

Development of a Power and Communications System for Remote Autonomous Polar Observations



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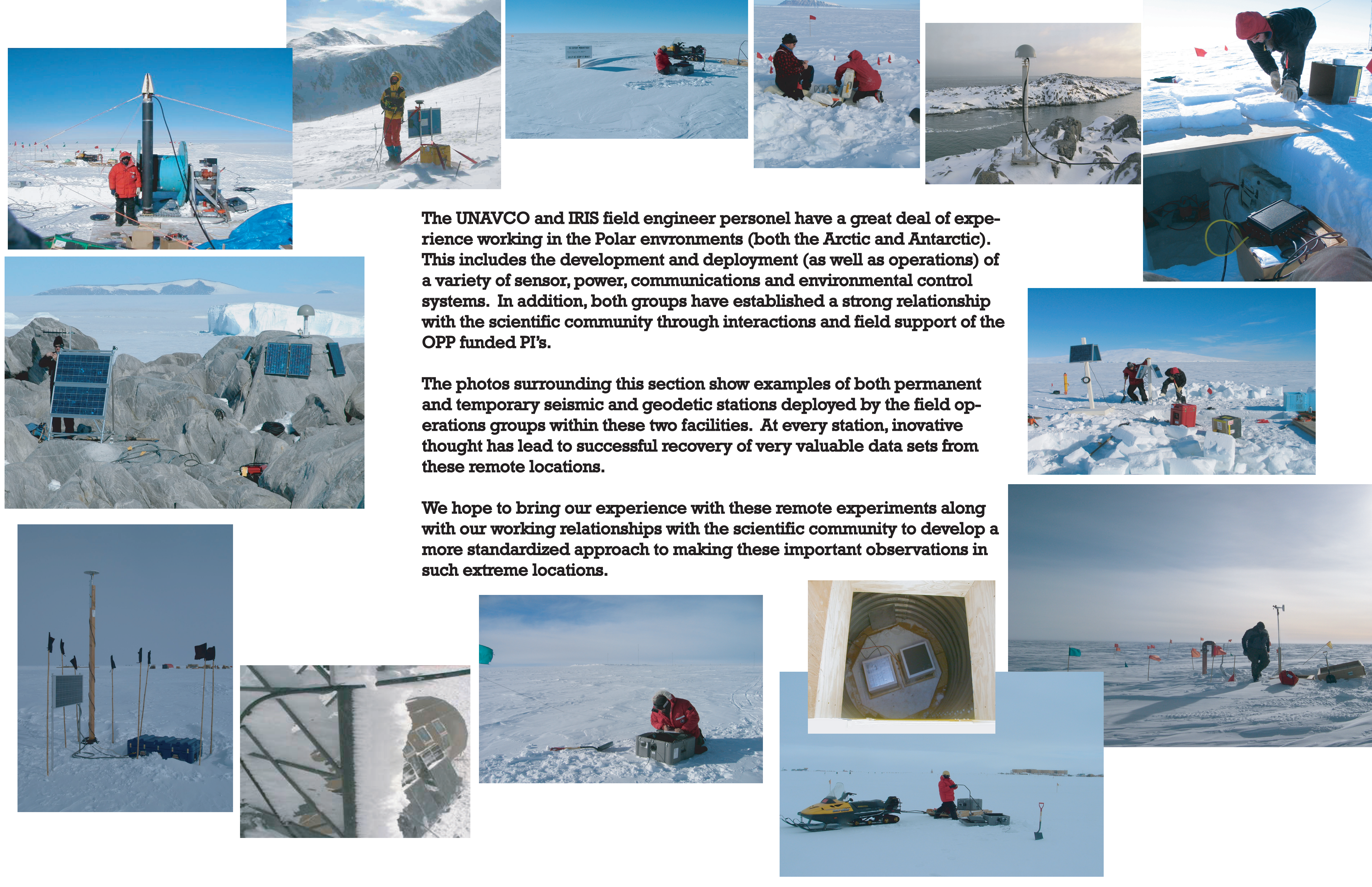
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Abstract

