UNAVCO

University NAVSTAR Consortium

GPS Support to the National Science Foundation Office of Polar Programs

2001-2002 Season Report

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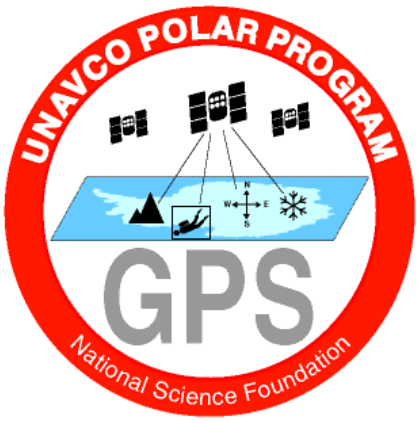

2001-2002 Season Report

April 15, 2002

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Cover photo: Erebus Ice Tongue Mapping – B-017

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Summary

UNAVCO provides year round support for scientific applications of the Global Positioning System (GPS) to the National Science Foundation's Office of Polar Programs (NSF/OPP). GPS support is provided to both the Antarctic and Arctic science programs. This support includes pre-season planning, field support, and post-season follow-up, as well as development work for supporting new applications. The UNAVCO Polar web site (www.unavco.ucar.edu/project_support/polar/polar.html) provides comprehensive and historical information related to UNAVCO support to NSF/OPP.

UNAVCO maintains a "satellite" facility at McMurdo Station, Antarctica during the austral summer research season, providing a full range of support services including GPS equipment, training, project planning, field support, technical consultation, data processing, and data archiving. Sixteen Antarctic projects received support in 2001/2002 as requested prior to the field season, and eight additional projects, including the Antarctic Drilling Project (ANDRILL) reconnaissance, were added during the field season. UNAVCO also installed a second dual-frequency continuous GPS station on Mount Erebus in support of New Mexico Tech (G-081). In addition to the science project support, the differential GPS base station at McMurdo was upgraded to broadcast a newer and more robust data format. Table 1 summarizes Antarctic projects using UNAVCO support, while Appendix A provides more detailed discussions of individual projects.

Support was provided to four NSF/OPP Arctic Program projects during the northern summer 2001, including a site visit to Barrow, Alaska to evaluate the application of a differential GPS base station at the Barrow Arctic Science Consortium (BASC). The incremental cost of supporting these projects was provided by the Arctic Program on a project-by-project basis with funds included in the overall FY 2002 OPP funding action to UNAVCO/UCAR. Table 2 summarizes Arctic projects that received UNAVCO support between April 2001 and April 2002, while Appendix B provides more detailed discussions of individual projects. Support is scheduled for several Alaskan projects during the summer of 2002, including Bench Glacier velocity survey, Kuparuk river basin permafrost measurements, real-time differential GPS (DGPS) support to BASC, and survey grade GPS support to Toolik Field Station.

Table 1 – 2001-2001 Antarctic Support Provided

Project	Point of Contact	Support Effort (%)	Eqp. Loan	Field Support	Training	Data Archived	Data processed	Preseason Request
I-153	Hamilton	13	Yes	No	Yes	Yes	No	Yes
G-081	Desmarias	9	Yes	Yes	Yes	Yes	Yes	Yes
I-205	Sturdy	7	Yes	No	Yes	Yes	No	Yes
B-042-F	Nylen	6	Yes	Yes	Yes	Yes	No	Yes
G-053	Sletten	5	Yes	Yes	No	Yes	Yes	Yes
B-017	Davis	4	Yes	Yes	No	Yes	Yes	Yes
G-052	Glover	4	Yes	No	No	No	No	Yes
G-180	Voight	4	Yes	Yes	Yes	Yes	No	Yes
I-163	Scambos	4	Yes	No	Yes	Yes	No	Yes
I-190	Bliss	4	Yes	Yes	Yes	Yes	No	Yes
I-210	Marshall	4	Yes	No	Yes	Yes	No	Yes
B-042-D	Doran	3	Yes	Yes	No	Yes	Yes	Yes
B-043	Bowser	3	Yes	Yes	No	Yes	Yes	Yes
K-114	Lavelle	3	Yes	Yes	Yes	Yes	No	No
I-171	Hawley	3	Yes	No	Yes	Yes	No	Yes
O-283	Thom	3	Yes	No	Yes	Yes	Yes	Yes
E-318	Klein	3	Yes	No	Yes	No	Real-time	Yes
K-407	Amos	3	Yes	No	No	Yes	No	No
K-352B	Rachid	3	Yes	Yes	No	Yes	Yes	No
NASA	McMurdo Ground Station	3	Yes	Yes	No	Yes	Yes	No
RPSC Environmental: Spills	Gilbert	2	Yes	Yes	No	Yes	Yes	No
RPSC Environmental: Streams	Gilbert	2	Yes	Yes	No	Yes	Yes	No
RPSC GIS	Brunt	3	Yes	Yes	No	Yes	Yes	No
B-005	Hunt/Hoefling	2	Yes	Yes	No	Yes	Real-time	No

Table 2 – 2001 Arctic Support Provided

Project	Point of Contact	Eqp. Loan	Field Support	Training	Data Archived	Data processed
Barrow Erosion	Manley	Yes	Yes	Yes	Yes	Yes
BASC DGPS	Johns	No	Yes	No	No	No
Iceland Tectonics	Dixon	Yes	No	No	Yes	No
Kuparuk Permafrost	Nelson	Yes	No	Yes	No	No

Science Support

Training

UNAVCO offers flexible options for field team training, including training before deployment to the field, training in the field, and direct field engineering support during the project. The level of training is tailored to the experience of each research group. For the 2001/02 season most training was provided at McMurdo Station or in the field, but training was also provided before the field season to B-042-F (Thomas Nylen), I-210 (H.P. Marshall), Mark Dugerov (Barrow Erosion), and Heath Sandall (Kuparuk River Basin Permafrost) at the UNAVCO Facility in Boulder, Colorado.

