

# The Antarctic Polar Earth Observing Network (POLENET)

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

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U.S. Geological Survey, Reston, Virginia

April 27, 2011

Civil GPS Service Interface Committee  
U.S. States and Local Government Subcommittee  
Regional Meeting  
Mystic Marriott Hotel & Spa, Groton, Connecticut



# Overview

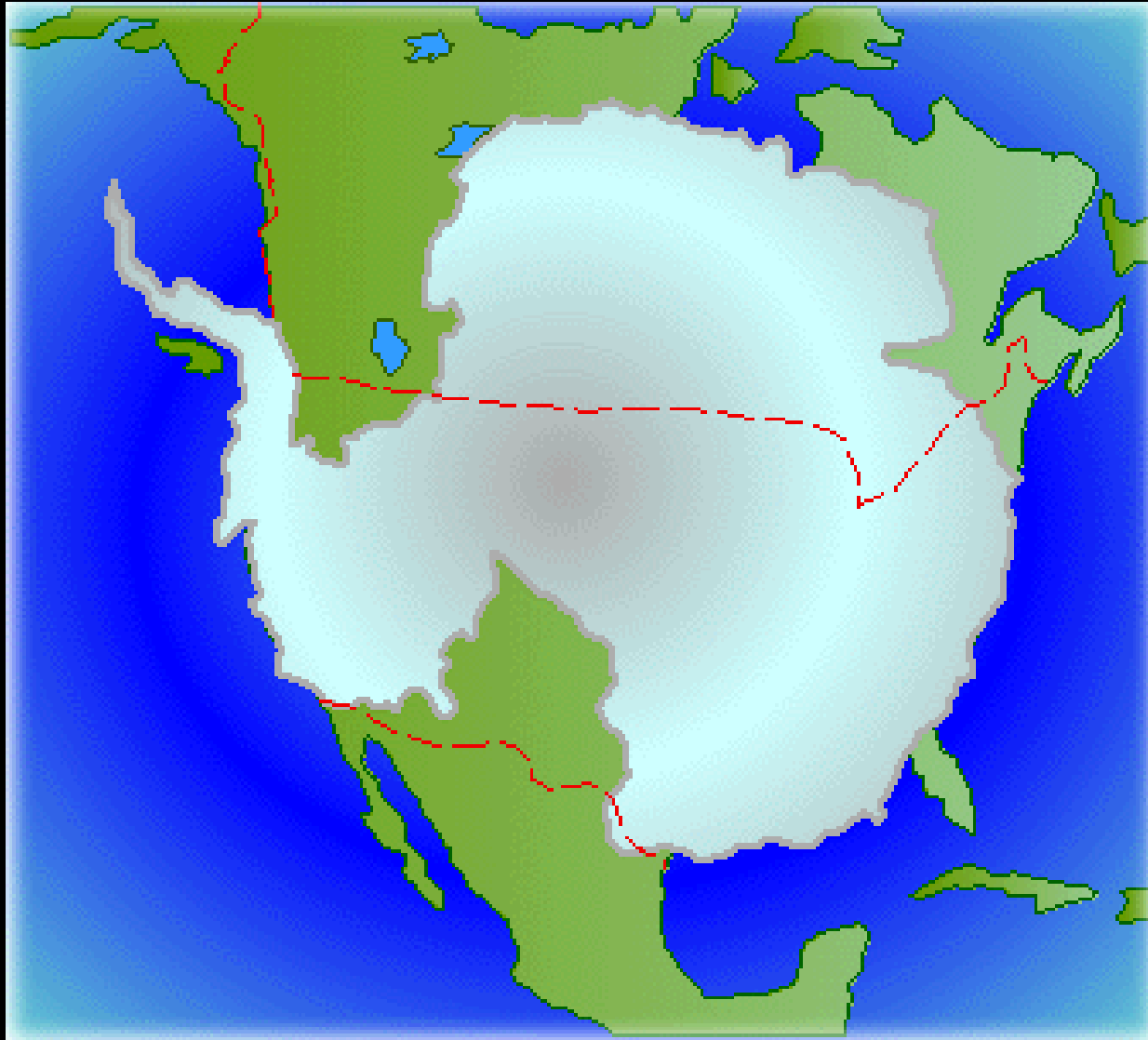
- **Collaborative Activities – Antarctic Geodesy and Science**
- **Antarctica – 7<sup>th</sup> continent**
- **POLENET – international program**
  - Science objectives
- **POLENET - Remote observatories**
  - Transport requirements
  - Many challenges that had to be overcome in the harsh polar environment 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

Produced by the Australian Antarctic Data Centre,  
Australian Antarctic Division,  
Department of the Environment and Heritage, January 2000  
© Commonwealth of Australia

