nine months for a senior systems analyst.

4. The data reduction staff (at both UTIG and LDEO) have been budgeted at the same level requested in the 1996/97 Annual Report with nine months support for data reduction specialists plus support of lower level data processors. The UTIG reduction budget also includes support for a senior systems analyst for upgrades and maintenance of the reduction software.

5. Support for completion of the design of the coherent radar will be supported by a research engineer from SOAR at a level of three months.

Administrative

SOAR intends to create a new lab manager position which will replace the administrative associate position. The lab manager will be responsible for logistical and information management and for North American QC coordination.

Field Activities

1. To meet SOAR's field computing needs, two systems analysts and a senior systems analyst will be hired. These augmented positions are budgeted at 4.5 months for the systems analysts and two months for the senior systems analyst. ECS may provide assistance to SOAR in filling these positions.

2. To prevent the loss of personnel due to the requirement of lengthy field deployments in multiple consecutive years, SOAR will fully implement its personnel rotation policy. The goal is an eight week field season for experienced SOAR personnel. An employee's first season will be considered a training period, requiring participation in a full Antarctic field season. Each subsequent consecutive season will be limited to approximately eight weeks. Because of the number of new SOAR core personnel expected during the 1998/99 field season, two experienced core personnel will be required in the field the entire season to maintain technical continuity.

3. The basic staff level to support survey operations in the upcoming field season is calculated to be sixteen, including seven core SOAR personnel. SOAR must augment its core field staff this season to include a science coordinator, an installation engineer and an installation systems analyst, as well as two augmented systems analysts, a research engineer, and two field assistants with one to be supplied by the USGS. A SOAR director will be available at critical times in the field to assist with operational transitions, bringing the personnel total to seventeen. This field staffing level is sufficient to handle aircraft and base assembly and takedown as well as aircraft and base station operation. Each satellite base (Downstream B and Ford Ranges) will require two SOAR personnel during its use.

4. We have budgeted for a temporary science coordinator (4.5 months) for the field season while the SOAR science coordinator, S. Magsino, is on maternity leave. We plan on filling

this position with a scientist with extensive Antarctic field experience to provide continuity to the program. This increased expense is balanced with a reduction of the science coordinator support from SOAR from twelve months to nine months.

Appendix E: Oversight Committee
SOAR Annual Report
1997/98

This appendix reviews goals, plans, accomplishments, outstanding issues, and future targets as a result of interactions with SOAR's Oversight Committee.

Goals

The charter for the SOAR Oversight Committee lies in the Cooperative Agreement established between the University of Texas at Austin and the National Science Foundation, Office of Polar Programs (NSF/OPP). In it, the facility was asked to establish an external oversight committee tasked with "defining broad areas of scientific interest and keeping abreast of technological developments."

Plans

The committee is to meet annually and is intended to represent the interests of the polar earth science, glaciology, general earth science and aerogeophysical operations communities. The facility co-directors, the NSF/OPP Program Officer and a US Antarctic Program Operations Manager are all to be represented at committee meetings.

Fifth Oversight Committee Member

Preliminary contacts have been made with Tim Ahern of the University of Washington. Ahern is affiliated with The Incorporated Research Institutions for Seismology (IRIS) and possesses expertise in data management issues. SOAR requested he join the Oversight Committee as its fifth member.

Next Meeting

SOAR allocated funds for the 1997/98 meeting of the Oversight Committee.

Accomplishments

Fifth Oversight Committee Member

Tim Ahern of the University of Washington agreed to act as SOAR's fifth Oversight Committee member.

Next Meeting

Funds were allocated for a 1997/98 Oversight Committee meeting, but scheduling of the meeting was postponed. SOAR did meet in Washington with NSF for its Third Year Review in April, 1997. This panel of three members of the glaciology and geophysics community, R. Bindschadler (NASA/Goddard), T. McConnell (Scintrex) and P. Gogineni (NASA/Headquarters), provided NSF with a review of SOAR activities through the first three years of the facility's activities.

Issues to Address and Future Targets

1997/98 Oversight Committee Meeting

The Oversight Committee meeting for 1997/98 still needs to be scheduled. A preliminary agenda includes the following items:

- Extension of SOAR's Cooperative Agreement (expiring July 31, 1999).
- Development of a definition for "Project Completion."
- Long Term Plans: Facility Usage.

Appendix F: Finances
SOAR Annual Report
1997/98

This appendix covers the plans, accomplishments and future targets for SOAR finances.

Goal

The financial goal of SOAR is to support the core staff and the physical facility necessary to prepare, configure, and operate a geophysical aircraft in Antarctica. Starting with SOAR Year 4, these activities will include reduction of raw data to a transect product. These objectives will be accomplished at the lowest cost consistent with the data volume and data quality specified in the facility's experimental tasking.

Plans and Accomplishments

The plans and accomplishments for the fourth year of SOAR operations are outlined in Attachment F.1. It presents original budget estimates from the 1996/97 annual report, modified budget estimates made in response to NSF requests, and budget reconciliations as of the end of April, 1998. Expenditures/encumbrances differ from the modified estimates for the following reasons:

1. The hiring of technical personnel continues to be difficult given the present market and the salaries that could be offered through the University of Texas. As a result the SOAR expenditure on salaries was less than planned.

