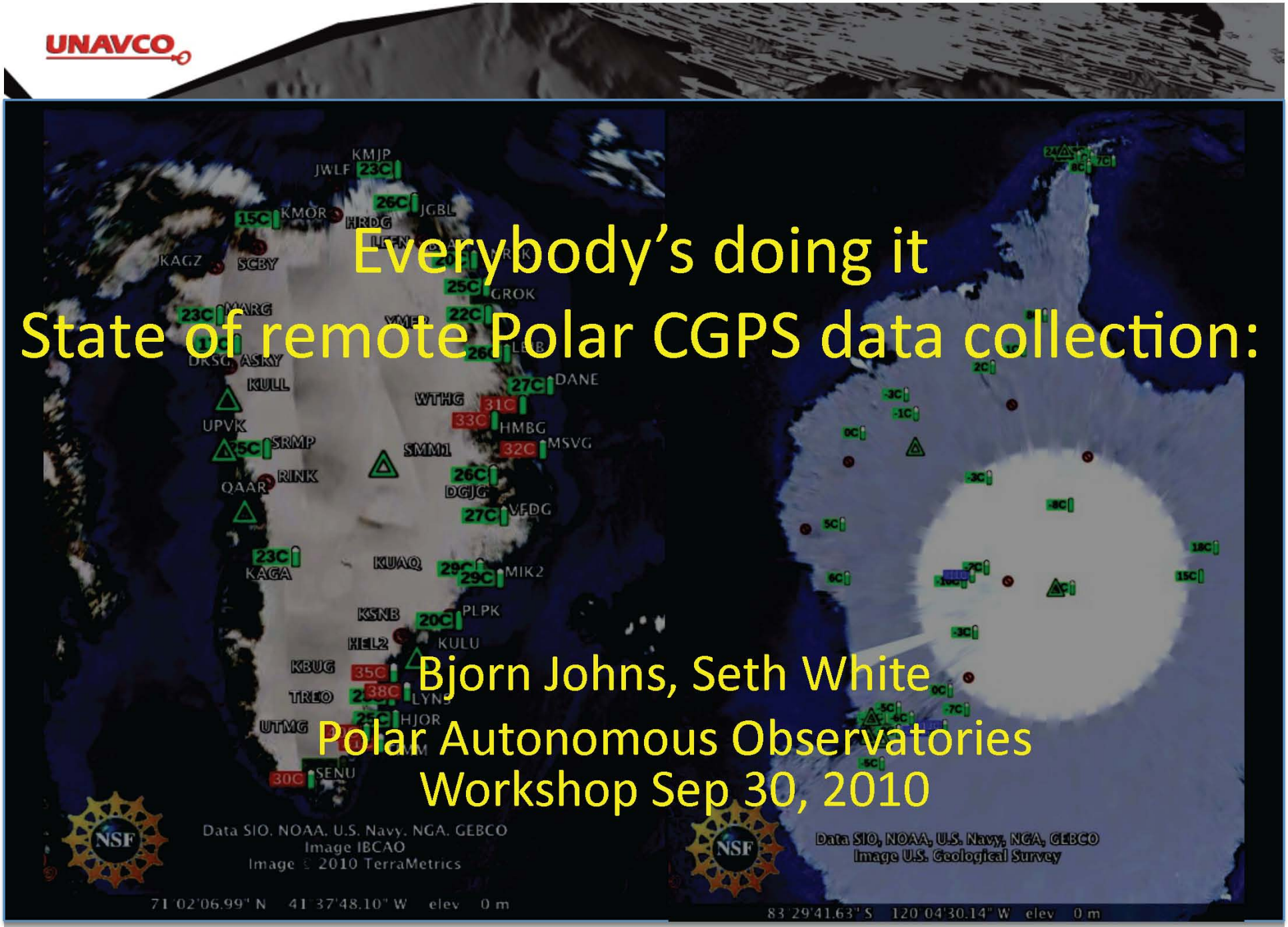

Everybody's doing it
State of remote Polar CGPS data collection:
Bjorn Johns, Seth White
Polar Autonomous Observatories
Workshop Sep 30, 2010
KMJP
JWLF
KMOR
JGBL
HRDG
KAGZ
SCBY
GROK
MARG
DRSG
ASRY
KULL
DANE
WTHG
HMBG
UPVK
SRMP
SMM1
MSVG
RINK
QAAR
DGJG
VFDG
KAGA
KUAQ
MIK2
KSNB
PLPK
HEL2
KULU
KBUG
TREO
LYN3
HJOR
UTMG
SENU
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image IBCAO
Image © 2010 TerraMetrics
71°02'06.99" N 41°37'48.10" W elev 0 m
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image U.S. Geological Survey