Field Support

UNAVCO engineers[1] were present at McMurdo Station throughout the mainbody season. The primary responsibilities of the field engineers are managing the large equipment pool and providing technical support to field projects. The field engineers also maintain the DGPS infrastructure and the Mount Erebus continuous station network data collection computer, and train the Raytheon Polar Services Company (RPSC) science technician on maintaining these systems over the winter. Direct field support was also provided to the Barrow Erosion project in Alaska.

Data Processing

Post-processing of differential GPS data is necessary (unless the McMurdo DGPS real-time kinematic (RTK) broadcast is used) to achieve the centimeter level precision required for most projects. UNAVCO supports data processing in the field using commercial software. As in previous seasons, an effort was made to ensure that most data processing was completed before field teams that do not have their own data processing resources left McMurdo. UNAVCO also continues to provide post-season data processing support, using commercial software, the NASA - Jet Propulsion Laboratory (JPL) Auto-GIPSY on-line data processing service, and advanced post-processing techniques for problem data sets.

Data Archiving

All GPS data handled by UNAVCO are archived, both locally at McMurdo Station and at the UNAVCO Boulder archive, to ensure data safeguarding and future accessibility. Antarctic data are sorted by project event number and by Antarctic field season, while Arctic data are archived on a project-by-project basis. UNAVCO archiving services are available to all NSF sponsored geodetic GPS projects – not just those directly supported by UNAVCO – and all investigators are encouraged to archive their data soon after project completion.

Data collected to geodetic standards are archived by site name and precise site coordinates, and site descriptions are readily available on-line. As this database of precise GPS coordinates continues to grow, future projects benefit by having pre-established geodetic control in their field study areas.

Meta-data from all UNAVCO-supported Antarctic projects can be accessed on-line by field season, project event number, or geographic location. The meta-data format is compatible with broader GIS initiatives both within the United States Antarctic Program (USAP) and the Scientific Committee for Antarctic Research (SCAR). UNAVCO-supported GPS project meta-data are also submitted to the National Snow and Ice Data Center (NSIDC) Antarctic Data Coordination Center.

[1] Chuck Kurnik (10/01-02/02) and Shad O'Neel (10/01-01/02)

Equipment

Science Pool

UNAVCO provides complete GPS equipment for both geodetic surveying and mapping applications. Twenty seven geodetic quality dual-frequency receivers from the UNAVCO pool (18 Trimble 4000 SSE/SSi receivers, four Trimble 4700 receivers, two Trimble 4800 receivers, and three Trimble 5700 receivers) were provided for Antarctic support throughout the field season. Prior to the field season all Trimble receivers were updated with the most recent firmware. All necessary ancillary equipment, such as data processing software, solar panels, batteries, chargers, tribrachs, tripods, and cables, was also provided. Because nearly every science group now brings their own laptop computers to the field, UNAVCO encourages and supports the use of these computers for GPS data processing.

Three new Trimble 5700 GPS receivers were purchased for the USAP pool. These current generation GPS receivers have several improved features such as improved data quality, reduced power consumption, smaller size, and increased memory that make them desirable to the Antarctic research community. These receivers were used on the C-16 iceberg, as the International Trans Antarctic Scientific Expedition ITASE unattended base station (I-153, Mayewski), and as a winter-over continuous GPS station on Mount Erebus (G-081, Kyle).

Table 3 highlights the features of this new equipment that are of significance to campaign data collection. Reduced power consumption results in a decrease in the batteries and solar panels required, significantly increasing field portability to remote sites. This can result in significant cost savings to all projects and especially those relying on light aircraft transport to remote field locations.

Increased receiver memory allows data collection for up to a year without data downloads, and allows for higher data logging rates without frequent downloads. Increased memory may eliminate data downloading visits to a site during a campaign, resulting in significant travel and staff time savings. The combination of low power consumption and high memory capacity is particularly well suited to semi-continuous applications in remote locations.

New equipment is also more compact, and a complete receiver-antenna-battery system can now be carried in a single suitcase-sized transport case instead of the two cases required for pool systems as illustrated in Figure 1. Eliminating the need for periodic data downloads and the reduction in bulk and weight are especially important in reducing field costs and logistical complexity for GPS sites only accessible by aircraft.

Table 3. Features of Trimble 4000 vs. new generation Trimble 5700 geodetic receiver

Feature	**Older Trimble 4000 Receiver**	**New Trimble 5700 Receiver**
power consumption	12 W	2.5 W
data logging memory	10 Mb (internal)	128+ Mb (removable commercial PC card)
weight, with battery for 24 hour survey	37.3 kg (82 lb)	14.5 kg (32 lb)
battery location	external	internal and/or external
size	6.3 cu. ft., 2 pcs.	2.0 cu. ft., 1 pc.