2. A number of items budgeted under the permanent equipment section for Year 4 came in under budget.

3. Various economies in the Other Direct Costs items summed to a significant cost savings.

Issues to Address and Future Targets:

The new issues for Year 5 which significantly influence the budget are:

1. Significantly increased personnel costs.

2. Anticipated termination of the ECS contract.

The cost savings resulting from the anticipated termination of the ECS contract is offset by increased personnel costs for augmented positions for field operations, and two new full time personnel. Personnel additions are required to meet SOAR's increased technical requirements, and the need to implement the rotation of SOAR personnel during field operations. The University of Texas has also accelerated the process of bringing the salaries for technical staff members up to industry standards.

Other budget targets are similar to those for Year 4, however adjustments have been made to Permanent Equipment to reflect changes in Portable Base and QC equipment. Attachment F.2 summarizes SOAR's budget estimates for Year 5.

Attachment F.3 summarizes total awards and expenditures for SOAR's first four years of operation.

Attachment F.1
Year 4 Budget Reconciliation - Institute for Geophysics
05/01/97 - 04/30/98

	Months	Original Budget	Reduced Budget	Projected Expenditures
A. Senior Personnel				
1. D.D. Blankenship	5			
B. Other Personnel				
2. Technical Coordinator	9			
Science Coordinator	12			
Senior Research Engineer/Installation Engineer	5			
Research Engineer	12			
Research Engineer for Coherent Radar	6		3	
Senior Systems Analyst	9			
Systems Analyst	12			
Research Engineer (Field Augment)	5			
Installation Engineer (Field Augment)	2			
Data Reduction Specialist (Data Reduction)	9		7.5	
Data Processor (Data Reduction)	4			
Senior Systems Analyst (Data Reduction)	2			
5. Administrative Associate	9			
Total Salaries		**364,293**	**349,293**	**288,802**
C. Fringe Benefits		89,782	86,085	43,090
Total Salaries & Fringe Benefits		**454,075**	**435,378**	**331,892**
D. Permanent Equipment				
1. (1) Geodetic GPS Receiver -- Ashtech		18,000	0	
2. (2) Equipment for Portable Base Stations		20,000		
3. (2) Cs Airborne Magnetometers		50,000	30,000	
4. Magnetometer Winch (backup)		7,000		
5. (2) DAI Systems (replace DAI 1200)		10,000		
6. Spares for Precision A/C Navigation		15,000	4,000	
7. Field QC Workstation (spare)		14,000		
8. GPS Download Computer		3,000		
9. Field Weather Imaging System		4,000	0	
10. Workstation (Data Reduction)		12,500		
11. Computer Tape Drive (Data Reduction)		4,500		
12. (2) Computer Disks (Data Reduction)		5,000		
13. Printer (Data Reduction)		2,500		
Total Permanent Equipment		**165,500**	**112,500**	**82,599**
E. Travel				
1. Domestic				
2 R/T Austin-Calgary		2,200		
6 Days Per Diem		840		
4 R/T Austin-Bay St. Louis		1,600		
8 Days Per Diem		960		
4 R/T (various)-Austin oversight committee meeting		2,400		
8 Days Per Diem		960		
2 R/T Austin-Washington D.C.		1,000		
4 Days Per Diem		560		
1 R/T Austin-Boston		600		
5 Days Per Diem		600		
1 R/T Austin-Denver		600		
5 Days Per Diem		600		
2 R/T Austin-Palisades NY (Data Reduction)		1,200		
10 Days Per Diem		1,200		
2. Foreign				
1 R/T Austin- Cambridge, UK		1,200		
7 Days Per Diem		1,120		
54 Days Per Diem, Christchurch		6,480		
Total Travel		**24,120**	**19,120**	**19,045**

Attachment F.1 (continued)
Year 4 Budget Reconciliation – Institute for Geophysics
05/01/97 – 04/30/98

	Original Budget	Reduced Budget	Projected Expenditures
G. Other Direct Costs			
1. Materials and Supplies:			
Lab Supplies	4,000		
Field Supplies	15,000		
Electronics	10,000		
Supplies for Data Reduction	900		
4. Computer Services (Data Reduction)	2,000		
5. Subcontracts			
USGS	33,700		
LDEO	190,451	181,611	
Expedition Computing Services	90,000		
6. Other:			
Computer Leasing	2,500		
Shipping	12,800		
Insurance	10,000	5,000	
8 Physicals	5,800	800	
Repair/Refurbishment	36,000		
Copying	800		
Communications	3,400		
Copying and Comms (Data Reduction)	500		
Lease Payments (including utilities)	94,400		
Total Other Direct Costs	**512,251**	**493,411**	**482,387**
H. Total Direct Costs	**1,155,946**	**1,060,409**	**915,923**
I. Indirect Costs 22% Excluding Equipment, Subcontracts and Lease Payments	128,017	120,604	93,260
J. Total Costs	**1,283,963**	**1,181,013**	**1,009,183**

Attachment F.1
Year 4 Budget Reconciliation - Lamont-Doherty Earth Observatory
05/01/97 - 04/30/98

