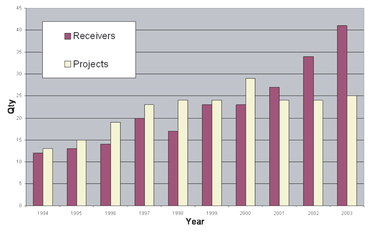
UNAVCO Support to the National Science Foundation Office of Polar Programs

UNAVCO provides year round support for scientific applications of GPS to the NSF Office of Polar Programs (NSF/OPP). Support is provided to a wide range of disciplines, including glaciology, geophysics, geology, volcanology, and biology. The applications of GPS range from crustal deformation and ice dynamics surveys to mapping and GIS applications. This support includes pre-season planning, field support, and postseason follow-up, as well as development work for supporting new applications. Every year over 30 individual projects are supported in both the Arctic and Antarctic, and UNAVCO maintains a "satellite" facility at McMurdo Station, Antarctica during the austral summer research season. UNAVCO provides a full range of support services including GPS equipment, training, project planning, field support, technical consultation, data processing and data archiving.

Polar projects supported and receivers used 1994-2003.



Technology

The introduction of the low power, high memory Trimble 5700 receiver system to the UNAVCO pool was spearheaded by the polar programs' unique equipment and logistical requirements. Their low power consumption has reduced the numbers of batteries and solar panels that are often flown to remote locations. These receivers allow for continuous data collection to internal memory for several months, which has resulted in many applications to look at both spatial and temporal variations over weeks to years, such as the TIDES and Bench Glacier projects featured here, as well as post seismic displacements from earthquakes such as the 2002 Denali fault rupture.

The large variety of GPS applications in Antarctica provides an excellent opportunity to field test new products for suitability to UNAVCO supported work.

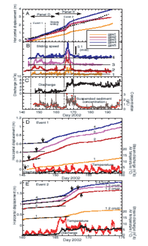
Monuments designed for Antarctic applications are easy to transport, require a minimum of equipment for installation, and ensure a fixed height and centered antenna at future occupations. Mount shown designed by Mike Willis, The Ohio State University.

Hardware may be subjected to temperatures below the manufacturers' specifications, requiring advance cold chamber testing to confirm proper operation in the field.

Bench Glacier Alaska

Principal Investigator: Robert Anderson
University of Colorado, Boulder

Continuous GPS monument on Bench Glacier.



Speed up of Bench Glacier measured by continuous GPS and compared to subglacial hydraulic discharge (R. Anderson)

Continuous GPS receivers were deployed to document the surface velocity field on this 7km long glacier in Alaska's Chugach Range 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.

Mt. Erebus Antarctica

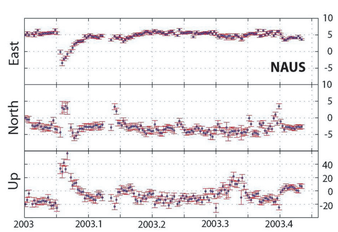
Principal Investigator: Philip Kyle - New Mexico

UNAVCO has worked with New Mexico Tech investigators to measure Mt. Erebus deformation since 1999. Mt. Erebus, the southernmost active volcano in the world, contains a persistent, actively convecting anorthoclase phonolite lava lake. The activity of Erebus makes it an ideal laboratory for studying eruption dynamics in a convecting magma conduit. Deformation, if any, is expected to be minimal. This is supported in GPS results which are currently being analyzed. A 10 station campaign network was installed in 1999. This project rapidly evolved to include the installation, maintenance, and operation of eight permanent stations to achieve better temporal resolution of the volcano deformation.

The network highlights some the difficulties of remote GPS operations in Antarctica. For example, the electronics are subjected to extreme cold below the manufacturers specifications, it is difficult to maintain power through the four months of winter darkness, and environmental factors such as rime ice may cause erroneous data interpretations.