Figure 1. Traditional UNAVCO pool campaign system (left) vs. a modern GPS campaign system (right). The modern system is less than half the size and weight of the older UNAVCO pool systems.

Capital equipment procurement has been integral to the past five support budgets to USAP, and has achieved a continuity of modern equipment for Antarctic research. The older equipment is used for applications where newer features are less important (such as the Erebus permanent station CONZ), while newer receivers are targeted to specific applications requiring low power, high memory, and/or field portability. Annual procurements have also allowed the USAP equipment pool to grow with increased demand, and it now makes up a quarter of the entire UNAVCO receiver pool (Table 4). Appendix C provides an itemized list of USAP capital equipment in the UNAVCO pool.

To address the aging NSF Earth Sciences Division (EAR) pool, which is shrinking due to attrition and lack of spare parts, UNAVCO has submitted a proposal, *Acquisition of New Equipment For The UNAVCO Community GPS Pool*, to the NSF-EAR Instrumentation and Facilities (I&F) Program**.** This proposal is currently under review, and if funded would provide an influx of 30 current generation GPS receivers with improved data quality, reduced power consumption, smaller size, and increased memory that make them desirable to the UNAVCO community. A state-of-the-art receiver pool will ensure the UNAVCO Facility's continued leadership in geodetic GPS technology for campaign applications. The proposed 30 receiver purchase will be spread over three years to reduce the initial investment by the EAR-I&F program and to ensure a continuum in age and capability of equipment in the pool. As new equipment becomes available for pool use, the current pool receivers will be phased out of the pool and into NSF-EAR funded research projects for use in permanent GPS installations. Clearly, both OPP and EAR-I&F communities have benefited from the joint use of a well-maintained and supported pool of GPS equipment.

Table 4. Current UNAVCO GPS receiver pool

NSF-EAR Receivers		
Receiver Type	**Quantity**	**Average Age**
Trimble 4000 SSE	14	8 years
Trimble 4000 SSi	10	6 years
Total NSF-EAR	**24**	**7 years**
NSF-OPP Receivers		
Receiver Type	**Quantity**	**Average Age**
Trimble 4000 SSE	2	7 years
Trimble 4000 SSi	6	4 years
Trimble 4700	3	3 years
Trimble 5700	3	1 year
Total NSF-OPP	**14**	**4 years**
Other Receivers		
Receiver Type	**Quantity**	**Average Age**
Ashtech Z12	2 (UNAVCO)	4 years
Trimble 4000 SSi	6 (NSF-ATM)	5 years
Trimble 4700	1 (American Mt. Everest Expedition)	1 year
Trimble 4800	3 (American Mt. Everest Expedition)	4 years
Total Other	**12**	**4 years**
Total Pool		
	Quantity	**Average Age**
	50	**6 years**

Differential GPS System

The McMurdo DGPS system was upgraded this season from a Trimble 4000 SSi to a Trimble 4700. The 4700 broadcasts corrections in Trimble's "CMR+" format, which is more robust than the "RTK" format used by the older 4000 receiver which is now in use as part of the pool. The UNAVCO DGPS equipment was used by B-005 and E-318 in the vicinity of McMurdo Station this season. In addition, the RPSC surveyors used the system with their own equipment for the annual ice runway layout and other survey jobs.

GPS Applications in Beacon Valley

Beacon Valley is home to a confusing bit of ice that underlies the boulder-strewn valley floor. Rock glaciers mix with alpine valley glaciers, and abandoned lateral moraines suggest massive warm-based glaciers once flowed *up*-valley. Today, frost polygons cover the valley floor, slowly stirring up the rubble and leaving only spurious rumors of the history of the valley. A debate rages on the age of the ice, which has been suggested may remain from the Pleiocene. UNAVCO provided several days of field support to Bernard Hallet and Ron Sletten (G-053), and applied GPS in several different ways to further the understanding of Beacon Valley geology.

For the past four years, UNAVCO has performed GPS campaigns on a twenty-one point network in Beacon, Mullins, and Friedmann Valleys. Velocities in Mullins and Friedmann Valleys are expected to be higher because of the steeper surface slope. The small annual displacements of the rocks in Beacon Valley make delineating the rock glacier a difficult task. Because this was the fourth year the boulders were surveyed, the errors on the measurements over this time frame should be lower than the actual displacements. Boulders with displacements less than 2 centimeters are considered stagnant, but those exhibiting larger displacements are truly in motion. These surveys will aid in deciphering where active rock glaciers are found and what parts of the valley contain ancient Taylor Glacier ice. One of the survey marks, BV09, was observed for three days. Future long-term occupations of this site will provide more accurate information about the lower velocities of the valley floor. BV09 is co-located with several thoroughly instrumented polygons. Instruments include strain gages to measure relative movement between polygons, a weather station, and soil thermometers.

In addition to the campaign survey, continuous kinematic surveys (Figure 2) of several frost polygons were performed to make small-scale digital elevation maps (DEMs) of these features. The outlines of the polygons will also be used to geo-reference LIDAR images, the result of a joint effort between the National Aeronautics and Space Administration (NASA) and the United States Geological Survey (USGS) this past season. A Ken Borek Twin Otter aircraft was instrumented and LIDAR data were collected in several locations throughout the Ross Island/Dry Valleys region, including Beacon Valley. The data will result in a high-resolution DEM of the area.