		Months	Original Budget	Reduced Budget	Projected Expenditures
A.	Senior Personnel				
	1. R.E. Bell, Associate Research Scientist	5			
B.	Other Personnel				
	2. Potential Fields Technician (Data Reduction)	9		7.5	
	5. Administrative Assistant	3			
	Total Salaries		**66,000**	**61,500**	**65,535**
C.	Fringe Benefits		18,744	17,466	18,611
	Total Salaries & Fringe Benefits		**84,744**	**78,966**	**84,146**
D.	Permanent Equipment				
	1. Sun Ultra Workstation (Data Reduction)		19,000		
	2. 9 GB Computer Disk (Data Reduction)		3,000		
	3. DLT Tape Drive (Data Reduction)		3,000		
	Total Permanent Equipment		**25,000**		**13,723**
E.	Travel				
	1. Domestic				
	2 R/T New York - Golden CO (Denver)		3,064		
	10 Days Per Diem		1,150		
	4 R/T New York - Austin		5,464		
	21 Days Per Diem		2,121		
	Misc. Ground Transportation		150		
	1 R/T New York - Denver CO (Data Reduction)		1,314		
	5 Days per Diem		575		
	Total Travel		**13,838**		**9,161**
G.	Other Direct Costs				
	1. Materials and Supplies		350		
	Materials and Supplies for Data Reduction		450		
	2. Computer Services		2,700		
	Computer Services for Data Reduction		4,500		
	6. Other:				
	Shipping		550		
	Copying and Communications		3,250		
	Copying and Comms for Data Reduction		250		
	Total Other Direct Costs		**12,050**		**17,750**
H.	**Total Direct Costs**		**135,632**	**129,854**	**124,780**
I.	Indirect Costs		54,819	51,757	61,271
	53% excluding equipment and computer services				
J.	**Total Costs**		**190,451**	**181,611**	**186,051**

Attachment F.1
Year 4 Budget Reconciliation - USGS/Geophysics Branch
05/01/97 - 04/30/98

		Months	Original Budget	Projected Expenditures
A.	Senior Personnel			
	1. C.A. Finn		N/C	
B.	Other Personnel			
	1. Electronics Technician	1.5	6,600	
	2. Field Assistant	4.0	13,001	
	Total Salaries and Benefits		**19,601**	**20,500**
E.	Travel			
	1. Domestic			
	2 meetings, 1 person		1,500	
	2. Foreign			
	7 days per diem		1,050	
	Total Travel		**2,550**	**4,550**
G.	Other Direct Costs			
	Materials and Supplies			
	Field		800	
	Electronics		1,200	
	Shipping		1,500	
	2 Physicals		1,200	
	Equipment Repair		5,600	
	Total Other Direct Costs		**10,300**	**3,900**
J.	**Total Cost**		**32,451**	**28950**

Attachment F.1
Year 4 Budget Reconciliation – Expedition Computing Services
05/01/97 – 04/30/98

		Months	Budgeted	Projected Expenditures
A.	Senior Personnel			
	1. Mark Maybee	2.0		
	Dwight Melcher	2.5		
	Eric Robison	2.5		
B.	Other Personnel			
	5. Systems Analyst	3.0		
	Total Salaries		**53,892**	**64,353**
C.	Fringe Benefits		17,784	21,236
	Total Salaries & Fringe Benefits		**71,676**	**85,590**
E.	Travel			
	1. Domestic			
	4 R/T Golden CO (Denver) - Austin		2,000	2,521
	42 Days Per Diem		5,040	3,480
	2. Foreign			
	28 Days Per Diem - Christchurch NZ		3,360	3,360
	Total Travel		**10,400**	**9,361**
G.	Other Direct Costs			
	1. Materials and Supplies		1000	0
	6. Other:			
	Shipping		500	62
	Communications		1,500	270
	Physicals		1,400	1,839
	Lease/rent/storage		7,000	2,750
	Postage		50	0
	Utilities		840	0
	Books/tech literature		800	0
	Misc		500	2,005
	Total Other Direct Costs		**13,590**	**8,700**
H.	**Total Direct Costs**		**95,666**	**101,877**
I.	Indirect Costs		0	0
J.	**Total Costs**		**95,666**	**101,877**

Attachment F.2
Year 5 Budget Estimate - Institute for Geophysics
05/01/98 - 04/30/99