Mt Erebus Crater

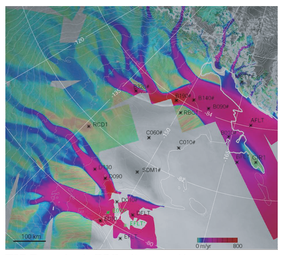
Rime icing at a Mt. Erebus site. Environmental sensor data indicated similar icing was likely just after 2003.05.



Time series for Mt. Erebus site NAUS. Is the event just after 2003.05 due to volcanic activity or environmental factors?

TIDES

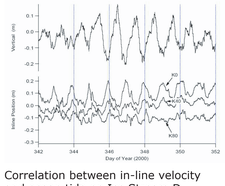
Principal Investigator: Sridhar Anandakrishnan, Pennsylvania State University



TIDE project GPS site locations

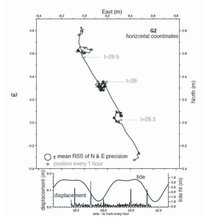
Setting up GPS stations

Co-PI Robert Bindschadler setting out GPS stations



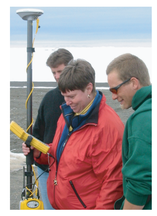
Correlation between in-line velocity and ocean tide on Ice Stream D

Ice from the West Antarctic Ice Sheet (WAIS) flows to the sea through a series of icestreams; the factors controlling the flow of the ice streams are not well understood. Recent observations give a brief glimpse of the surprisingly sensitive reaction of the ice streams to tidal oscillations. Measuring the response of the ice streams to the rise and fall of the tide is an excellent natural "experiment" to improve understanding of controls on the ice streams, and improve the ability to model the WAIS. Twenty-one GPS receivers were depolyedd in arrays on ice streams E, D, C and the Whillans Ice Stream (B), and at fixed base stations to record vertical and horizontal components of ice stream motion and to correlate these motions to ocean tides in the Ross Sea over two tidal cycles. Passive seismic sensors were also deployed in conjunction with the GPS units.

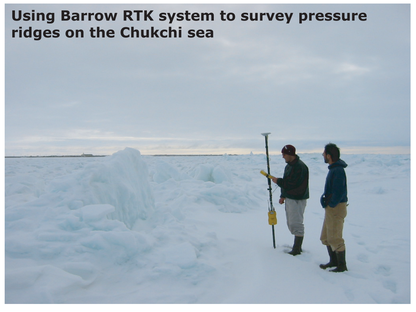


Stick slip behavior on Whillans Ice Stream

Barrow, Alaska Schoolyard Program



In conjunction with the installation of a GPS surveying system in Barrow, Alaska (the northernmost town in the U.S.), UNAVCO staff participated in the Barrow Schoolyard program - an NSF funded educational outreach activity to connect grade school students with scientific visitors to Barrow. The UNAVCO seminar included a talk and demonstration of how GPS positioning works, a slideshow of GPS research from pole to pole, and a hands-on GPS "easter egg hunt" using both handheld navigation receivers and an RTK system.



Using Barrow RTK system to survey pressure ridges on the Chukchi sea

Polar RTK Stations

UNAVCO supports scientific use of real-time kinematic (RTK) GPS broadcasting systems in Barrow, Alaska and McMurdo Station, Antarctica. The dual-frequency survey system provides centimeter level differential corrections, simplifying many GPS survey tasks that would otherwise require collection and post-processing of raw data. The Barrow system is also set up for post-processed static and kinematic surveys over 100km away from the base, and a dedicated GPS data processing computer is set up at the Barrow Arctic Science Consortium facility. A portable repeater is also available to ensure line-of-sight radio coverage for RTK work within the Barrow Environmental Observatory (BEO). A similar system will be installed at the University of Alaska Fairbanks Toolik Field Station in 2004, also on Alaska's North Slope, with an emphasis on commonality with the Barrow system.

McMurdo Station RTK transmitter site on Crater Hill