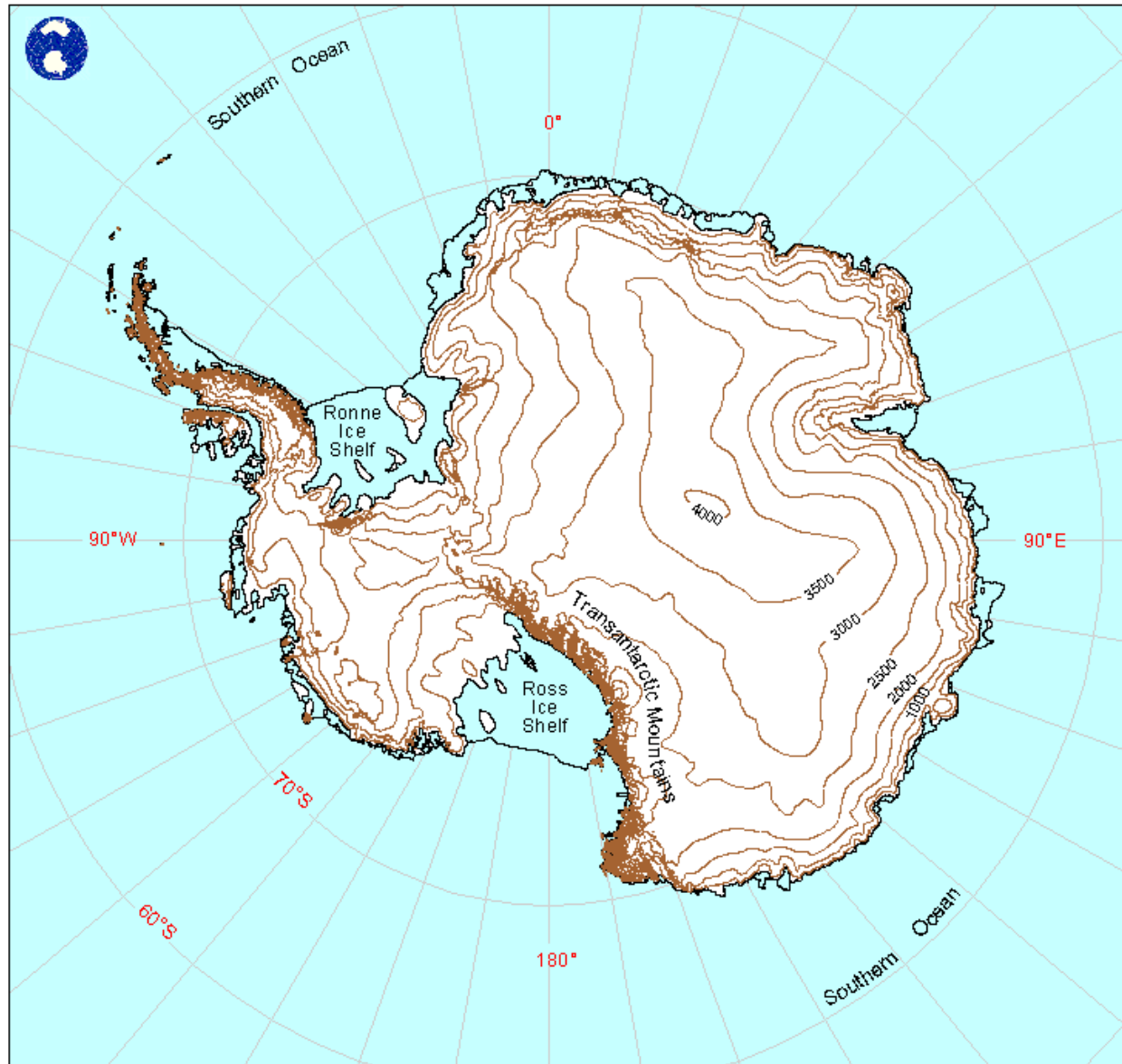


Projection: Polar Stereographic  
True Scale at 71°S

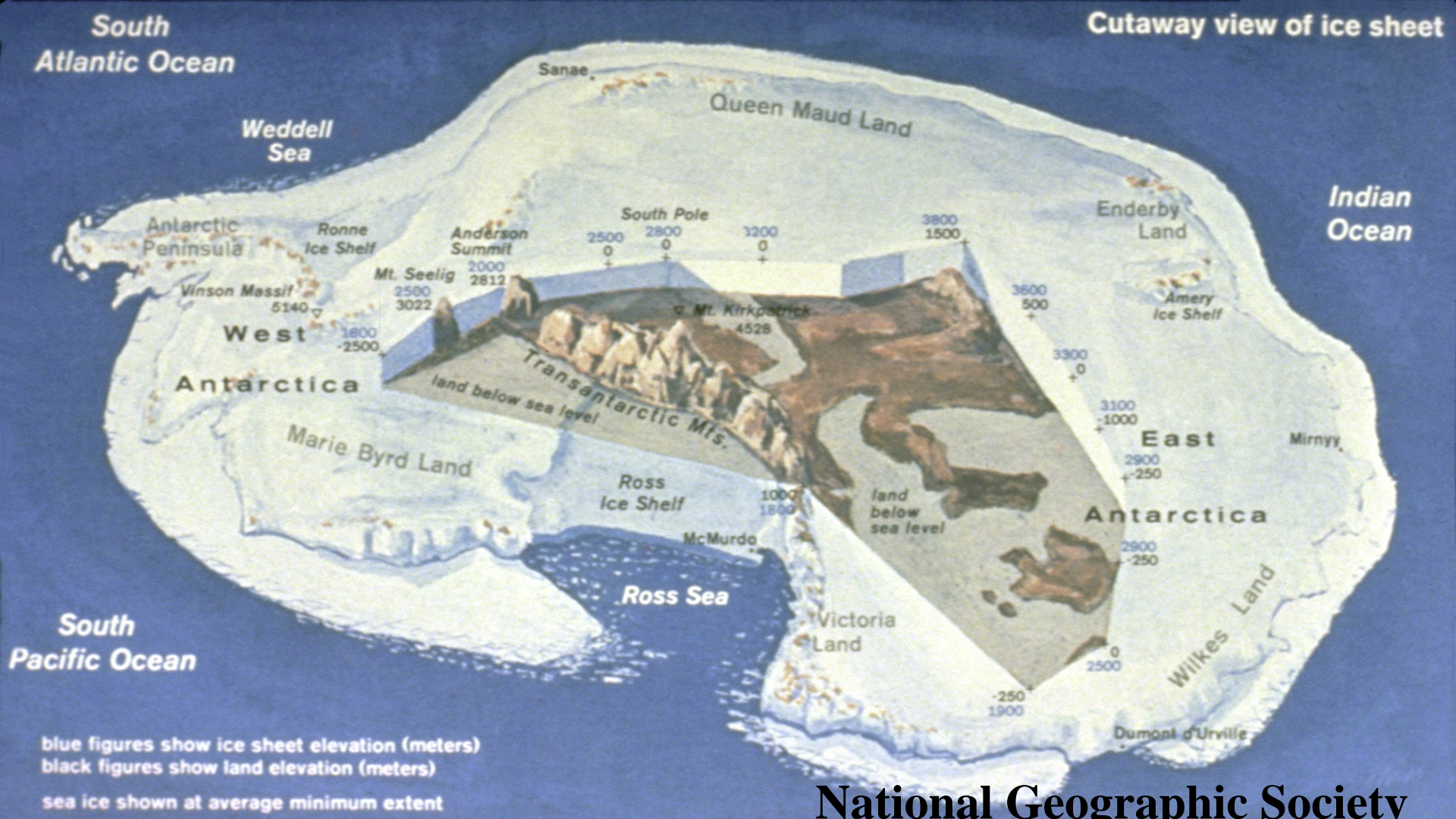
# Antarctica

500 metre contours

Produced by the Australian Antarctic Data Centre,  
Australian Antarctic Division,  
Department of the Environment and Heritage, January 2000  
© Commonwealth of Australia



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.