The Twin Otter was also outfitted with a digital camera, and optical images were taken of the Valley floor. UNAVCO geo-referenced three of these images by performing “stop-and-go” kinematic surveys of boulders that could be identified both on the image and in the landscape. Data collected by other continuous kinematic surveys will be used to delineate several old surfaces that are found on the valley sidewall. These surfaces can be differentiated visually by the density of the boulder population. The GPS data will be overlaid on the LIDAR images to examine differences in topography in this area.

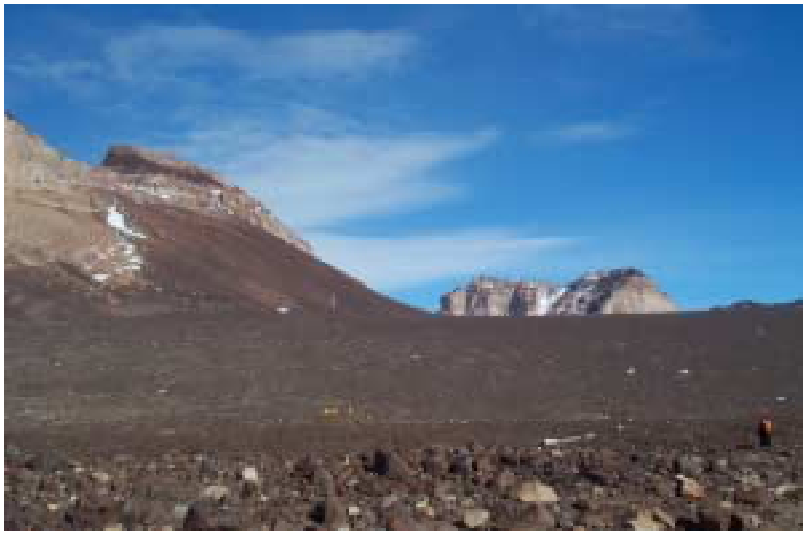

Figure 2. Continuous kinematic survey near the Beacon Valley camp.

Geographical Information Systems (GIS) Products

The increased popularity of GIS with USAP research projects has created a demand for geo-referenced coordinates of physical features. UNAVCO has assisted several projects in obtaining geo-referenced spatial data for several seasons. Examples include control points for aerial photography, boundary surveys, and digitized physical features for mapping and other applications. Many of these data sets are of potential interest to users other than the project team that originally collected the data.

This season, UNAVCO mapped the coastline from Hut Point to Cape Evans, including the Erebus Ice Tongue and Dellbridge Islands (Figure 3). The data collected for B-017 (Davis) will be included on the "GIS Data Products" section of the UNAVCO Polar website.

Figure 3. McMurdo area coastlines.

Appendix A - Detailed Summary of Antarctic Support Provided

B-005 (Art DeVries)

Ben Hunt and Kevin Hoefling requested assistance in locating dive holes and a conductivity-temperature-depth (CTD) monitoring gauge. In all cases the work required locating holes in the sea ice, and a Trimble 4700 with DGPS capability was used. Dr. DeVries' research may require returning to these specific locations in future seasons. UNAVCO provided field support, data processing, and data archiving.

B-017 (Randy Davis)

UNAVCO provided support to map the coastline around the west side of Ross Island, from Hut Point to Cape Evans, including the Dellbridge Islands. Major crack systems and seal holes were also surveyed. UNAVCO provided field support using Trimble 4700 systems, data processing and archiving.

The surveys will be used in conjunction with the group's seal tracking efforts. Dr. Davis' group applies "dead-reckoning" methods to study dive paths of Weddell seals. These surveys are also useful to the McMurdo GIS community for ground-truthing satellite imagery for mapping purposes, and the georeferenced coordinates will be added to the "GIS Data Products" section of the UNAVCO website.

B-042-D (Peter Doran)

Dozens of boulders lie on the permanently frozen surface of Lake Hoare. They provide a unique opportunity to study the dynamics of the lake ice. Bolts have been installed on 14 boulders scattered about the lake surface and these marks are surveyed annually. Two ablation stakes were also surveyed to measure lake ice displacement and translation. UNAVCO provided field support with Trimble 4700 receivers, as well as GPSurvey post processing and data archiving services.

B-042-F (Andrew Fountain)

Alpine glaciers in the Taylor valley are significant contributors of water to the completely contained lake system. Estimates of mass balance for these glaciers require both ablation/accumulation measurements and motion surveys. UNAVCO assisted Thomas Nylen and Andrew Fountain in surveying markers on Canada, Commonwealth, and Taylor Glaciers. Cryoconite holes were simultaneously sampled for biomass analysis. UNAVCO support included training, field assistance (Figure 4), and data archiving. Thomas Nylen came to the UNAVCO Facility in Boulder in July 2001 for training prior to the field season.

Figure 4. UNAVCO field support on Taylor Glacier.

B-043 (Sam Bowser)

Dr. Bowser requested a survey of the New Harbor research area, where the field team studies the unique shallow water occurrence of agglutinated foraminifera, a dominant member of cold, deep-sea sediment ecosystems. GPS was used to obtain sub-meter positions of the shoreline at both high and low tide, and the perimeter of tidepools. UNAVCO provided field support, data processing, and data archiving for this project, which was performed with the Trimble 4700 receiver system in kinematic mode. The coordinates obtained will be used for mapping purposes and to determine changes in water volume between high and low tide.