83°29'41.63" S 120°04'30.14" W elev 0 m

Outline

1. UNAVCO, geodesy, and cGPS
2. Recent MRI (NSF-ANT 0619908) development project outcomes
3. Related support services
4. Networks overview, data return, and performance

What is UNAVCO

UNAVCO, a non-profit membership-governed consortium, facilitates geoscience research and education using geodesy.

As a facility

-Support NSF and NASA PI projects

-Maintain a community archive of GPS and other geodetic data

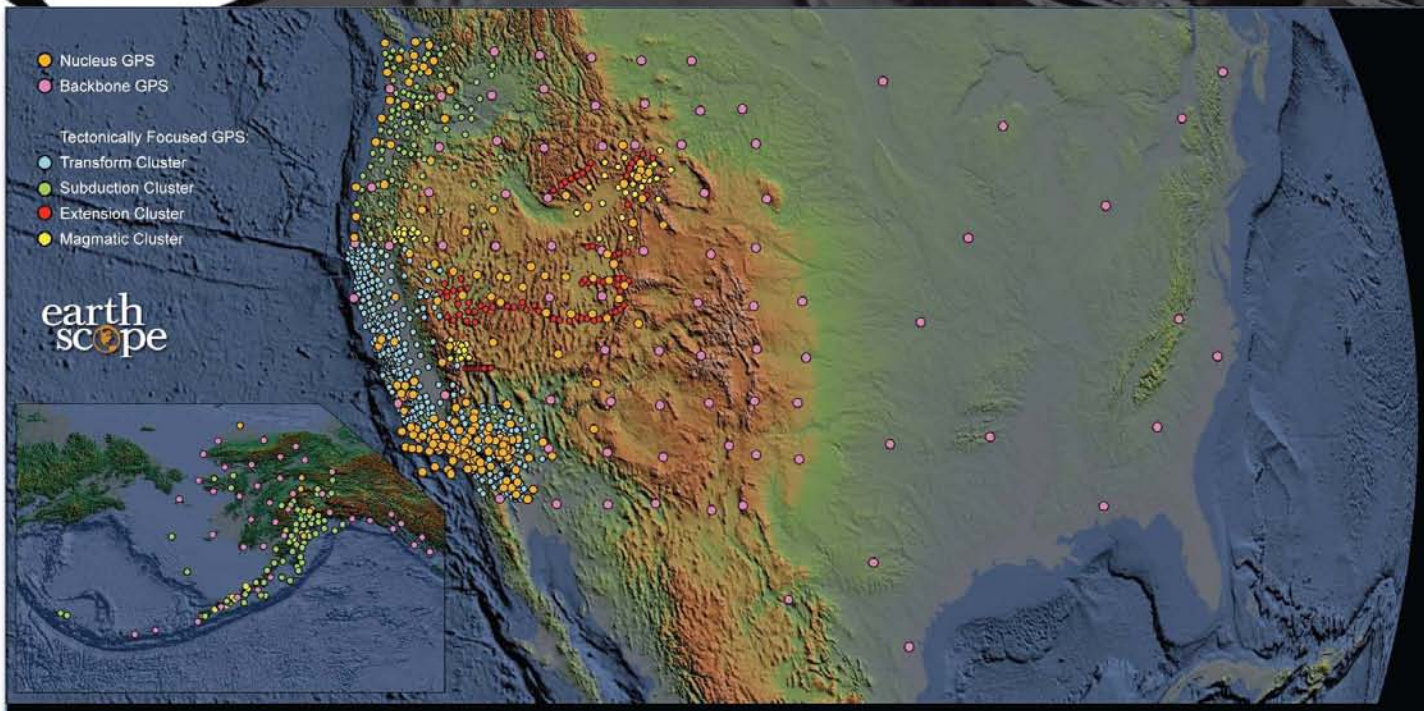
-Large project management, network operation and maintenance