The National Science Foundation has awarded a Major Research Initiative (MRI) grant to UNAVCO and the Incorporated Research Institutions for Seismology (IRIS) to develop a power and communications system that will improve remote autonomous geophysical observations in the polar environments. To date, each OPP-funded PI must develop their own support infrastructure for their experiments to provide power, communications, and environmental controls as necessary, for their particular transducers. There is currently no forum to exchange ideas on successful designs, nor means to avoid pitfalls discovered by others. While some groups have had good success in completing their experiments, those successes are not necessarily available to the broader community to take best advantage. Our goal is to provide a standardized approach to scaling infrastructure support designs to the seismological and geodetic community's particular experimental designs. Through testing in each facility's cold chambers and through field trials at test-beds located locally and in Antarctica, the MRI project will investigate optimal battery designs (both rechargeable and non-rechargeable), power systems (solar, wind), environmental conditioning, and telemetry systems appropriate for these extreme conditions. The aim of this collaborative project is to not only take best advantage of the field engineering experiences of the two consortia, but to also create a means of incorporating expert design contributions and exchanging ideas, designs and experiences with the entire polar research community. In conjunction with the MRI funding, IRIS and UNAVCO are developing a new joint advisory committee made up from scientists working in the polar-regions with representation from the IRIS and UNAVCO facilities, which will allow for the exchange of information on infrastructure design for these experiments between the facilities and the research community. Although the startup of this advisory committee is tied to the MRI funding, it is hoped that this committee will continue to function beyond the MRI window to ensure formal representation of scientists working in these extreme environments. In addition, we will also build and distribute beta-test versions at mid-points along the funding profile that will allow actual field trials of the intermediate designs in actual OPP-funded experiments, thus allowing both highly controlled testing scenarios as well as realistic, in-field applications. This will engage the scientific community as an able partner in the success of the MRI while providing valuable data on actual field deployments to the facilities before the final designs are determined. Data from each of these experiments will be put into a final product of a scalable design for remote autonomous support.

Experience



The UNAVCO and IRIS field engineer personnel have a great deal of experience working in the Polar environments (both the Arctic and Antarctic). This includes the development and deployment (as well as operations) of a variety of sensor, power, communications and environmental control systems. In addition, both groups have established a strong relationship with the scientific community through interactions and field support of the OPP funded PI's.

The photos surrounding this section show examples of both permanent and temporary seismic and geodetic stations deployed by the field operations groups within these two facilities. At every station, innovative thought has led to successful recovery of very valuable data sets from these remote locations.

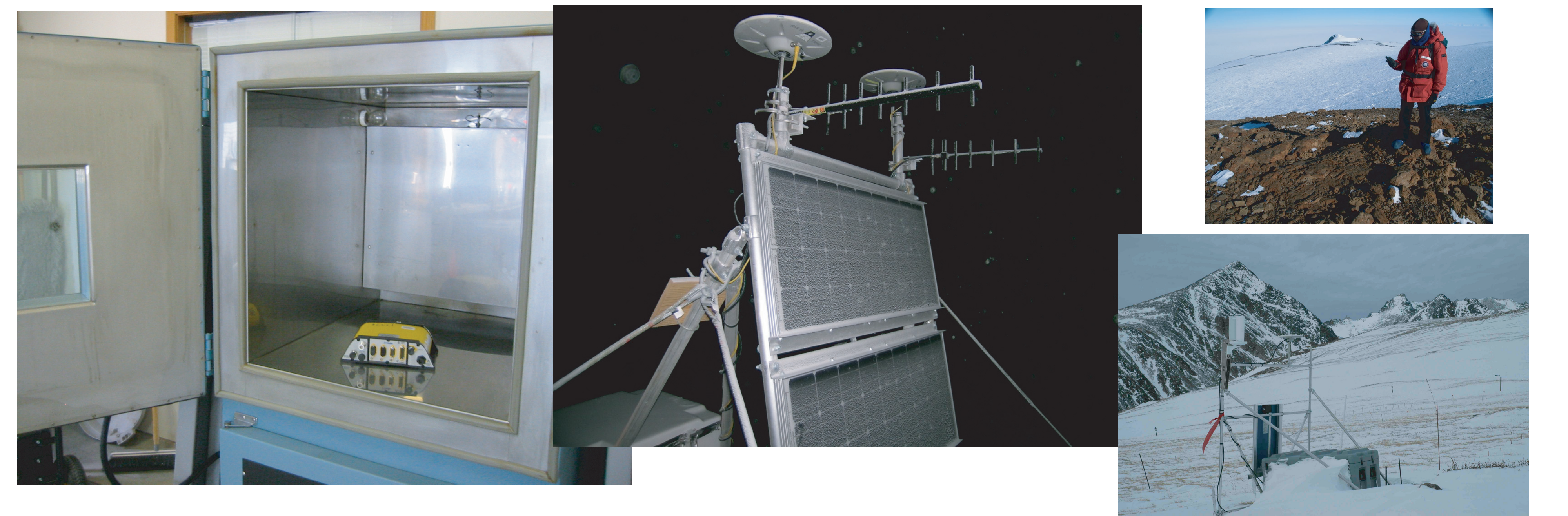
We hope to bring our experience with these remote experiments along with our working relationships with the scientific community to develop a more standardized approach to making these important observations in such extreme locations.