G-052 (Jerry Mullins)

The US Geological Survey (USGS) performed several multi-day surveys in the area of the Scott Coast and the Dry Valleys in the continuing effort to map, monitor, and provide geodetic control of the McMurdo Sound region. UNAVCO supported this effort with two geodetic receivers and chokering antennas. UNAVCO also collaborated with the USGS this season by occupying two Trans Antarctic Mountain Deformation (TAMDEF) survey points on peaks above Beacon Valley during UNAVCO's field support of G-053.

G-053 (Bernard Hallet)

UNAVCO performed a survey to measure surface displacements in Beacon Valley which occur due to sub-surface ice beneath the valley floor. This survey in January 2002 was an annual repeat of the initial survey from January 1999 and will reveal surface velocities as small as 1 centimeter/year. With a four-season time series, any movement of the valley floor will be apparent. Kinematic surveys of frost polygons and other features were also performed. These data will be used in conjunction with LIDAR data collected this season to draw inferences based on regional topography. Five geodetic receiver systems, field support, data processing, and data archiving were provided. TAMDEF survey mark BEA4 on University Peak was used for the reference receiver location. During support of G-053, UNAVCO also occupied TAMDEF mark BEA0, assisting the USGS with the annual TAMDEF survey.

G-081 (Philip Kyle)

Dr. Kyle requested UNAVCO support to re-survey the nine monument GPS deformation network that was installed on Mount Erebus during the 1999/2000 season (Figure 5). UNAVCO personnel deployed four geodetic receivers early in the field season, and the G-081 team finished the survey. The network is used to monitor deformation of the volcano caused by the migration of magma. UNAVCO also provided two receivers, data processing software, field support and training to research assistant Emily Desmarias to position and map fumaroles. Data processing support and data archiving were provided after the season.

In addition to the episodic campaign survey, maintenance was performed on the dual-frequency permanent GPS station at Truncated Cones (CONZ) and the L1 network stations at the side crater (E1GP), Hooper's Shoulder (HOOZ), and Nausea Knob (NAUS). Data from these permanent stations are downloaded daily to McMurdo Station, and transferred to the UNAVCO archive where they are on-line and publicly available. A second continuously operating dual-frequency receiver was installed on the deformation network monument (ELHT) at the Erebus Lower Hut. This receiver is one of the new low power/high memory Trimble 5700 receivers with capacity to log data throughout the winter. The receiver is powered by the wind and solar electric system at Lower Erebus Hut, and it will be downloaded at the beginning of the 2002-03 season.

UNAVCO is also working with Dr. Kyle on the broadband seismometer and geodetic GPS Major Research Infrastructure project slated for installation in November 2002. UNAVCO's participation in this includes GPS receiver selection and purchasing, GPS specific development support, and GPS data management and archiving.

Figure 5. Mt Erebus deformation campaign.

I-153 (Paul Mayewski)

Seven GPS receivers, including a new 5700 system, and training were provided to ITASE GPS manager Gordon Hamilton. The equipment was used extensively to locate the traverse path and radar pulses, and for campaign surveys of Ian Whillans' "coffee can" sites that estimate accumulation rates at various locations around the West Antarctic Ice Sheet. The project GPS data were archived after the field season. UNAVCO also provided two receivers to Gordon Hamilton after the field season to integrate GPS and ground penetrating radar (GPR) data streams in preparation for next season's ITASE traverse.

I-163 (Charles Raymond)

GPS point of contact Ted Scambos received four geodetic receivers and training to measure velocity profiles near the shear margins of Ridge A-B as part of the study of the recent history of the Siple Coast glaciers. UNAVCO archived the data after the season.

I-171 (Ed Waddington)

UNAVCO provided two Trimble 4000 receivers to field assistant Bob Hawley to determine accurate locations of the Siple Dome 1000-meter borehole. These measurements are required for paleoclimate reconstructions using borehole thermometry. UNAVCO also provided archiving and training.

G-180 (Sridhar Anandakrishnan)

Dr. Anandakrishnan's group is studying tidal forcing of both velocity and seismicity near the grounding zone of Ice Stream D. UNAVCO assisted in deployment of four Trimble 4000 receivers along the length of the ice stream. One receiver was set up at each of the following locations: the Ross Ice Shelf, the ice stream itself, Ridge D-E, and Siple Dome. 24-hour files will be split into four-hour files for tidal correlation analysis. UNAVCO provided field and data archiving support.

I-190 (Doug MacAyeal)

Dr. MacAyeal is studying B-15A and C-16, the most recent of the large icebergs to calve from the Ross Ice Shelf. UNAVCO engineers Chuck Kurnik and Shad O'Neel accompanied field team leader Andy Bliss and mountaineer Chris Simmons to C-16 to install the GPS receivers, a tilt meter, and an Automated Weather Station (AWS) on a 10-meter tower. The data will be used to understand how tides, winds and sea currents affect the movement of the iceberg. UNAVCO provided field support (Figure 6), three geodetic receivers, and data archiving.