159 members

Main office in Boulder, Colorado

www.unavco.org

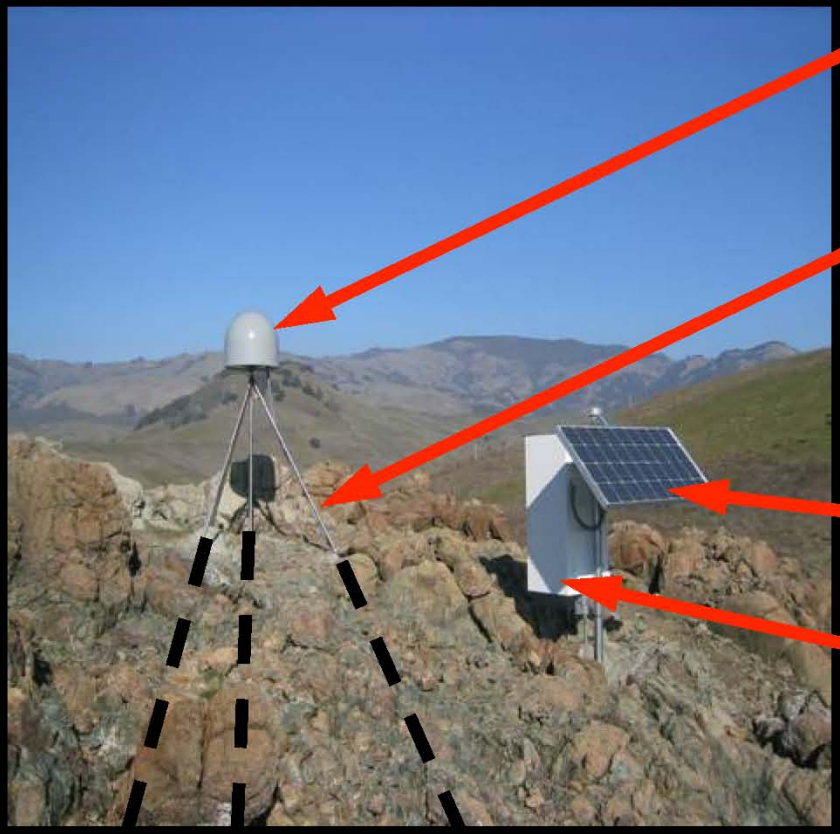
UNAVCO



Recently completed the 1100 GPS station Plate Boundary Observatory component of the EarthScope Major Research Equipment and Facility Construction (MREFC) project.

EarthScope is operated and maintained as a collaborative effort between UNAVCO and IRIS (USArray).

Anatomy of a high-precision contnuous GPS Station



GPS antenna inside of dome

Monument solidly attached into the ground

If the ground moves, the antenna moves

Solar panel for power

Equipment enclosure
- GPS receiver
- Power system/ba[eries
- Communica9ons
- Data storage/ memory

Acknowledgements

-NSF-OPP

-IRIS-PASSCAL (following talk)

-Research project stakeholders: POLENET, LARISSA, Erebus Network, WISSARD, Norway-US IPY Traverse, PIG Network, …

-Industry and support providers: SRI International, CH2M Hill Polar Services, Raytheon Polar Services, Trimble Navigation, Genasun, FlexCharge, British Antarctic Survey, Xeos Technologies, JPL, …

Back in 2006

Impetus for UNAVCO and IRIS MRI proposal:

- *"Operating stations for more than one year without servicing has not yet been achieved because of the lack of a power/communication system sufficiently robust and lightweight to permit autonomous station operation year-round over several years."*

Also in 2006

We proposed :

- *"The power/communication units built will form the nucleus of a new IRIS/UNAVCO equipment pool for supporting the next generation of polar researchers, (and researchers facing similar remote deployments elsewhere), and will allow the science community to achieve the first long-duration deployment of continuously-recording GPS and seismic stations across the Antarctic continent as well as in other remote Polar regions, proposed to commence during the International Polar Year (IPY 2007-2009)."*