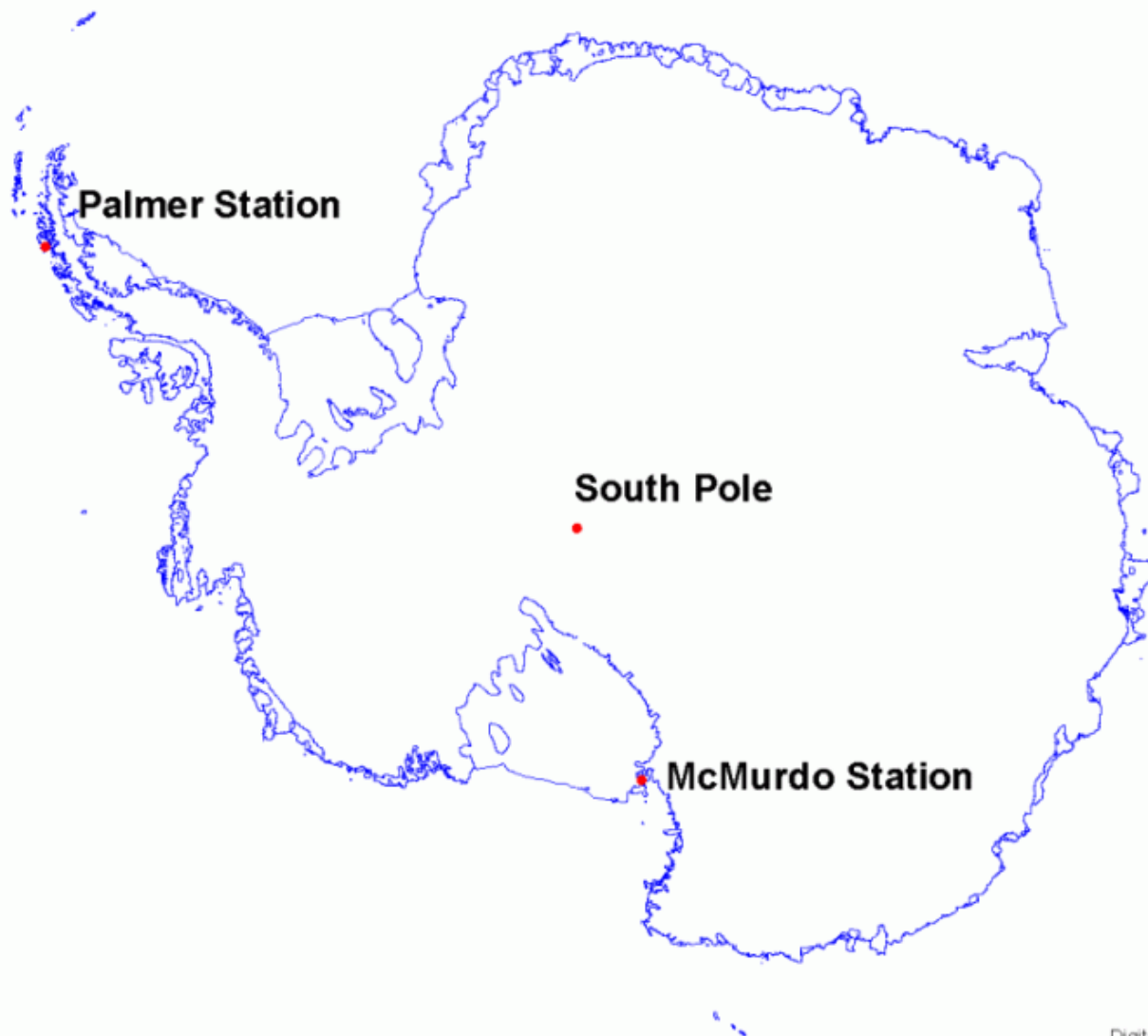


Ave. thickness ice sheet: 7,100 ft;  
 thickest point 15,669 ft.



90% of world's ice  
 70% of world's fresh water

# Antarctica

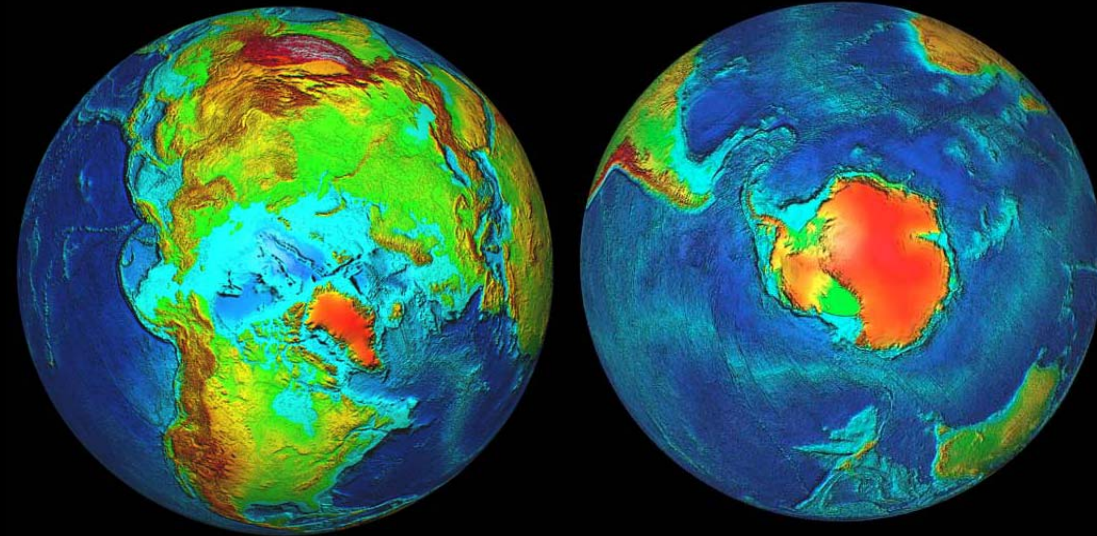


Digital Coastline:  
Antarctic Digital Database, 2000  
Polar Stereographic Projection  
Central Meridian 0, Base Latitude 71 S