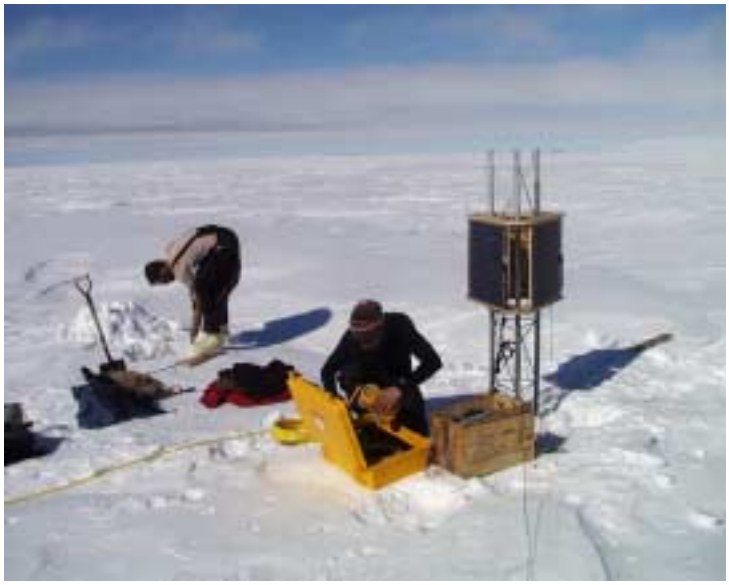

Figure 6. Installation of Trimble 5700 on iceberg C-16.

I-205 (Dave Morse)

Three Trimble 4000 receivers were provided for motion surveys in the Ice Stream D region. The main focus of the project is understanding the onset of streaming flow for the Siple Coast ice streams using radar and GPS techniques. UNAVCO also provided data processing training and archived the data.

I-210 (Howard Conway)

UNAVCO provided three Trimble 4000 receivers and training to field assistant H.P. Marshal to survey old balance/motion poles located on Ridge A-B in the Siple Dome region. The group is also performing extensive ground-based radar measurements in efforts to decipher the glacial history of the region as part of regional paleoclimate studies. UNAVCO archived the data after the season.

O-283 (Chuck Stearns)

UNAVCO provided a Trimble 4700 receiver, training, data processing support, and data archiving to the Automated Weather Station field team in an ongoing effort to produce accurate site elevations used in climate models. These surveys are conducted as “opportunity surveys” during scheduled maintenance visits to the AWS sites.

E-318 (Chuck Kennicutt)

Dr. Kennicutt requested support in locating randomly generated Universal Transverse Mercator (UTM) coordinates in the McMurdo area where samples are taken as part of an environmental monitoring program. UNAVCO provided a Trimble 4700 RTK system and training in the operation of the equipment.

K-114 (Tim Naish)

Mark Lavelle requested GPS support in the New Harbor region as part of reconnaissance work for the Antarctic Drilling Project (ANDRILL), a major international drilling initiative that is scheduled to begin in 2003. Information about the seafloor basement was gathered from active seismology, and GPS was used to determine the hydrophone locations. Sea ice movement was documented over several weeks to understand stresses to which the drill bit will be exposed. UNAVCO provided two Trimble 4700 GPS receivers and ancillary equipment, in-field training, processing training, and archiving for this project.

K-352B (Zainol Rachid)

GPS data were collected continuously for approximately 3 weeks on Crater Hill outside of McMurdo Station with a Trimble 4000 receiver. The data will be used by Dr. Rachid in the study of upper-atmosphere ice crystals in the region. Antarctica New Zealand provided logistical support to this project, and UNAVCO provided the GPS receiver and related equipment, field support, initial data processing and data archiving.

K-407 (Emma Waterhouse)

UNAVCO provided Matt Amos of Land Information New Zealand (LINZ) with a Trimble 4700 and Trimble 4000 to aid in mapping areas around Scott Base and Terra Nova Bay. The work is being done in support of environmental impact studies in the area. UNAVCO provided GPS receivers, ancillary equipment, and data archiving for the project.

NASA (Nik Sinkola)

McMurdo Ground Station (MGS) personnel requested assistance in locating the center of the satellite-tracking dish antenna inside the large white radome near Arrival Heights. The dish antenna was put into "access" position and the GPS antenna was mounted to the "S-Feed". The dish antenna was then rotated to 90 degrees, and the GPS receiver started. The position will be used to geo-reference satellite images of the area. A Trimble 4000 GPS receiver and ancillary equipment, field support, data processing, and data archiving were provided by UNAVCO.

RPSC Environmental Support (Gilbert)

Jeff Gilbert requested assistance from UNAVCO to survey the locations of all fuel tanks at McMurdo Station. This request was in response to a spill from a McMurdo fuel tank and support was provided on a resource-available basis. A post-processed kinematic survey was performed to locate the center of the tanks to approx 30 cm. Historic spill sites in excess of 40 gallons were also marked using a handheld GPS receiver.

A second survey measured the vertical profiles of two possible stream diversions (Figure 7) that RPSC considered due to large run-off of existing streams caused by the warm temperatures this year. These streams cut through fuel spill contaminated areas or are undercutting roads. Accurate vertical elevation profiles are required to determine the feasibility of re-routing these streams. UNAVCO surveyed the possible routes using a Trimble 4000 receiver. Data from both surveys were processed and archived.

