UNAVCO

University NAVSTAR Consortium

GPS Support to the National Science Foundation Office of Polar Programs Arctic Sciences

2002 Annual Report

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Arctic Sciences

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Cover photo: Benchmark survey during installation of Barrow GPS stations, May 2002.

Table of Contents:

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) Arctic Sciences Section. This support includes pre-season planning, field support, and post-season follow-up, as well as development work for supporting new applications. A full range of support services are available, including GPS equipment, training, project planning, field support (Figure 1), technical consultation, data processing, and data archiving. Five Principal Investigator based projects encompassing a range of applications were supported during 2002. UNAVCO also installed a differential GPS surveying system as general use infrastructure for scientists working at the Barrow Area Science Consortium facility in Barrow, Alaska. Table 1 summarizes projects using UNAVCO support, while Appendix A provides more detailed discussions of individual project support. The UNAVCO web site (www.unavco.ucar.edu) provides comprehensive and historical information related to Polar Programs support.

Figure 1 – Field team on Bench Glacier, Chugach Mountains, Alaska.

Table 1 – 2002 UNAVCO Support Provided

Project	Point of Contact	Eqp. Loan	Field Support	Training	Data Archived	Data processed
Barrow DGPS	Bjorn Johns	Yes	Yes	Yes	Yes	Yes
Bench Glacier	Robert Anderson	Yes	Yes	Yes	Yes	Yes
Black Rapids	Martin Truffer	Yes	No	No	No	No
Kuparuk Permafrost	Frederic Nelson	Yes	No	Yes	Yes	No
Matanuska Glacier	Richard Alley	Yes	No	Yes	No	No
Toolik Lake	Andrew Balser	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. Training was provided at the UNAVCO Facility prior to the field season to Craig Tweedie (Barrow DGPS), Jon Little (Kuparuk Permafrost), and Todd Johnson (Matanuska Glacier). Training was also provided in the field to Craig Tweedie (Barrow DGPS), Robert Anderson and Mike Loso (Bench Glacier), and Andrew Balser (Toolik Lake).

Field Support

UNAVCO provides remote engineering support to Arctic research projects via telephone, email, and documentation on the web. Field support is also available to groups that desire technical support for their geodetic GPS surveys. Direct field support was provided to install the Barrow DGPS system and to the Bench Glacier project.

Data Processing

Post-processing of differential GPS data is required for most projects (unless the Barrow DGPS broadcast is used) to achieve centimeter level precision. UNAVCO supports data processing in the field using Trimble Geomatics Office (TGO) software. UNAVCO also provides post-season data processing support, using TGO software, the NASA - Jet Propulsion Laboratory (JPL) Auto-GIPSY on-line data processing service, and advanced post-processing techniques for problem data sets. Data processing beyond the level typically performed by UNAVCO was provided to the Bench Glacier project as requested by the principal investigator. Due to the large volume of data processed, this effort was funded directly by the investigator's institution.

Data Archiving

All GPS data handled by UNAVCO are archived at the UNAVCO Boulder archive to ensure data safeguarding and future accessibility. The data are sorted by project name and year. 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.

Equipment

Science Pool

UNAVCO provides complete GPS equipment for both geodetic surveying and mapping applications. Three state-of-the-art Trimble 5700 geodetic survey receivers were purchased for the UNAVCO pool on behalf of NSF-OPP Arctic Sciences, and twelve receivers from the UNAVCO pool (8 Trimble 4000 receivers, two Trimble 4700 receivers, and two Trimble 5700 receivers) were provided for arctic project support throughout the field season. All necessary ancillary equipment such as data processing software, solar panels, batteries, chargers, tribrachs, tripods, and cables was also provided.

Barrow Differential GPS System

A Trimble 5700 real-time kinematic (RTK) differential GPS (DGPS) system was purchased and installed in May 2002 for dedicated use at the Barrow Area Science Consortium (BASC) to meet the surveying needs of NSF sponsored researchers working at BASC (Figures 2 and 3). RTK broadcasts provide real-time surveying capability within a seven kilometer radius of BASC, and a portable repeater is available to ensure line-of-sight radio coverage for RTK work within the Barrow Environmental Observatory (BEO). A dedicated GPS data processing computer is set up at the BASC facility, and by collecting and post-processing data centimeter-level accuracy can be realized over 100 kilometers away from the Barrow base station, including the Atqasuk research sites.