# POLENET

<http://www.polenet.org>



## *Polar Earth Observing Network*

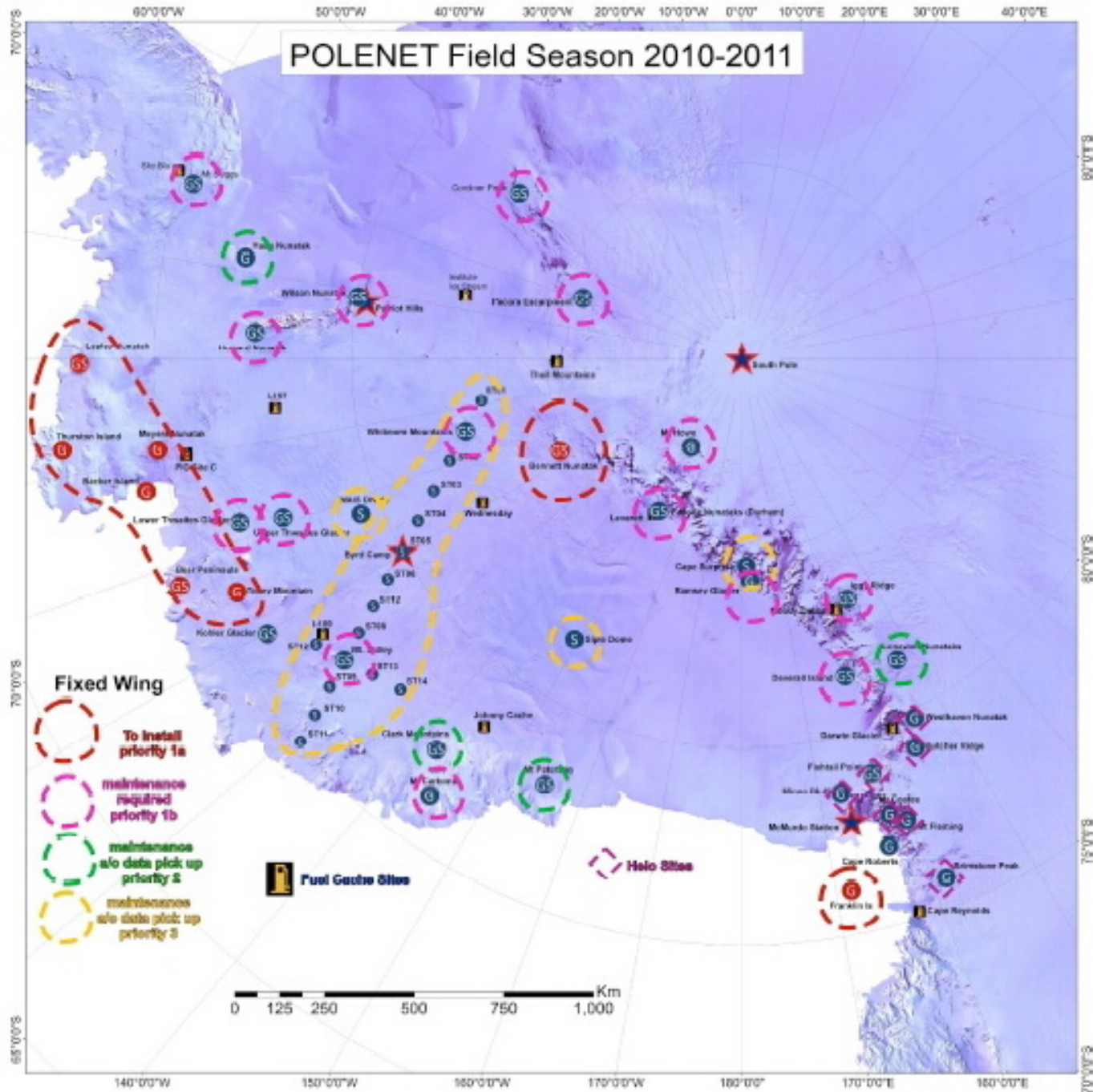
Principal Investigator: Dr. Terry Wilson, School of Earth Sciences, Ohio State University, Columbus