Design Goals – Logistics

From proposal:

- 1) Light aircraft deployable design, compatible with Bell 212 helicopter and Twin Otter fixed-wing aircraft. <1500 lbs total system weight.
- 2) Individual modules weighing less than 100 lbs for 2 person handling.
- 3) Designed for two year minimum service interval.
- 4) Optimized for three person field teams.
- 5) Designed for minimal field wiring.
- 6) Designed to minimize fieldwork with simple status checks, component swaps, etc.
- 7) Compatible with "near year-round" operation in case delivering a year-round power system is not practical. Must demonstrate graceful summertime recovery after winter data outage.
- 8) Avoid air-transport-restricted materials.

UNAVCO

Two systems:

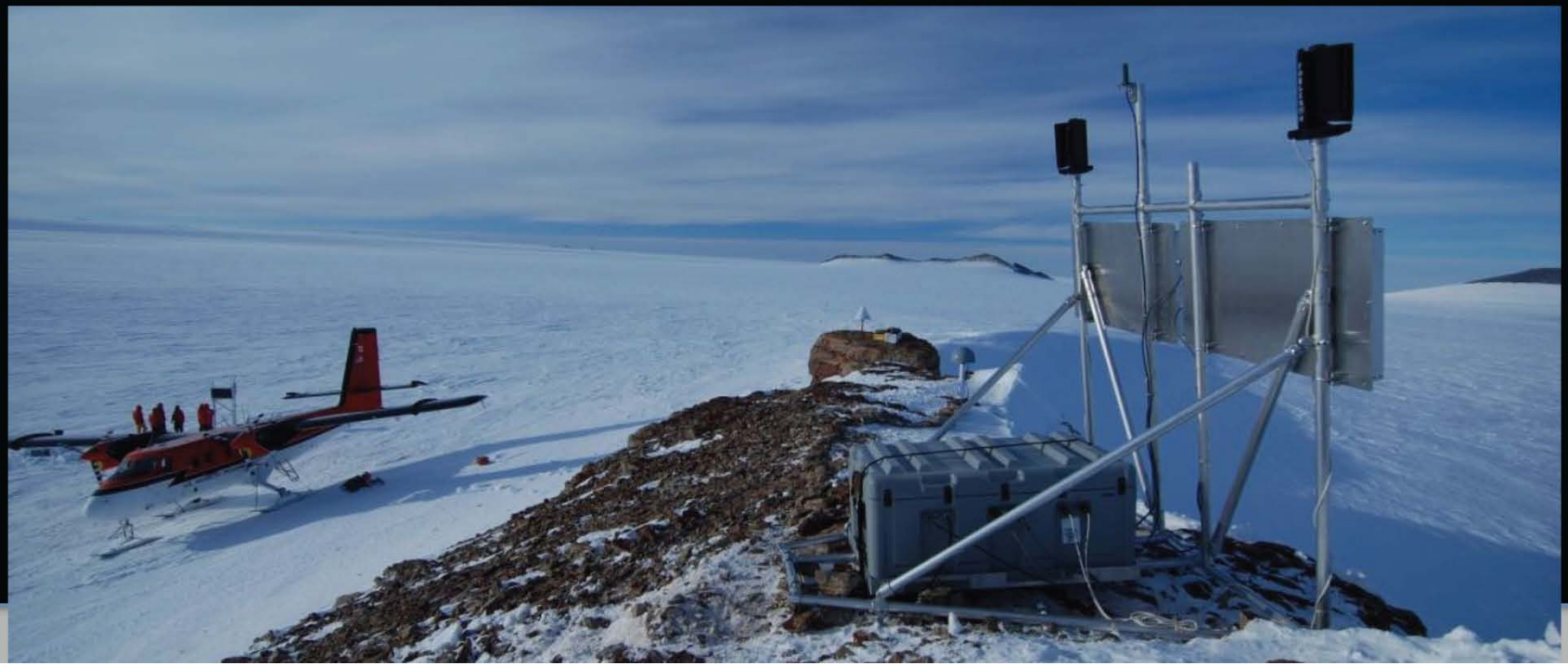
PLATEAU >>>>>>>>>>

(and crossover , site specific designs)

