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

National Science Foundation

IRIS

Kent R Anderson (kent@iris.edu); Bruce Beaudoin (bruce@passcal.nmt.edu);
Jim Fowler (jim@iris.edu); Tim Parker (tparker@passcal.nmt.edu)
Incorporated Research Institutions for Seismology

UNAVCO

Bjorn Johns (johns@unavco.org); Seth White (white@unavco.org)
UNAVCO

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.

The first deployment of the MRI occurred this past Austral Summer (Jan/Feb 2007) and field test beds were established at McMurdo Station and the Amundsen-Scott South Pole Station. These test beds include benchmark stations as currently deployed along side newly developed equipment for portable deployments including solar and wind power systems, sealed-vacuum insulated panel environmental enclosures and new designs for structural and anchoring components. Data from these test beds flow in real time to the data centers of IRIS and UNAVCO.

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.

Further Information

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

ant-obs@unvaco.org.

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

Work performed on this project funded under the collaborative awards to IRIS (ANT-0619708) and UNAVCO (ANT-0619908)

Polar Plateau Seismic Prototype

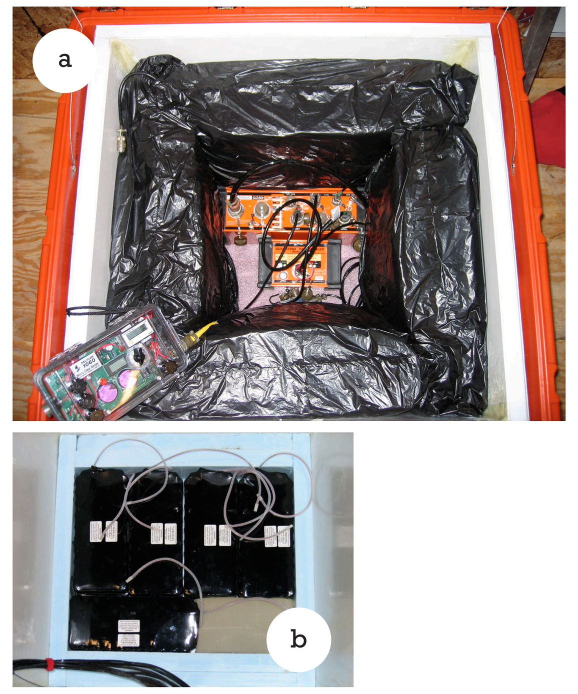


Figure 1: Station enclosure (a) and lithium thionyl chloride battery pack (b).

Figure 2: Seismic vault (a) and Trillium 240 installed on phenolic block (b).

Objective:
1) Year round operation
2) Maintain datalogger to within operating specification
3) Minimize payload and deployment time
4) Operate broadband sensor at ambient

Approach:
1) Year round operation - Lithium Thionyl Chloride, non-rechargable batteries (Figure 1b) as primary system with AGM and PV for secondary (Figure 3a).
2) Heavily insulated using R-50 vacuum panels and R-5 blue styrene inside rotomolded case (Figure 1a). Passive heating using the <1W dissipated by datalogger.
3) Modular design. Collapsible PV frame (Figure 3a). Bulkhead connectors on exterior of station enclosure. Quick-deploy snow anchors (Figure 3b).
4) Broadband seismometer installed in 1-m vaults on 5 cm thick phenolic block with 15-cm-thick of blue styrene enclosure. Sensor vault completely buried in snow (Figures 2 & 3).

Specifications:

Weights & Sizes:
- enclosure 55 kg, 76x76x76 cm
- sensor and vault 30 kg
- solar panels and mount 45 kg, folded size: 203x102x15 cm
- primary batteries 57 kg, 0.03 m^3 (1900 Ah @ 15V @ -40°C)
- secondary battery 136 kg (3 100Ah AGM, future reduce to 1)
- digitizer and ancillary equipment 10 kg

Total Station Weight: 250 kg
Station Power specification: 2W

Seismic Data Available from the IRIS DMC:

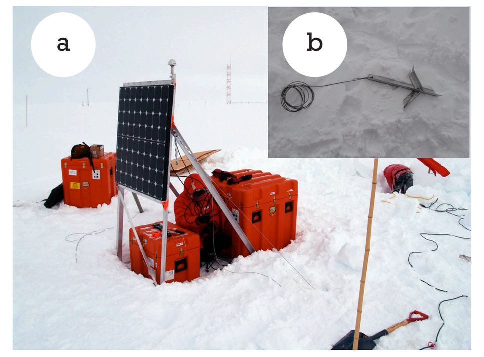
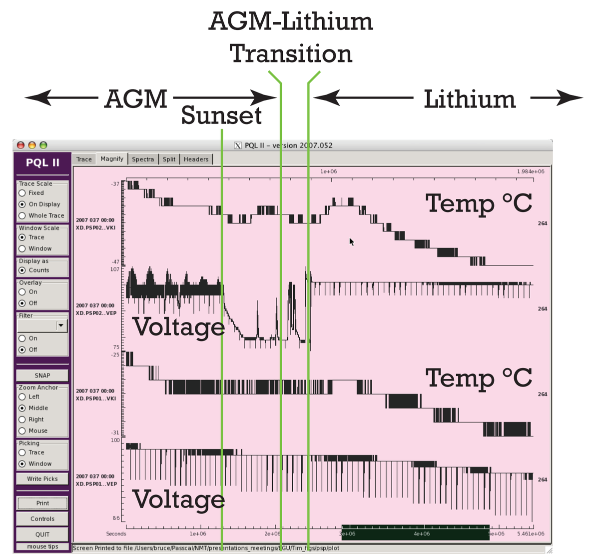
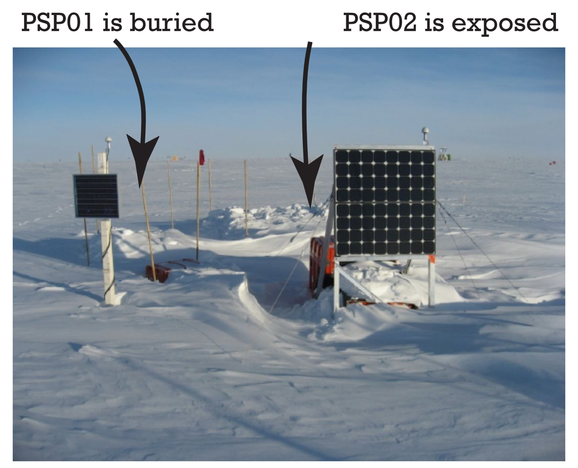
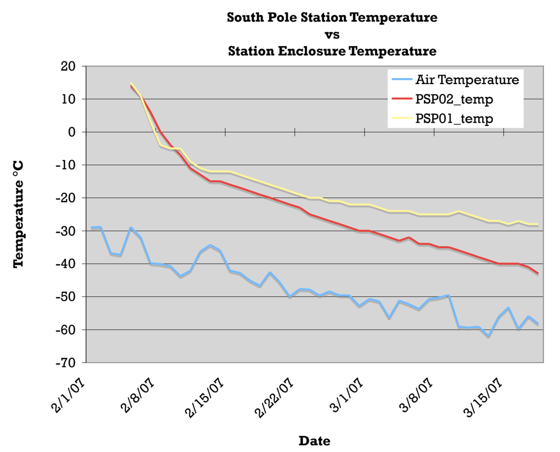


Figure 3: Station PSP02 with PV mount, station box, and secondary battery box (a). Snow stake (b).

Future Plans:
- additional primary battery testing
- explore alternate secondary batteries (e.g. Lithium Ion)
- determine balance between primary & secondary batteries
- build and test a foam-only enclosure
- test new Guralp cold rated sensor
- test new Iridium controller
- shrink solar panel mount for plateau
- develop a new charge controller (mppt technology)







Continental Margin GPS Prototype

Continental Margin Prototype Station MIN0

MIN0 Antenna and Mast

Location: Minna Bluff, Antarctica: 78° 39' S 167° 10' E

Summary:
The goal of this effort was a field shakedown of a GPS system that can be mass produced, is easy to transport and set up, and withstands the harshest Antarctic continental margin environment. Station MIN0 was installed by a three-person team using two flights of a Bell 212 helicopter.

This prototype station will be upgraded with advanced power components for year-round operation as the MRI project evolves. Approximately twelve weeks down-time in late winter is expected from the current configuration.

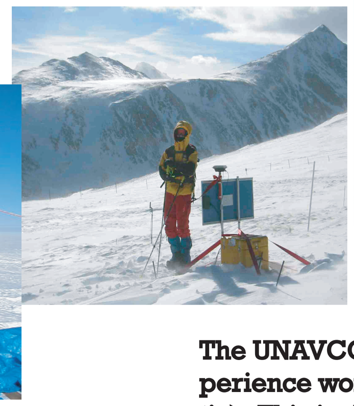
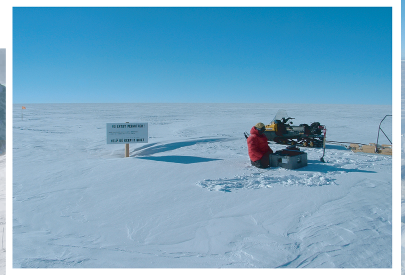
System specifications:

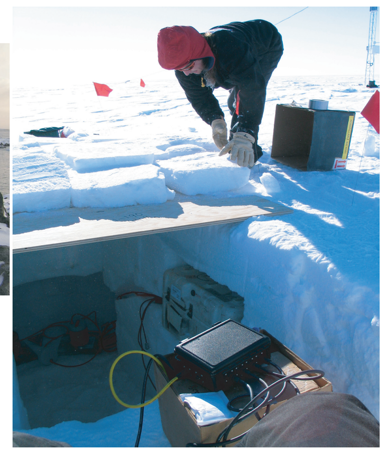
Receiver:	Trimble NetRS
Antenna:	Trimble choke ring with SCIS radome
Mast:	Ohio State 1 meter mast
Solar:	2x 90W Sunpower SPR-90 panels, wind-hardened with rigid foam and plywood backing
Wind:	Forgen 500 vertical-axis wind turbine
Comms:	NAL Research AL3A Iridium modem
Batteries:	10x Deka SLA gel-cell solar 100 amp-hour batteries
Frame:	4 cm aluminum pipe with bolted-through fittings
Enclosure:	Hardigg MM24 polyethylene case
Anchoring:	Steel stakes, 3-point, 76-91 cm depth each
Power Draw:	5.25 W average
Station Weight:	590 kg

GPS Data:
To access the GPS data, anyone can go to:
http://facility.unavco.org/data/gnss/perm_sta.php
and search on the 4-char ID: MIN0

More Information:
UNAVCO Remote Station Engineering:
http://facility.unavco.org/project_support/polar/remote/remote.html

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 lead 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.