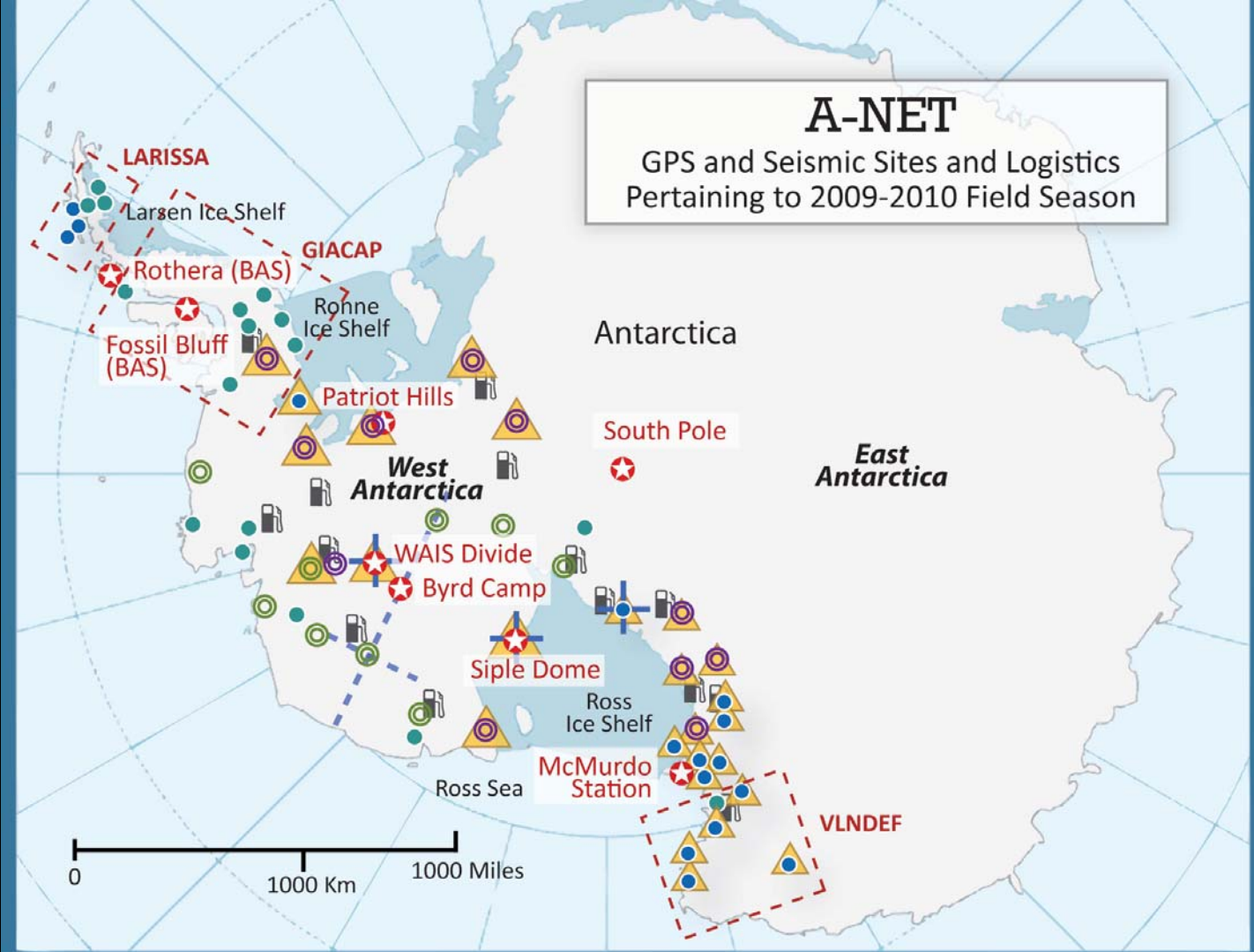
# ***Polar Earth Observing Network***

## **Geophysical Observatories**

- ***GNSS (GPS+)***
- ***Seismic***
- ***Gravity: absolute and relative***
- Tide Gauges
- Geomagnetic
- Multisensor deep-sea observatories
- Space and airborne remote sensing measurements

# POLENET Field Season 2010-2011














# A-NET

GPS and Seismic Sites and Logistics  
Pertaining to 2009-2010 Field Season

A sense of scale: West Antarctica is roughly the size of the United States east of the Mississippi River.

-  Stations/Hubs
-  GPS Deployed
-  GPS to deploy 2009-10
-  Site Visit 2009-10
-  Seismic Deployed
-  GPS & Seismic Deployed
-  GPS & Seismic to deploy 2009-10
-  Fuel Cache
-  Seismic Transect Line