		Months	Budgeted
A.	Senior Personnel		
	1. D.D. Blankenship	5	
B.	Other Personnel		
	2. Technical Coordinator	6	
	Science Coordinator	9	
	Senior Research Engineer/Installation Engineer	5	
	Research Engineer	12	
	Research Engineer	9	
	Research Engineer for Coherent Radar	3	
	Senior Systems Analyst	9	
	Systems Analyst	12	
	Systems Analyst	9	
	Science Coordinator (Field Augment)	4.5	
	Research Engineer (Augment, antenna design)	7	
	Installation Engineer (Field Augment)	2	
	Installation Senior Systems Analyst (Field Augment)	2	
	Systems Analyst (Field Augment)	4.5	
	Systems Analyst (Field Augment)	4.5	
	Field Assistant (Augment)	4.5	
	Laboratory Manager	8	
	Data Reduction Specialist (Data Reduction)	9	
	Data Processor (Data Reduction)	4	
	Senior Systems Analyst (Data Reduction)	2	
	Total Salaries		**457,731**
C.	Fringe Benefits		104,649
	Total Salaries & Fringe Benefits		**562,380**
D.	Permanent Equipment		
	2. (2) Equipment for Portable Base Stations		42,000
	3. Cs Airborne Magnetometer		25,000
	7. (2) Equipment for Portable QC Stations		48,000
	10. Intercom System		4,000
	11. Satellite Telephones		6,000
	13. Computer Disk and Tape Drives (Data Reduction)		5,500
	14. Printer (Data Reduction)		2,500
	15. Shipping Containers		7,700
	16. Desktop Computers (lab)		7,000
	Total Permanent Equipment		**133,000**
E.	Travel		
	1. Domestic		
	1 R/T Austin-Calgary		1,100
	3 Days Per Diem		420
	3 R/T Austin-Calgary		3,300
	9 Days Per Diem		1,260
	4 R/T Austin-Bay St. Louis		1,600
	8 Days Per Diem		960
	5 R/T (various)-Austin (Oversight Committee meeting)		3,000
	10 Days Per Diem		1,200
	2 R/T Austin-Washington D.C.		1,000
	4 Days Per Diem		560
	1 R/T Austin-Pasadena		350
	5 Days Per Diem		800
	1 R/T Austin-Denver		600
	5 Days Per Diem		600
	2. Foreign		
	60 Days Per Diem, Christchurch		7,200
	Total Travel		**23,950**

Attachment F.2 (continued)
Year 5 Budget Estimate – Institute for Geophysics
05/01/98 – 04/30/99

	Months	Budgeted
G. Other Direct Costs		
1. Materials and Supplies:		
Lab Supplies		4,000
Field Supplies		15,000
Electronics		10,000
Supplies for Data Reduction		900
4. Computer Services		
Data Acquisition		500
Data Reduction		3,000
5. Subcontracts		
USGS		32,451
LDEO		170,732
Expedition Computing Services		0
6. Other:		
Shipping		15,000
Insurance		5,000
15 Physicals		7,500
Repair/Refurbishment		24,000
Copying		800
Communications		3,400
LEO Satellite Communications		4,800
Copying and Comms (Data Reduction)		500
Lease Payments (including utilities)		90,000
IAGSA Membership		10,000
Total Other Direct Costs		**387,583**
H. Total Direct Costs		**1,106,913**
I. Indirect Costs (22% excluding equipment, subcontracts, and lease payments)		149,761
J. Total Costs		**1,256,674**

Attachment F.2
Year 5 Budget Estimate - Lamont-Doherty Earth Observatory
05/01/98 - 04/30/99

		Months	Budgeted
A.	Senior Personnel		
	1. R.E. Bell	4	
B.	Other Personnel		
	2. Potential Fields Technician (Data Reduction)	9	
	Processing Technician (Data Reduction)	2	
	5. Administrative Assistant	3	
	Total Salaries		**65,313**
C.	Fringe Benefits		18,549
	Total Salaries & Fringe Benefits		**83,862**
D.	Permanent Equipment		
	(1) DLT Tape System		5500
	Total Permanent Equipment		**5,500**
E.	Travel		
	1. Domestic		
	2 R/T NY - Golden Co (Denver)		2,868
	10 days per diem		1,260
	4 R/T NY - Austin TX		5,736
	21 days per diem		2,499
	Miscellaneous Ground Transportation		150
	1 R/T NY - Denver CO (data reduction)		1,434
	5 days per diem		630
	Total Travel		**14,577**
G.	Other Direct Costs		
	1. Materials and Supplies:		
	Office and Computer Supplies		350
	Data Reduction Supplies		450
	2. Computer Network Subscription		2,700
	Computer Network Subscription for data reduction		4,500
	3. Other		
	Shipping		550
	Communications and Copying		3,250
	Communications and Copying for Data Reduction		250
	Total Other Direct Costs		**12,050**
H.	**Total Direct Costs**		**115,989**
I.	Indirect Costs (22% excluding equipment, subcontracts, and lease payments)		54,743
J.	**Total Costs**		**170,732**

Attachment F.2
Year 5 Budget Estimate – USGS/Geophysics Branch
05/01/98 – 04/30/99

		Months	Budgeted
A.	Senior Personnel		
	1. C. A. Finn		N/C
B.	Other Personnel		
	2. Technician	1.5	
	Field Assistant	4.0	
	Total Salaries		**19,601**
C.	Fringe Benefits		N/C
	Total Salaries & Fringe Benefits		**19,601**
D.	Permanent Equipment		0
	Total Permanent Equipment		**0**
E.	Travel		
	1. Domestic		
	2 R/T CO - Austin TX		1,500
	2. Foreign		
	13 Days Per Diem, Christchurch		1,050
	Total Travel		**2,550**
G.	Other Direct Costs		
	1. Materials and Supplies		
	Supplies		2,000
	6. Other:		
	Shipping		1,500
	Physical Exam		1,200
	Repair/Refurbishment		5,600
	Total Other Direct Costs		**10,300**
H.	**Total Direct Costs**		**32,451**
I.	Indirect Costs		N/C
J.	**Total Costs**		**32,451**