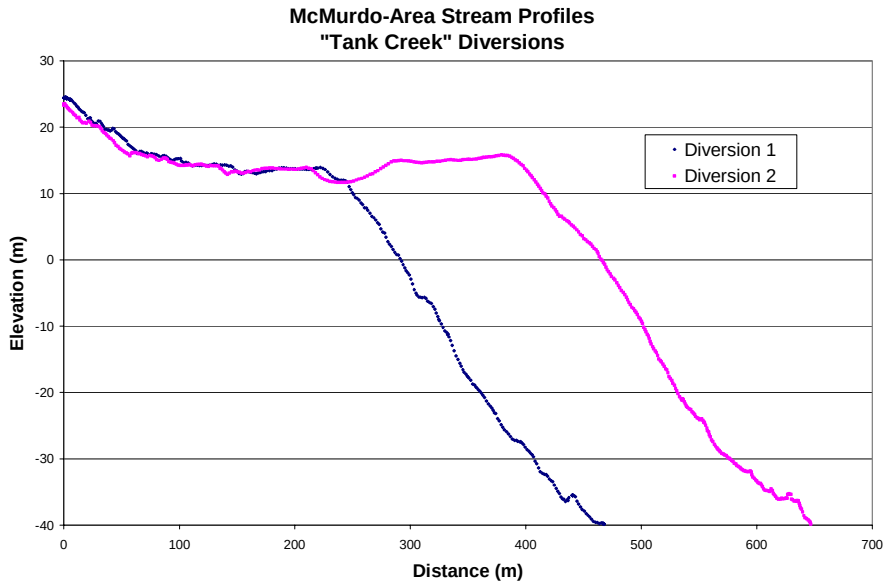

Figure 7. McMurdo area drainage stream profiles.

RPSC GIS (Kelly Brunt)

Kelly Brunt requested UNAVCO GPS support to survey a portion of the Ross Island coast. These data will be used to more accurately geo-reference computer-generated maps of the Ross Island/Dry Valleys area. A Trimble 4700 kinematic backpack system and a Trimble 4000 base station were used to perform a continuous kinematic survey of a coastline just west of Scott Base. UNAVCO also provided field support, data processing, and data archiving. Data collected by UNAVCO for B-017 will also be used for this geo-referencing project. The results from this survey will be added to the "GIS Data Products" section of the UNAVCO webpage.

Appendix B - Detailed Summary of Arctic Support Provided

Barrow Erosion (Amanda Lynch)

UNAVCO provided three GPS receivers, training, and field support to co-PI Bill Manley. GPS was used to aid in the study of Barrow coastal erosion, both to map and digitize the current coastline and to provide ground control to geo-reference aerial and satellite imagery. For this project, a temporary base station was set up at the Barrow Area Science Consortium (BASC) facilities. The kinematic coastline surveys were performed from a four wheeler driven on the beach (Figure 8), and the ground control surveys of features identifiable in aerial imagery were performed as rapid static surveys throughout the Barrow area. After the field project UNAVCO processed and archived the data.

Figure 8. Kinematic GPS survey of Barrow coastline

Barrow Area Science Consortium (BASC) DGPS (Glenn Sheehan)

Bjorn Johns from UNAVCO visited BASC in July 2001 to evaluate the possibility of future DGPS support to BASC, including dedicated geodetic quality equipment and a real-time base station. There was significant interest and enthusiasm for such a system from the scientists using BASC resources, and after the field visit UNAVCO followed up with a support proposal to the NSF-Arctic program. This proposal has been approved, and the system will be available at BASC beginning May 2002.

System installation, technical support, and training will be provided by UNAVCO, and the system will be available year-round to scientists hosted by BASC. By having a dedicated GPS system at BASC, visiting scientists will be able to collect quality GPS data without having to obtain their own GPS equipment. By adding real-time kinematic (RTK) functionality to the base and rover GPS receivers, the system will provide centimeter level precision in real-time in a 5-10 kilometer radius from the base station at BASC. Real-time stakeouts allow the user to return to an exact location without any markers left in the ground.

A Trimble 5700 dual-frequency geodetic GPS base station will be located at BASC. Local users can operate this station as needed, and they will have full control over data collection settings such as sample rate. Successful GPS results require properly trained GPS users, and technical support is critical to ensure effective use of the equipment provided. This support will be provided jointly by UNAVCO and BASC, where UNAVCO provides annual training sessions at Barrow, and also provides on-demand training in Boulder to researchers on their way to Barrow. BASC will provide a local GPS contact for the GPS users. With time, local users will become more familiar with the equipment, and they are likely to provide some support to their colleagues who want to use the equipment for the first time. A dedicated section on the UNAVCO web page will also provide specific documentation for the GPS system at BASC.

UNAVCO is also currently collaborating with the University of Alaska, Fairbanks to install a SuomiNet (atmospheric and geodetic GPS network) permanent GPS station at the NOAA Climate Monitoring and Diagnostics Laboratory (CMDL) facility in Barrow. This permanent station may be installed as soon as May 2002, and will also provide local GPS base station data. Data from SuomiNet sites are archived at UNAVCO, and they are publicly available via the Internet. This site will be a good backup to the planned base station at BASC, as it will provide another source of geodetic GPS control.

Iceland Tectonics (Timothy Dixon)

UNAVCO provided three GPS receivers to Dr. Dixon for investigation of the strain field in the eastern volcanic rift zone and the south Iceland seismic zone and surface deformation at Torfajokull and Hekla volcanoes. This exploratory field project was in collaboration with Icelandic researchers, and resulted in the submission of a proposal to NSF-OPP for continuation of the research. Projects such as this are examples of UNAVCO support to exploratory, pre-proposal research consistent with the goals of the scientific community. Projects that are not tied to a current, funded proposal from a core UNAVCO sponsor receive lower priority and are supported on a resource available basis. The data were archived at UNAVCO after the field season.