Kenn Borek Air Ltd

C-FMKB









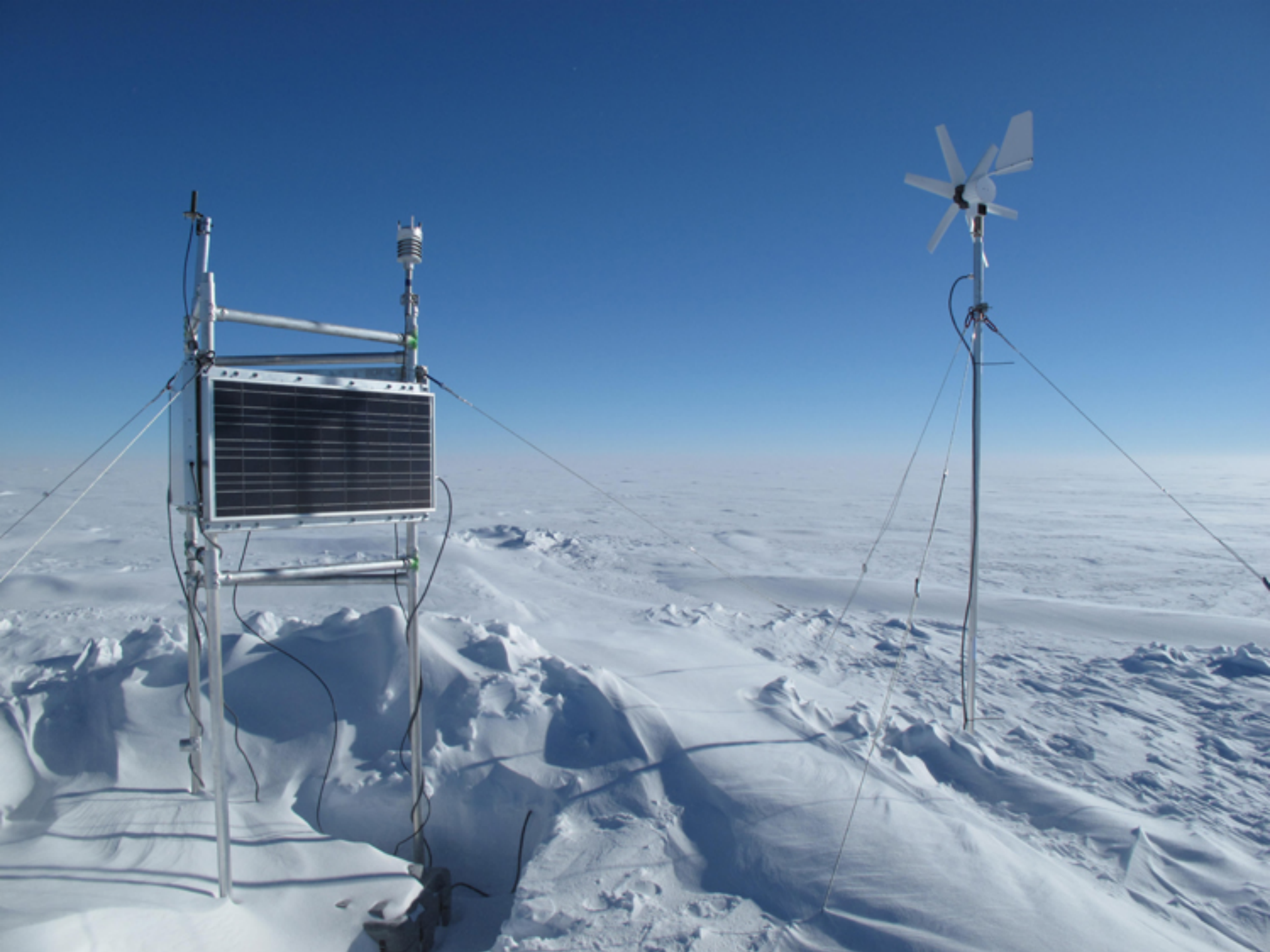




# Polar Plateau System

Designed for extreme cold and moderate winds





# Continental Margin System

Designed for extreme winds and moderate temperatures



**TAMDEF CORS at Westhaven**  
**Nunatak.**

**4 X 40 Watt Solar Panels**

**1" Tube A-Frame**

**R-40 Vacuum Insulated Box**

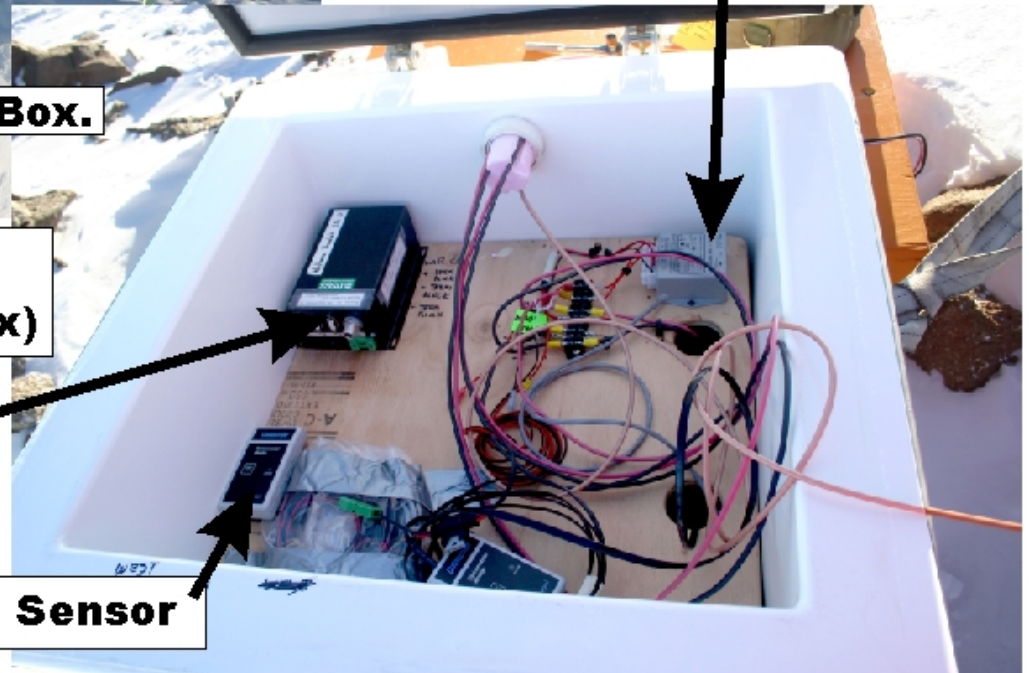
**"Blu-Board" Insulated Battery Box.**

**16-Amp Rated Low-Voltage  
Disconnect and  
Charge Controller**

**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**



# 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

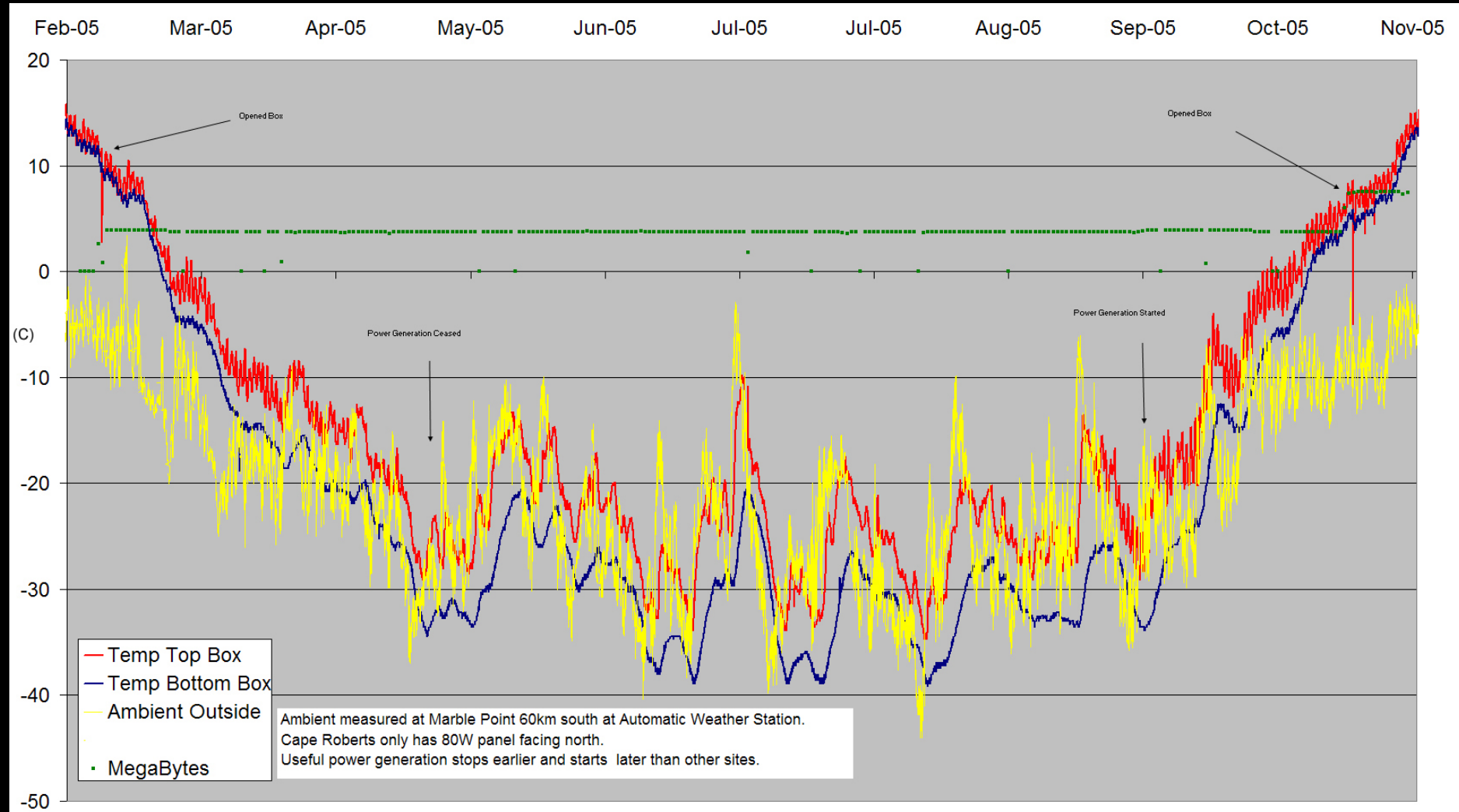
**In 2000, GPS station established with first combined solar powered and battery storage system; successfully demonstrated all-year operation of GPS receiver**