Attachment F.3
Total Expenditures – Institute for Geophysics
08/01/94 – 04/30/98

		Awarded	Projected Expenditures
A.	Senior Personnel		
B.	Other Personnel		
	Total Salaries	**1,013,938**	**979,554**
C.	Fringe Benefits	226,340	210,759
	Total Salaries & Fringe Benefits	**1,240,279**	**1,190,313**
D.	Permanent Equipment	383,273	349,795
E.	Travel	77,451	75,678
G.	Other Direct Costs		
	1. Materials and Supplies:		
	4. Computer Services		
	5. Subcontracts		
	USGS	128,941	128,941
	LDEO	456,102	441,491
	Expedition Computing Services	203,175	197,543
	6. Other:	733,570	709,427
	Total Other Direct Costs	**1,521,788**	**1,477,403**
H.	**Total Direct Costs**	**3,222,792**	**3,093,191**
I.	Indirect Costs 22% Excluding Equipment, Office Lease, and Subcontracts (except first $25,000)	389,042	375,504
J.	**Total Costs**	**3,611,835**	**3,468,692**

Attachment F.3
Total Expenditures - Lamont-Doherty Earth Observatory
08/01/94 - 04/30/98

		Budgeted	Projected Expenditures
A.	Senior Personnel		
B.	Other Personnel		
	Total Salaries	**134,207**	**129,791**
C.	Fringe Benefits	36,630	34,944
	Total Salaries & Fringe Benefits	**170,837**	**164,735**
D.	Permanent Equipment	32,782	21,823
E.	Travel	36,881	26,548
G.	Other Direct Costs	38,700	49,548
H.	**Total Direct Costs**	**279,200**	**262,654**
I.	Indirect Costs	126,415	120,022
J.	**Total Costs**	**405,615**	**382,686**

Appendix G: Cooperative Agreement
SOAR Annual Report
1996/97

This appendix contains the five-year Cooperative Agreement between the National Science Foundation Office of Polar Programs and the University of Texas at Austin creating the Support Office for Aerogeophysical Research.

COOPERATIVE AGREEMENT NO. OPP-9319379

PARTIES:	**National Science Foundation** **and** **The University of Texas at Austin**
TITLE:	**Support Office for Aerogeophysical Research (SOAR)**
AMOUNT:	**$3,734,824**
EFFECTIVE DATE:	**August 1, 1994**
EXPIRATION DATE:	**July 31, 1999**
AUTHORITY:	This agreement is awarded under the authority of the National Science Foundation Act (42 U.S.C. 1861 et seq.) and the Federal Grant and Cooperative Agreement Act (31 U.S.C. 6301 et seq.)

This Cooperative Agreement is entered into between the United States of America, hereinafter called the "Government," represented by the National Science Foundation, hereinafter called the "Foundation" or "NSF," and The University of Texas at Austin, hereinafter called the "Awardee".

NSF Program Official:

Scott G. Borg
Office of Polar Programs
Telephone (703) 306-1033
Electronic mail: sborg@nsf.gov

NSF Grant and Agreement Official:

Pamela A. Hawkins
Division of Grants and Agreements
Telephone (703) 306-1213
Electronic mail: pahawkin@nsf.gov

TABLE OF CONTENTS TO

COOPERATIVE AGREEMENT OPP-9319379

I. Special Conditions

I. SPECIAL CONDITIONS

Article 1. Statement of Purpose and General Responsibilities

A. The Support Office for Aerogeophysical Research (SOAR), hereinafter called the "Facility," is a research facility for aerogeophysical work in Antarctica. The goal of the Facility is to develop, maintain and operate a suite of geophysical systems aboard a Twin Otter Aircraft in support of research in Antarctica for five years. The Facility has the capability of collecting and reducing ice penetrating radar, laser altimetry, magnetics and gravity data sets in addition to GPS navigation information. The Facility data product will be a well organized data set under a spatially based hierarchy described in Attachment I. Data is to be made available to the general research community according to NSF policies (see Article 2.D.4 and Article 11.B.(1) (b).

B. The Facility will be housed at the Institute for Geophysics at the University of Texas at Austin.

C. The Awardee will manage joint aerogeophysical projects under the terms and conditions of this Cooperative Agreement and an Annual Program Plan in accordance with the awardee's proposal dated July 12, 1993, revised budget dated July 7, 1994 and revised cover page dated August 22, 1994 An Annual Program Plan is to be developed in consultation with the NSF Program Official in accordance with Article 2.

D. The National Science Foundation through its Polar Earth Sciences Program will provide general project oversight, monitoring, coordination and evaluation to help assure appropriate project performance and administration.

Article 2. Scope of Work and Specific Responsibilities of Awardee

A. The Awardee will ensure that the Office of Polar Programs' scientific and other programmatic needs are effectively integrated with NSF needs as well as the needs of the national and, where appropriate, the international scientific community. All work shall be performed in accordance with this Agreement and an Annual Program Plan.

B. The Awardee shall be responsible for the activities and projects agreed upon in the Annual Program Plan. The Awardee shall establish the facilities, organization, and staffing, as well as perform the supervisory functions of scheduling, planning, budgeting, resource allocation, fiscal control, contracting, and administration necessary to fulfill the requirements of the program delineated in this Agreement and in the Annual Program Plan.

C. The Awardee shall establish the means whereby it will control the business functions of the Facility and its tasks such as, but not limited to: schedule and budget development; fiscal control, reporting, accountability, and strategic planning; and selection and subcontracting for the Facility.