Test Facilities

Both UNAVCO and IRIS have at their disposal facilities to test all components and complete systems at the ambient temperatures to be expected in Antarctica.

This Austral summer, we will establish and augment test beds at McMurdo Station (Observation Hill), and South Pole (at the station and near the SPRESSO). This will allow for field check of equipment at the USAP bases of operation to allow mid-winter adjustments, as necessary, by the highly qualified winter-over technical staff.

In addition, we will utilize floor space at the National Ice Core Laboratory to test complete systems at low temperatures in a very controlled environment.

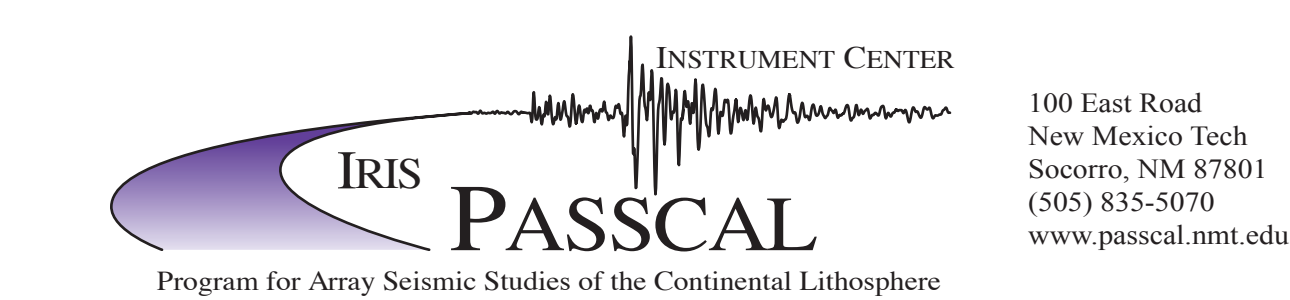


Progress

Although the project was just awarded in October, we have made preparations to participate in Antarctica this season and plan to establish testbeds near McMurdo Station and the Admunsen-Scott South Pole Station. These testbeds will allow us to field check new designs for the autonomous systems in the coastal and plateau environments while still maintaining contact with the equipment (both through realtime telemetry as well as hands-on via winter-over technical support).

To date, the equipment for these testbeds has been designed, constructed and tested in the facilities cold chambers (some of these components shown at the right). These components will now be shipped south for a field deployment planned for late-January, 2007. In addition, a new GPS station will be established on Minna Bluff to test current capabilities in power and communications systems on a permanent installation.

Personnel from both UNAVCO and IRIS will participate in all aspects of the field deployments.