Kuparuk Permafrost (Frederick Nelson)

UNAVCO provided two receivers and training to research assistant Heath Sandall. GPS was used to measure seasonal elevation changes in the permafrost active layer in the Kuparuk river basin area on the Alaskan North Slope. The GPS equipment was also used to measure topography to generate digital elevation models of terrain features.

Appendix C – USAP Capital Equipment in the UNAVCO Pool

Item	Manufacturer	Description	Model	Serial Number	UNAVCO ID
COMPUTER	TOSHIBA	LAPTOP	SATELLITE	41215281PU	12587
COMPUTER	TOSHIBA	LAPTOP	5253 CDS	29490350A1	11614
COMPUTER	TOSHIBA	LAPTOP	PR124U1 VCD	Z7462705	11348
COMPUTER	TOSHIBA	LAPTOP	PA1225U VCD	09638973-3	10771
COMPUTER	TOSHIBA	LAPTOP	PA1225U VCD	09634311 -3	10765
GPS ANTENNA	TRIMBLE	GROUNDPLANE	4000SSE	0220126940	11686
GPS ANTENNA	TRIMBLE	GROUNDPLANE	4000SSE	0220143951	11674
GPS ANTENNA	TRIMBLE	GROUNDPLANE	4000SSE	0220156115	11662
GPS ANTENNA	TRIMBLE	GROUNDPLANE	4000SSE	0220125575	11442
GPS ANTENNA	TRIMBLE	GROUNDPLANE	4000SSE	0080122259	6911
GPS ANTENNA	TRIMBLE	GROUNDPLANE	4000SSE	0080104451	6898
GPS ANTENNA	TRIMBLE	GROUNDPLANE	4000SSE	0220125576	11456
GPS ANTENNA	TRIMBLE	GROUNDPLANE	4000SSE	220125577	11492
GPS ANTENNA	TRIMBLE	COMPACT	Microcentered	0220168823	11762
GPS ANTENNA	TRIMBLE	COMPACT	Microcentered	0220169305	11737
GPS ANTENNA	TRIMBLE	COMPACT	Microcentered	0220209404	13440
GPS ANTENNA	TRIMBLE	5700	ZEPHYR	11906361	12763
GPS ANTENNA	TRIMBLE	5700	ZEPHYR	12235208	12732
GPS ANTENNA	TRIMBLE	5700	ZEPHYR	12235268	12741
GPS CONTROLLER	TRIMBLE	W/CASE	TSC1 4700	0220169233	11746
GPS CONTROLLER	TRIMBLE	W/CASE	TSC1 4700	0220208065	13430
GPS CONTROLLER	TRIMBLE	W/CASE	TSC1 4700	0220169407	11723
GPS CONTROLLER	TRIMBLE	W/CASE	TSC1	0220236980	12326
GPS RECEIVER	TRIMBLE	GEODETIC	4000SSE	3427A06738	6897
GPS RECEIVER	TRIMBLE	GEODETIC	4000SSE	3427A06745	6910
GPS RECEIVER	TRIMBLE	GEODETIC	4000SSI	3751A21424	11457
GPS RECEIVER	TRIMBLE	GEODETIC	4000SSI	3827A20726	11443
GPS RECEIVER	TRIMBLE	GEODETIC	4000SSI	3912a25543	11667
GPS RECEIVER	TRIMBLE	GEODETIC	4000SSI	3911A25544	11683
GPS RECEIVER	TRIMBLE	GEODETIC	4000SSI	3838A24051	11695
GPS RECEIVER	TRIMBLE	GEODETIC	4000SSI	3810A21953	11466
GPS RECEIVER	TRIMBLE	GEODETIC	4700	0220212269	13420
GPS RECEIVER	TRIMBLE	GEODETIC	4700	0220168366	11722
GPS RECEIVER	TRIMBLE	GEODETIC	4700	0220168601	11747
GPS RECEIVER	TRIMBLE	GEODETIC	5700	0440100569	12743
GPS RECEIVER	TRIMBLE	GEODETIC	5700	0440102280	12734
GPS RECEIVER	TRIMBLE	GEODETIC	5700	0440103873	12764
MET PACKAGE	VAISALA	SUOMINET	PTU200	V3310010	13902
MONITOR	VIEWSONIC	FLAT SCREEN	VLCDS21833-1	A07011510155	12576
RADIO MODEM	PACIFIC CREST	DGPS	RFM96W	96397081	10713
RADIO MODEM	PACIFIC CREST	W/35W AMPLIFIER	RFM96W	96184911	10716
RADIO MODEM	PACIFIC CREST	DGPS	RFM96W	97281550	11118
RADIO MODEM	PACIFIC CREST	DGPS	RFM96W	97281553	11119
RADIO MODEM	PACIFIC CREST	DGPS	RFM96W	97281548	11120
RADIO MODEM	PACIFIC CREST	W/35W AMPLIFIER	RFM96W	97342043	11121
RADIO MODEM	PACIFIC CREST	DGPS	RFM96W	97281551	11143
RADIO MODEM	FREEWAVE	EREBUS	DGR-115R	903-5817	13470
RADIO MODEM	FREEWAVE	EREBUS	DGR-115R	903-5825	13452
RADIO MODEM	FREEWAVE	EREBUS	DGR-115R	903-5819	13451
RADIO MODEM	FREEWAVE	EREBUS	DGR-115R	903-5817	13471