D. The Facility will be used to support the Office of Polar Program sponsored aerogeophysical research in Antarctica. The projects to be supported involve the need for high quality, integrated, geographically based ice thickness, surface elevation, magnetics and gravity data sets from continental Antarctica. The following elements are integral components of the overall Awardee responsibilities:

(1) **Facility Capability**: The basic Facility will provide approximately 55 survey flights per year operating from a single base camp over approximately a 3.5 month field season. The Facility will collect ice penetrating radar, laser altimetry, magnetics and gravity data sets in addition to GPS navigation information. The personnel required to maintain this effort will be 5 facility personnel supported approximately 9 months per year augmented by temporary personnel. The Facility will include the flexibility to expand the number f lights and bases of operations with appropriately increased funding levels. As the number of science groups supported by the Facility expands, increased management expenses will also be budgeted. The Facility staff will operate the platform exclusively during this initial period of five years.

(2) **Facility Management**: The operating structure of the facility will be a Management Team consisting of two co-directors, a technical coordinator and a scientific coordinator. The co-directors are responsible for scientific guidance and technical direction of the facility. The technical coordinator will be responsible for day-to-day management of the facility and will serve as the point of contact for NSF/Operations, U.S. Antarctic Program contractors, facility contractors and sub-contractors. The scientific coordinator will be responsible for evaluating and maintaining data quality and will serve as the point of contact for collaborating investigators.

(3) **Community Interaction**: Optimum use of this community facility requires that survey design and other planning be accomplished prior to funding and scheduling of any work. During the pre-proposal phase, the Facility will be responsible for ascertaining its capabilities and limitations with respect to the proposed work, including, but not limited to, data accuracy and resolution, the design of field experiments and data management considerations. This interaction should begin no later than 60 days prior to proposal submission. The pre-proposal interaction will ensure that the investigator's specific goals can be met, that the proposed project is technically feasible, and that the project could be accommodated with uncommitted facility time. The Awardee will maintain an ongoing dialogue with NSF to allow adequate planning of future work. After notification by NSF of science project funding, the Awardee, NSF and investigators will develop plans for budgeting and project implementation. Scheduling of the aircraft will be the responsibility of the Facility Management Team in consultation with NSF. The collaborating investigator and other users of the facility may provide a representative on site during data acquisition but this representative will not be used to supplement the technical personnel either abroad the aircraft or in a ground support role. The facility personnel will be solely responsible for field operations.

(4) **Data Products and Data Policy**: The Facility product will be a well organized data set of contiguous transacts under a spatially based hierarchy (see Attachment I). Following the field season the data requested in each proposal will be gathered into its spatial hierarchy and sent by the Awardee to the collaborating investigator; this task will be completed within six months following the end of data acquisition. Each investigator may process this data to meet his/her specific objectives. The facility will also collaborate with users who do not wish to reduce their own data. The budgets for this reduction including staffing, computer resources and any associated software development will be negotiated directly with NSF. Approximately two years after acquisition of a geographically contiguous data set is completed for a science project, the data will be available for release to the general community contingent on the approval of the NSF Program Official.

(5) **Scientific Oversight**: The Facility will establish an external oversight committee tasked with defining broad areas of scientific interest and keeping abreast of technological developments. The external oversight committee, representing both the earth science and glaciology communities, will meet at least once annually and may visit the Facility annually. This committee will consist of four members; one representing the polar earth science community, one representing the polar glaciology community, one member with technical expertise in aerogeophysical operations, and one member from the general earth science community. The Facility Co-Directors will be present at all oversight committee meetings. NSF will be represented at oversight committee meetings by the NSF Program Officer, or a designated representative, and an NSF Operations Manager from the U.S. Antarctic Program. The Awardee will negotiate costs to support the activities of the oversight committee directly with the Office of Polar Programs.

(6). **Technical Development**: The Facility will pursue appropriate technical development to enhance its ability to accomplish its scientific goals. Development of capabilities beyond those required to accomplish these goals will be considered directly by NSF in consultation with the Facility Management Team and oversight committee.

(7) **Facility Administration**: The Awardee will identify points of contact to ensure close communication between the Awardee, the NSF Program Official and the NSF Grants and Agreements Official. These points of contact will be the Director of the Office of Sponsored Projects, the Office of Accounting and the Assistant to the Director of the Institute for Geophysics. Their particular responsibilities will include implementation and monitoring of Articles 8, 13 and 15 outlined below. The Awardee will also be responsible for providing a centralized location with proximal laboratories and office space of sufficient size and stability to allow facility personnel both to accomplish the tasks outlined in this article and to interact effectively with collaborators, subcontractors and other Facility visitors. The Awardee will maintain its commitment to the matching salary support outlined in the budget justification of the attached budget estimates.

Article 3. Period of Performance

This Agreement shall be effective for 60 months -- from August 1, 1994 through July 31, 1999.

Article 4. Contractual Arrangement

The Foundation authorizes the Awardee to enter into the proposed contractual arrangements with Lamont-Doherty Earth Observatory and the U.S. Geological Survey, and to fund such arrangements with agreement funds up to the amount indicated in the approved budget. Such contractual arrangements should contain appropriate provisions consistent with the applicable agreement general terms and conditions and any special conditions included in this Agreement.

Article 5. Antarctic Clause

Neither Article 5, Expenditures for Related Projects," of GC-1 nor Article 3, "Programs of Related Projects," of FDP-II may be applied to agreements from NSF's Office of Polar Programs relating to the U.S. Antarctic Program.

