The Antarctic Polar Earth Observing Network (POLENET)

Challenges of Autonomous and Continuous GPS/GNSS Observations at Remote Sites

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Civil GPS Service Interface Committee
U.S. States and Local Government Subcommittee
Regional Meeting
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Overview

• Collaborative Activities – Antarctic Geodesy and Science

• Antarctica – 7th continent

• POLENET – international program
  – Science objectives

• POLENET - Remote observatories
  – Transport requirements
  – Many challenges that had to be overcome in the harsh polar environment of Antarctica
  – Power and communications

• Close
Collaborative Activities
Antarctic Geodesy & Geophysics Research Support

- **Polar Earth Observing Network (POLENET)**
- **Absolute gravity measurements**
  - international joint project of POLENET
- **International GNSS System (IGS) global network**
  - stations at McMurdo, South Pole, and Palmer
- **Geodetic Infrastructure for Antarctica (GIANT)**
  - SCAR Expert Group
- **GPS for Weather and Space Weather Forecasting (GWSWF)**
  - SCAR Action Group
How large is Antarctica and how do you get there by air
Antarctica
Winter Stations

Projection: Polar Stereographic
True Scale at 71°S
highest, driest, coldest, windiest, and emptiest place on earth
5.4 million square miles
Only 2.6% not ice-covered.
Ave. thickness ice sheet: 7,100 ft; thickest point 15,669 ft.
90% of world's ice
70% of world's fresh water
Polar Earth Observing Network

Principal Investigator: Dr. Terry Wilson, School of Earth Sciences, Ohio State University, Columbus

http://www.polenet.org
Polar Earth Observing Network

Geophysical Observatories

- **GNSS (GPS+)**
- **Seismic**
- **Gravity: absolute and relative**
- Tide Gauges
- Geomagnetic
- Multisensor deep-sea observatories
- Space and airborne remote sensing measurements
A sense of scale: West Antarctica is roughly the size of the United States east of the Mississippi River.
Polar Plateau System

Designed for extreme cold and moderate winds
Continental Margin System

Designed for extreme winds and moderate temperatures
1" Tube A-Frame

4 X 40 Watt Solar Panels

R-40 Vacuum Insulated Box

"Blu-Board" Insulated Battery Box.

12 X 100 AmpHr Batteries
(6 in Insulated Box, 6 in Battery Box)

JNS-EURO-GDA 40-Channel GPS Receiver (1.8W to 2.4W) with 1Gb Flash Card Storage

Temperature Sensor

16-Amp Rated Low-Voltage Disconnect and Charge Controller

TAMDEF CORS at Westhaven Nunatak.
Cape Roberts: LINZ/USGS/OSU installed

**CHALLENGES**
- low storage capacity initially
- Drifting snow
- Vibration concerns

**SOLUTIONS**
- New receiver, more storage
- New panels, redundant power
- New monument
- Line-of-sight data comms link
- Station system is monitored
Cape Roberts

In 2000, GPS station established with first combined solar powered and battery storage system; successfully demonstrated all-year operation of GPS receiver.
Cape Roberts:

Operates to as low as -45°C.
Lonewolf Nunatak
Extremely windy and low temperatures

CHALLENGES
- Wind destroyed system.....twice
- Battery charge controller failed

SOLUTIONS
- Strengthened panels
- Redundant power
- Improved sealing of system
Spindrift in sealed enclosure.

Spindrift in sealed enclosure following year.

Lower profile – reinforced solar panel frame

Panel ripped off again

Site worked even though the environment was extremely difficult.
Example of GPS site:
Battery banks powered by solar panels and wind turbines.
Iridium satellite antenna to transmit GPS data.
Power and Communications through the Polar Night

Today’s Features and Specifications

• 5 watts power and 1Mb/day data transfer year-around
• System deployed by 2-3 people in a single aircraft trip
• Solar and wind power for multi-year operation
• Gel-cell or sealed batteries
• Lithium batteries an option
• Snow (plateau) or rock installations
• GNSS/GPS data retrieved via Iridium satellite data link
• Via Iridium link: system monitoring, diagnostics, firmware upload, etc.
POLENET Sites in Antarctica
A MAJOR ADVANCEMENT

Real-time or near-real-time data communication systems
Monument Design

- Quick to install
- Anchored by 4 X 40cm expansion bolts
- Bolts set using epoxy
- Demonstrated stability
- Zero offset for antenna
  - Constant for all stations
- Concern: Multipath
  - Tests needed
Antarctic realities
Thank you