PASSCAL Polar Support

PASSCAL currently supports approximately 60 experiments per year worldwide, with 3-10% currently funded by the National Science Foundation (NSF) Office of Polar Programs (OPP). Polar projects commonly require a level of support that is several times that of seismic experiments in less demanding environments inclusive of very remote deployments (e.g. Tibet). In order to ensure OPP funded Antarctic projects the highest level of success, we have established a PASSCAL Polar Program and have secured funds from OPP to support new and ongoing experiments in Antarctica.

The primary focus of PASSCAL's Polar support efforts are:

- 1) Developing successful cold station deployment strategies.
- 2) Collaborating with vendors to develop and test $+55^{\circ}\text{C}$ rated seismic equipment.
- 3) Establishing a pool of instruments for use in cold environments.
- 4) Building a pool of cold station ancillary equipment.
- 5) Creating a resource repository for cold station techniques and test data for seismologists and others in the polar sciences community.

To better support Antarctic science, IRIS is investigating the establishment of a named-as-necessary instrument center at McMurdo Station, Antarctica. The goal of this center would be to: test and vet equipment as it arrives on continent allowing events to field more efficiently; provide timely and cost-effective training; offer easily reachable expert troubleshooting; afford on-continent instrument performance and data QC; aid with data backup and archiving; and make available installation support as required/requested.

In parallel with PASSCAL's internal Polar support efforts, IRIS and UNAVCO have recently received NSF MRI funding to develop a power and communications system for remote autonomous GPS and seismic stations in Antarctica. In January 2007, IRIS/PASSCAL will collaborate with UNAVCO to install the first MRI prototype test-beds at South Pole and McMurdo stations. These prototype stations are designed to test primary battery systems, the first cold-rated broadband sensor, new digitizer firmware tuned for the cold, and specialized cold station enclosures.

Polar Networks Science Committee

This program also intends to create a means to incorporate advanced designs into experiments and exchange ideas, designs and experiences with the researchers. IRIS and UNAVCO recently formed a new joint advisory committee with scientists working in the polar regions to facilitate the exchange of information on infrastructure design between the facilities and the research community.

The initial membership for this committee was drawn from both the geodetic and seismological communities and include:

- Terry Wilson, Ohio State (Chair)
- Doug Wiens, Washington Univ (vice-chair)
- Sridhar Anadakrishnan, Penn State
- Rick Aster, New Mexico Tech
- Carol Raymond, JPL
- Bob Smalley, Univ Memphis

Membership to this committee approved by the UNAVCO and IRIS board of directors.

Education and Outreach

The project also features an education and outreach component that will fund an upper-level undergraduate student to participate in this polar technology project. This important component is associated with "Research Experiences in Solid Earth Science for Students" (RESESS), a program of multiple research experiences and mentoring and community building to increase the number of Masters and PhD earned degrees in solid Earth geosciences in underrepresented populations.



MRI Field Kit Usage Agreement

As a part of this project, we will produce intermediate design "kits" that will be distributed to interested (and funded) field projects on the polar regions. These systems will be operated by the field parties in addition to their own design systems.

- MRI will provide 5 field kits to funded Antarctic field program consisting of:
- Environmental enclosures
 - Proto type power systems (less expendables)
 - Proto type communications systems (low bandwidth) if available

In return, it is expected that the participating field projects will provide the following:

- 1) All data (including SOH and scientific data (time series)) will be distributed immediately to the UNAVCO/IRIS facilities as appropriate. The scientists will still retain proprietary use of the scientific data and the data sent to the facilities will be used for engineering purposes only. Standard data use policies for the respective facilities will still apply.
- 2) Comments from field projects on installation/maintenance concerns, logistics and general comments on design. A template for field comments will be provided.

Condensed engineering reports will be made public via the MRI website.

If you are interested in fielding one of the field kits, please send a request to

ant-mri@unavco.org

We are looking for a variety of projects (Seismic, GPS) deploying to a variety of environments in the Arctic or Antarctic. Distribution of these test systems will be determined by UNAVCO and IRIS.

Further Information

For more information and updates on the progress of the MRI, please feel free to join our list server at

ant-obs@unavco.org

This will be the primary forum for the exchange of information with the community.