Figure 2 – BASC DGPS base station.

Figure 3 – RTK survey equipment on the Chukchi Sea ice.

UNAVCO is available for year-round technical support to users of this system, and a dedicated web page (Figure 4) provides system documentation and various options for requesting UNAVCO assistance. Users who intend to use the system for a significant amount of field surveying are strongly encouraged to arrange for training at the UNAVCO Facility prior to their field season. Field support may also be available for projects with a significant GPS surveying component. Specific on-line documentation is available for users familiar with GPS surveying and data processing, and a complete set of system documentation is available at BASC. Remote (email and telephone) support is also provided, and upon project completion GPS data and meta-data archival is available for permanent safeguarding.

Support in Barrow includes equipment scheduling, check-out, and check-in. During the 2002 summer season, this support was provided by Michigan State University researcher Craig Tweedie and undergraduate research assistant Shawn Serbin. In addition to managing the equipment, they supported several local requests for survey data collection, and provided limited system training. Although informal, this support was effective and a similar arrangement will be explored for future years.

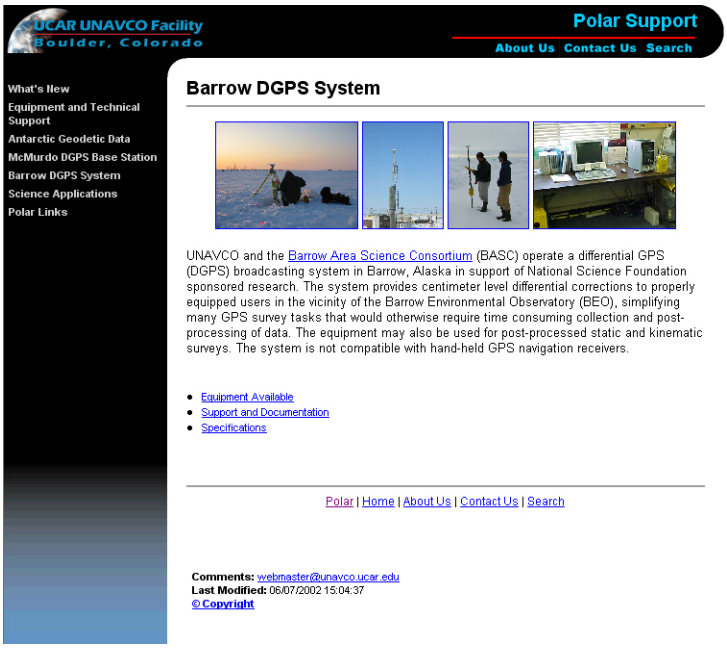

Figure 4 – Dedicated Barrow DGPS system support web page.

A second GPS base station, SuomiNet site SG27, was also installed by UNAVCO and University of Alaska, Fairbanks staff during the May 2002 visit as part of the SuomiNet atmospheric and geodetic permanent GPS network (Figure 5). This fixed geodetic GPS base station is located at the NOAA Climate Monitoring Diagnostics Laboratory, and provides a post-processing backup to the GPS base station at BASC. RINEX data files are publicly available on-line from the UNAVCO Data Archive, and higher rate raw data files are available by email request.