This agreement is subject to the Antarctic Conservation Act, 16 U.S.C. 2401 ("ACA"). Unless authorized by regulation or permit, violation of the ACA may result in civil or criminal fines up to $10,000, imprisonment for up to one year, and where appropriate, administrative sanctions up to and including debarment. Please refer to the USAP Personnel Manual for general guidance.

Article 6. Allotment of Funds

A. The total estimated cost of this Agreement from its effective date through expiration is $3,734,824.

B. For purposes of payment of cost, pursuant to the terms outlined in Article 6, the total amount currently allotted by the Government to this Agreement is $666,075. This allotment covers the initial 9-month period of performance through April 30, 1995.

Article 7. Funding Schedule and Review

A. Contingent on the availability of funds, and the acceptance of the Annual Progress Report and Annual Program Plan, NSF expects to provide funding at the following approximate levels:

Fiscal Year	Approximate Funding Level	Period of Performance
1995	$785,895	12 months
1996	$742,886	12 months
1997	$755,820	12 months
1998	$784,148	15 months

B. Under normal circumstances, data organization and management activities continue after data acquisition and are performed concurrently with planning and preparation for the next field season. In light of this, and because of the schedule in year one, an additional three months has been added to the period of performance of the final fiscal year. This will allow completion of the required organization, management and distribution of data from the final field season.

C. The actual level of continued NSF support for years 2 through 5 will be negotiated annually with the Awardee and will depend upon an annual review of progress, which may include a site visit, and the availability of funds. Continuation is dependent on NSF decisions to fund peer reviewed science proposals requiring the Facility. Should NSF decide to terminate the Facility, NSF and the Awardee will negotiate support to complete all projects in progress at that time. In the event that the anticipated level of NSF support cannot be awarded because of budgetary constraints, NSF and the Awardee will negotiate a change in the scope of Facility activities. The Facility will be reviewed after the third year of this agreement (after completion of the third field season) as described in this Article 7.D below. The review will determine if the Awardee is meeting the stated goals and objectives in order to determine if an aerogeophysical facility should be continued beyond the five year period under this Agreement.

D. A formal review of the Facility will be conducted prior to April 30, 1997. The purpose is to determine if the Facility is meeting the stated goals and objectives of this Agreement in order for NSF to determine if an aerogeophysical capability should be continued beyond the five year term of this Agreement. If this capability is to continue, this review will also be used by NSF to determine how continued work should be competed. The review is to be scheduled as not to jeopardize field operations to acquire data. The review process can include observations of NSF or reviewers from any time during the performance prior to the formal review. The review panel will be selected by NSF. The Awardee will negotiate costs to support the activities of the review panel directly with the Office of Polar Programs.

Article 8. Limitation of Funds

NSF shall not be obligated to reimburse the Awardee for costs incurred in excess of the amount currently allotted to the Agreement. The Awardee shall not be obligated to continue performance under this Agreement or incur costs in excess of said amounts unless and until the NSF Grants and Agreements Officer notifies the Awardee in writing that the amount allotted to the Agreement has been increased and specifies in such notice a revised allotment which constitutes the amount allotted for performance under this Agreement.

Article 9. Indirect Costs

The amount granted includes an indirect cost allowance at the following rate: 22% off campus rate. This modified total direct costs consists of all salaries and wages, fringe benefits, materials and supplies, services, travel and subagreements and subcontracts up to $25,000 of each subagreement or subcontracts. Equipment, capital expenditures, charges for patient care and tuition remission, rental costs, scholarships, and fellowships as well as the portion of each subagreement and subcontract in excess of $25,000 shall be excluded from the modified total direct costs.

Article 10. NSF Responsibilities

A. NSF involvement must be consistent with the general scope of work as set forth in this Agreement.

B. Performance under this Cooperative Agreement shall be subject to the general oversight and monitoring of the NSF Program Official cited on the Agreement's cover page. This NSF involvement may include, but is not limited to, the following:

1. provide advice, especially with regard to integration and coordination with NSF's Office of Polar Program activities, including:

   (a) negotiate support for science project interaction with the Facility, including definition of annual tasking and deliverables;
   (b) negotiate for twin otter support and other resources required to implement field work in Antarctica under the Annual Program Plan;
   (c) enforce and support the policy for release of data to the general research community. This policy is that approximately two years after acquisition of a geographically contiguous data set is completed for a science project, the data will be available for release to the general community. The NSF Program Official will be responsible for determining the date of completion of data acquisition for specific projects and for approving the release of data.

C. The NSF Program Official does not have the authority to and may not:

(1) request additional work outside the general scope of the Agreement;

(2) issue instructions which constitute a change as defined in Article 8 of GC-1;

(3) cause an increase or decrease in the estimated cost or time required for performance under the Agreement; or

(4) change the expressed terms and conditions of the Agreement.

D. If, in the opinion of the Awardee, any instructions or requests issued by the NSF Program Official are within one of the categories as defined in 10.C (1) through (4) above, the Awardee shall not proceed, but shall notify the NSF Grants and Agreements Officer and request, if appropriate, modification of the Agreement in accordance with Article 38, "Changes -- Limitation of Funds," of the attached Cooperative Agreement General Conditions.