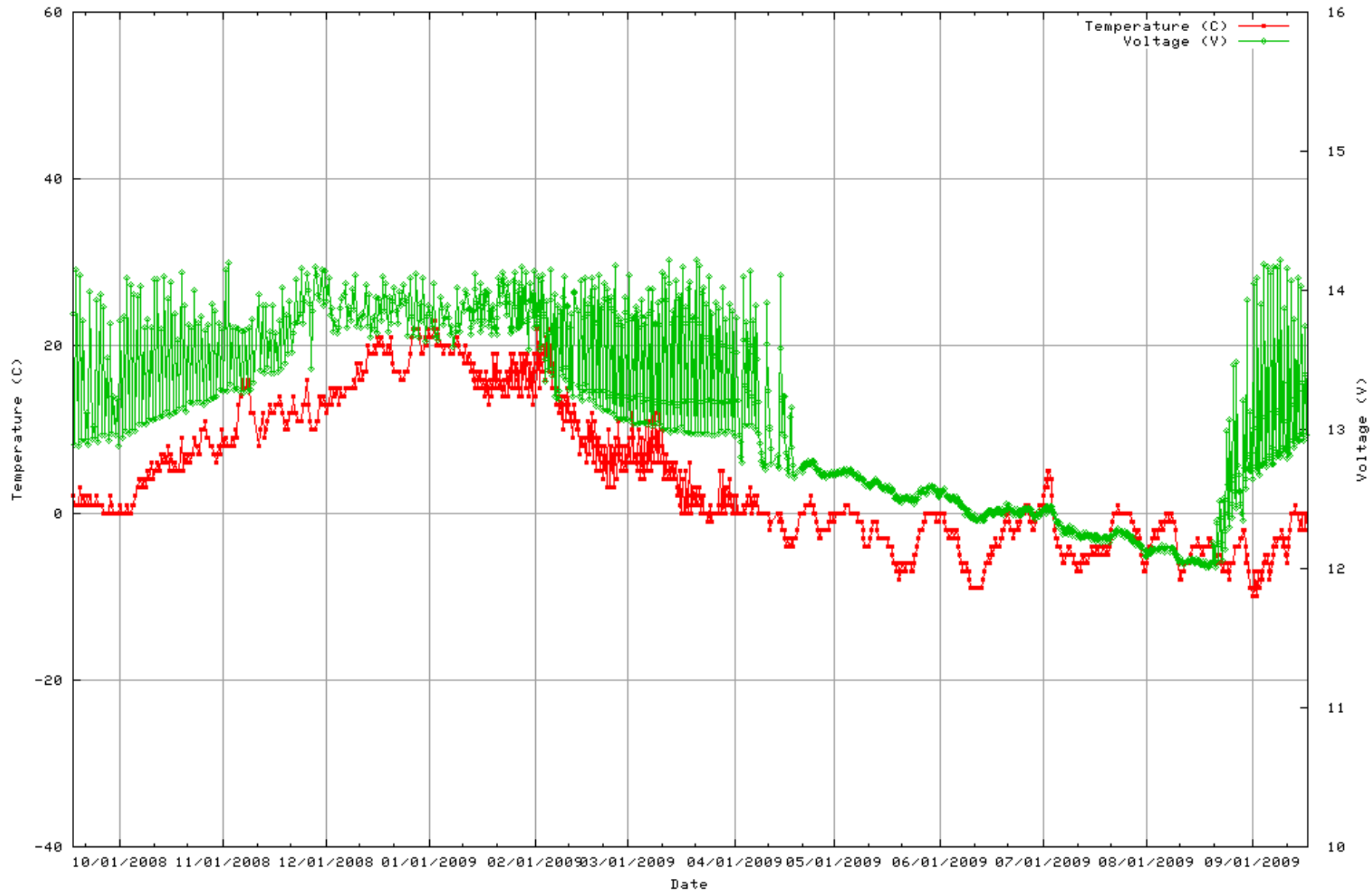


# Cape Roberts:

## Operates to as low as -45C.



Polarbear Statistics - COTE-soh-year.log



# Lonewolf Nunatak

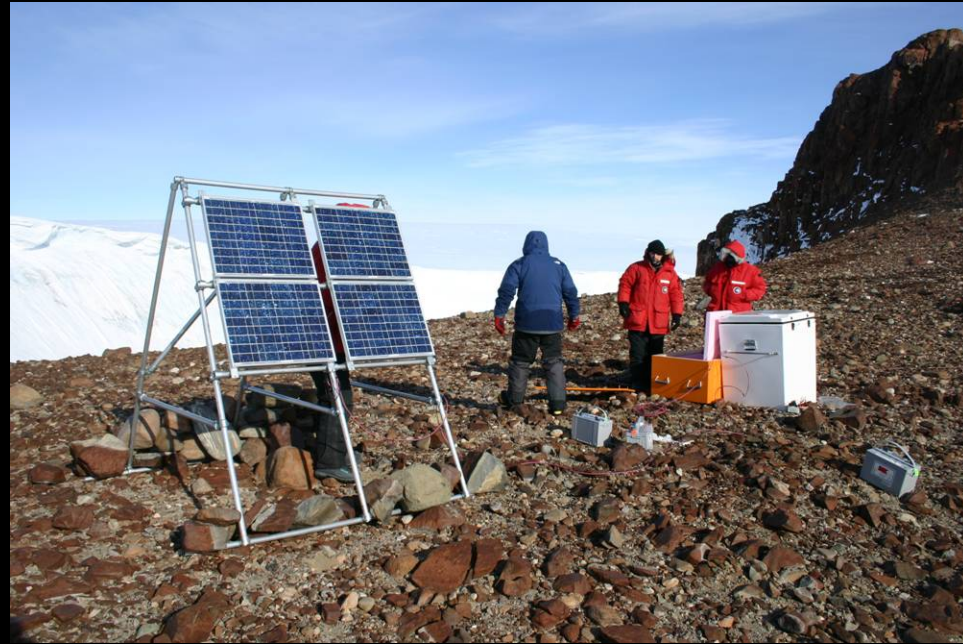
Extremely windy and  
low temperatures

## CHALLENGES

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

## SOLUTIONS

- Strengthened panels
- Redundant power
- Improved sealing of system





Spindrift in sealed enclosure.