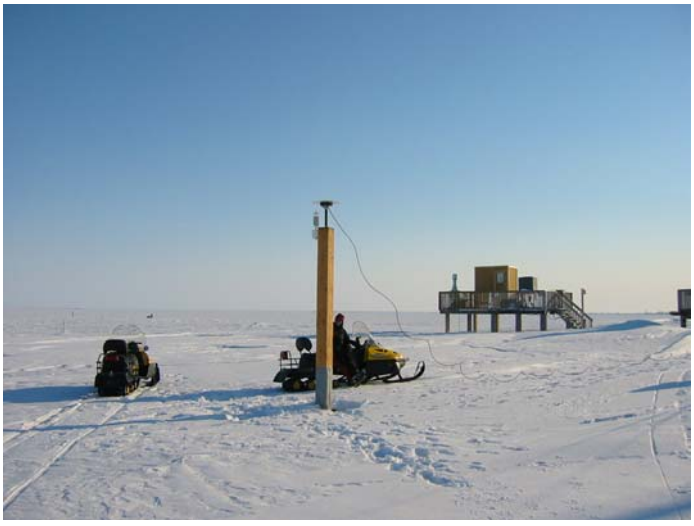

Figure 5 – Barrow SuomiNet permanent GPS station SG27.

Appendix A - Detailed Summary of Support Provided

Barrow DGPS (Bjorn Johns)

UNAVCO purchased and installed a Trimble 5700 RTK DGPS system for dedicated use by researchers supported by the Barrow Arctic Science Consortium. This system consists of base and rover GPS receivers, a radio transmitter for differential corrections, and a dedicated computer with data processing software. UNAVCO also developed a dedicated web page with customized documentation for the system, and is available for technical support year-round. Training was provided to Michigan State University researcher Craig Tweedie, both at UNAVCO in Boulder and on-site in Barrow. During the field season, Dr. Tweedie's staff were instrumental in assisting other scientists wanting to use the system for their surveying needs.

Bench Glacier (Robert Anderson)

UNAVCO provided six GPS receivers (Trimble 4000s and 5700s), field support, data processing, and data archiving to measure temporal and spatial variations of surface speeds of Bench Glacier in Alaska's Chugach Mountains. Continuous GPS (Figure 6) was used to document the surface velocity field on this 7km long glacier over the course of the beginning of the melt season. In field efforts in 1999 and 2000, an up-glacier-traveling wave of high surface velocity was documented, which presumably reflects a wave of enhanced sliding at the bed. It travels at 200-250m/day, and lasts on the order of a few days at any particular site. This wave is difficult to document using optical surveying methods (used in 1999), and shows up much more clearly in continuous GPS data (which was used in 2000 at one site). The sharp arrival of the surface speed anomaly, its duration, its peak speed, and the related vertical motion of the ice surface, is best obtained using GPS rather than optical methods. The processed GPS data will be used to document the wavelength, speed and amplitude of the wave as it progresses up-glacier. This will be done in concert with documentation of the water balance on the glacier in order to separate the surface speed into a deformation and sliding component to relate the speed anomaly to changes in basal hydraulics.

Figure 6 – Continuous GPS monument on Bench Glacier.

Black Rapids Glacier (Martin Truffer)

One Trimble geodetic GPS receiver was provided to measure the surface motion of Black Rapids Glacier, together with internal deformation rates of the ice and the sub-glacial till. The goal is to better understand and quantify distribution of shear stress at the base of the glacier. These changes drive variations in surface speed by almost an order of magnitude every spring.

Kuparuk Permafrost (Frederic Nelson)

UNAVCO provided two GPS receivers, data processing software, and training to research assistant Jon Little. 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 Barrow DGPS base station was also utilized by this project during data collection in Barrow. The data were archived at UNAVCO after the field season.

Matanuska Glacier (Richard Alley)

UNAVCO provided training, one Trimble 4000 GPS receiver, and remote support to field team leader Todd Johnston for velocity measurements on the Matanuska Glacier near Palmer, Alaska. This project is part of the NSF Research Experience for Undergraduates (REU) program. Dr. Alley also purchased two Trimble 5700 GPS receivers through UNAVCO for Pennsylvania State University glaciology applications.

Toolik Lake (Andrew Balser)

UNAVCO provided two geodetic GPS receivers, training, and data processing software to Toolik Lake GIS Manager Andrew Balser. Although there is already excellent mapping grade GPS equipment at the Toolik Field Station, there is also an emerging need for centimeter level precision for hydrology related project support. The equipment was provided as a pilot project to evaluate the need and response to UNAVCO support via the local GIS/GPS manager.