E. Unless stated otherwise, all NSF approvals, authorizations, notifications and instructions required pursuant to the terms of this Cooperative Agreement must be set forth in writing by the NSF Grants and Agreements Officer.

Article 11. Awardee Reporting Requirements

A. The Awardee shall provide the NSF Program Official with annual program report detailing the prior year's effort by March 1st of each year (normally five (5) copies will be sent). This will also serve as the Awardee's request for continued support. The documentation will usually include, but is not necessary limited to the following:

(1) summary of accomplishments, future plans, and discussion of major change in direction/pace.

(2) a financial report containing the following information:

(a) a budget explanation by major project and major function for the current fiscal year and the preceding fiscal year;

(b) 4-column table (use Form 1030 budget categories) containing actual expenditures, project estimates to end of the current fiscal year, and total expenditures (actual plus projected costs). This information should also be supplied for subcontracts;

(c) a statement of funds estimated to remain unobligated at the end of the current award year;

(d) a proposed program plan in accordance with this agreement and a proposed budget for the next award year in accordance with NSF Form 1030.

B. The Awardees' staff will meet, as necessary, with NSF staff to review the relevant operations of the Facility and to exchange views, ideas, and information concerning the Facility and the Polar Earth Sciences Program.

C. The reports and plans shall be sent in the specified number of copies to the following destination:

No. of Copies	Addressee
5	National Science Foundation Office of Polar Programs, Room 755 Polar Earth Sciences Program Attn.: NSF Program Official

Article 12. Acknowledgment of NSF Support and Reports from Users

In accordance with Article 20, "Publication" of the GC-1 Grant General Conditions, appropriate acknowledgment of NSF's support should be included in reports or publication based on work performed under this Agreement.

Article 13. Key Personnel

The Facility will be under the direction of a Management Team. The following individuals are considered to be essential to the work being performed. Any change in these individuals, or any significant change in the level of effort of the individuals, under this Agreement shall require the prior written approval of the NSF Grants and Agreements Officer.

Personnel	Title	Level of Effort
Donald D. Blankenship	Scientific Director	4 months/year
Robin E. Bell	Scientific Director	4 months/year
Keith A. Najmulski	Technical Coordinator	9 months/year
TBD	Scientific Coordinator	9 months/year

Article 14. Prior Approval and Notification Requirements

In addition to the prior approval requirements as set forth in Article 2 of the GC-1 General Conditions, prior written approval by the NSF Program Official is required for equipment purchases over $15,000, which were not identified in the approved budget, and the reprogramming of funds over $30,000.

Article 15. Permanent Equipment

Title to all equipment purchased and/or fabricated with Government funds under this Agreement shall passed directly to the Government from the vendor. Within 30 days from the date of delivery by the vendor, the Awardee shall furnish the Foundation Property Management Officer with a full description of the equipment, including model and serial number, acquisition cost (including transportation charges), and the date of acquisition. The Awardee shall be responsible for property control over Government equipment until such time as it is delivered to an agent of the Foundation. Upon expiration of the Agreement, disposition of the equipment will be determined by the Foundation in consultation with the Awardee.

Article 16. Order of Precedence

Any inconsistency in this Cooperative Agreement shall be resolved by giving precedence in the following order: (a) the Special Conditions; and (b) the General Conditions.

II. General Conditions

The following General Conditions attached hereto shall apply to this Cooperative Agreement and are incorporated herein:

1. **Grant General Conditions**, GC-1 (5/94)

2. **Cooperative Agreement General Conditions**, NSF CA-1 (5/94), which is amended as follows:

   Delete Article 41, "GC-1 Deletions" in its entirety and substitute the following in lieu thereof.

41. GC-1 Deletions

The following articles in GC-1, Grant General Conditions, are not applicable to this Cooperative Agreement:

4. No-Cost Extensions
5. Expenditures for Related Projects
33. Resolution of Conflicting Conditions (GC-1)
40. Resolution of Conflicting Conditions (CA-1)

IN WITNESS WHEREOF, the parties have executed Cooperative Agreement No. OPP-9319379 "Support Office for Aerogeophysical Research (SOAR)."

UNITED STATES OF AMERICA:	**ACCEPTANCE:**
Aaron R. Asrael	X S Monti
(Signature)	(Signature)
Aaron R. Asrael Grants and Agreements Officer	STEPHEN A. MONTI VICE PROVOST
(Name and Title)	(Name and Title)
8/31/94	SEP 27 1994
(Date)	(Date)
NATIONAL SCIENCE FOUNDATION **Arlington, VA**	**UNIVERSITY OF TEXAS** **Austin, TX**

Attachment I

The data stream from each of the aircraft's independent geophysical and navigation systems is collected by a central acquisition computer. A similar system is used to collect base station observations. These acquisition computers, upon recognizing a packet from a particular system, tag it with an identifier and the time from a master clock. This packet is then written in the order of its arrival to an archival medium. At the completion of a flight, these multiplexed data structures both for the aircraft and the base station are demultiplexed and recombined into a hierarchical file structure. This file structure contains a continuous data stream for each aircraft system along each transect and a continuous data stream for each base-station system for the entire flight period. At the completion of the field season the large radar data stream is separated from the other aircraft streams and all transects are spatially gathered. The data streams requested for each proposal/investigator are then archived for distribution.