Lower profile – reinforced solar panel frame



Spindrift in sealed enclosure following year.



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.**



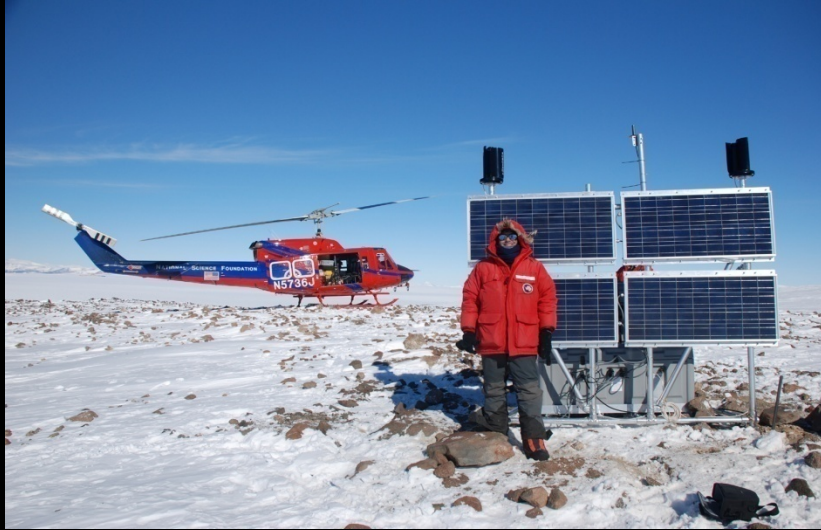
# **Power and Communications through the Polar Night**

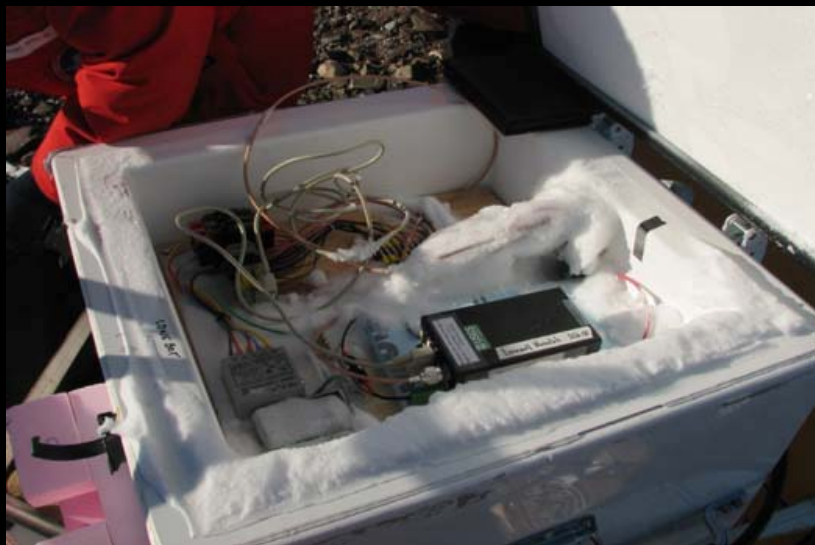
## **Today's Features and Specifications**

- **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.**



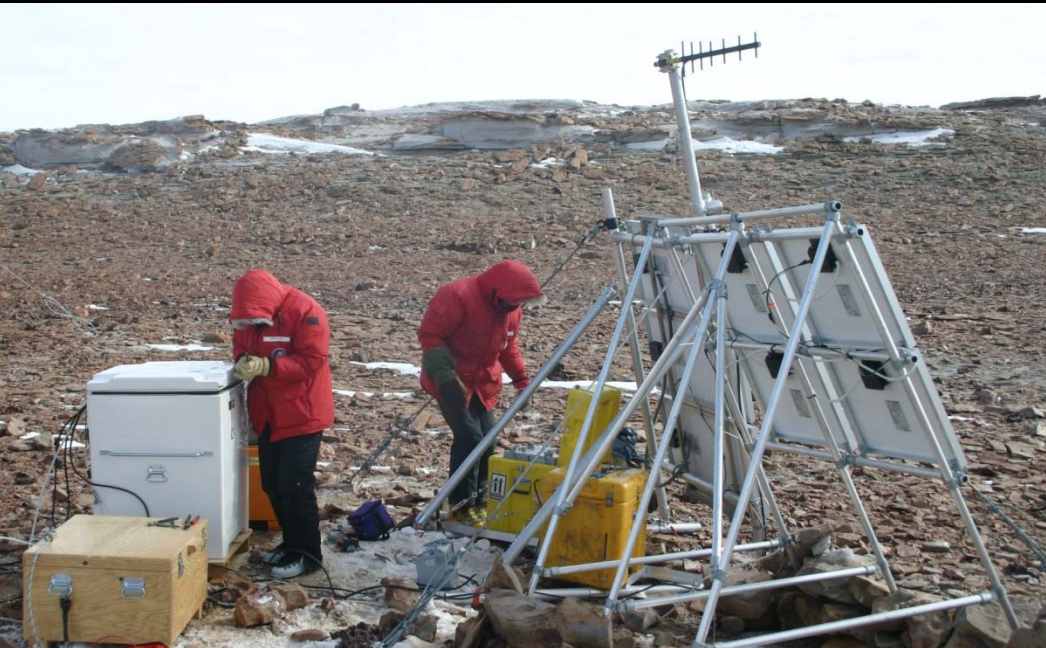
# POLENET Sites in Antarctica





# 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