CONTINENTAL MARGIN

V

V

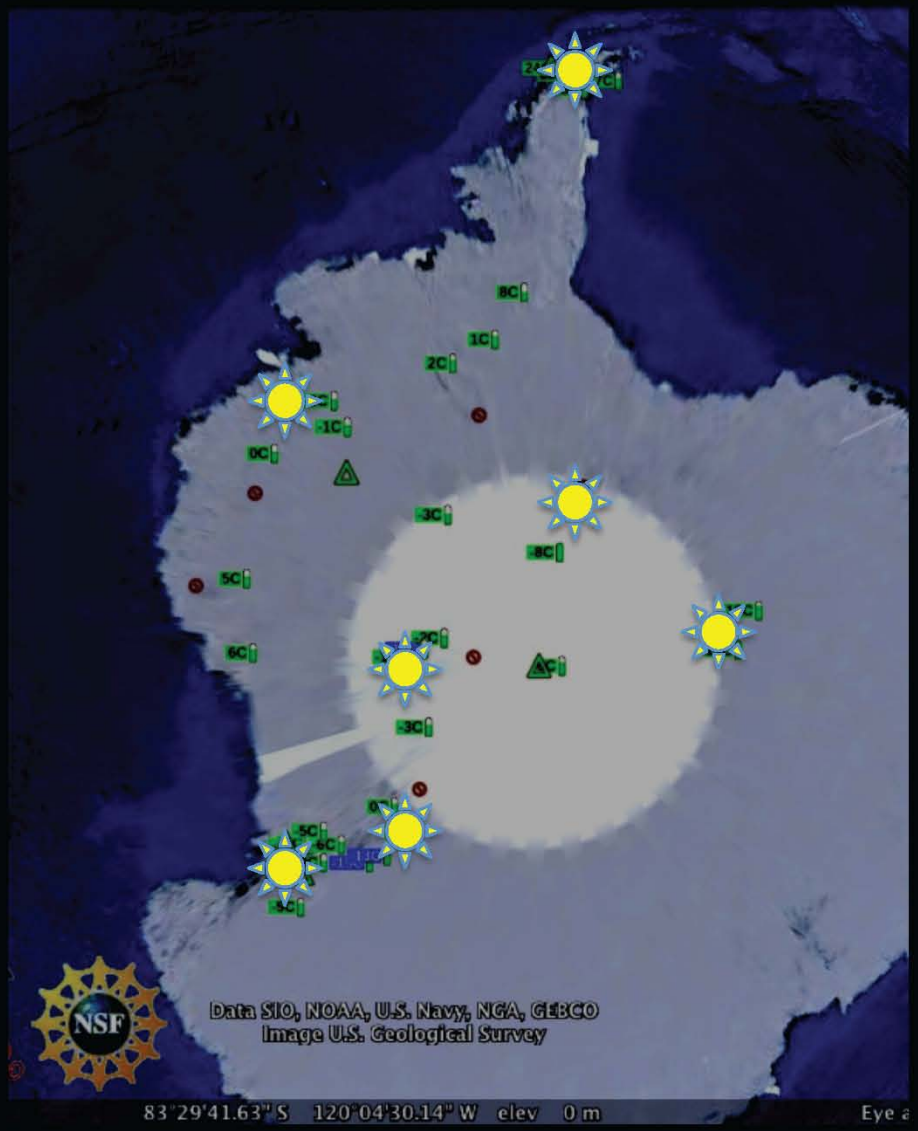


Design goals were achieved

- Installations with 1 flight, 3 people, a few hours ground time
- 2 year MTBF likely exceeded
- Near-year-round operation and graceful wakeup demonstrated
- 20 field kits installed in a variety of geographic locations, environmental conditions, scientific applications. (This is a small subset of the polar network CGPS sites.)
- Lessons are learned and fed back into “best-practices” evolving design

UNAVCO

20 MRI Kits Installed

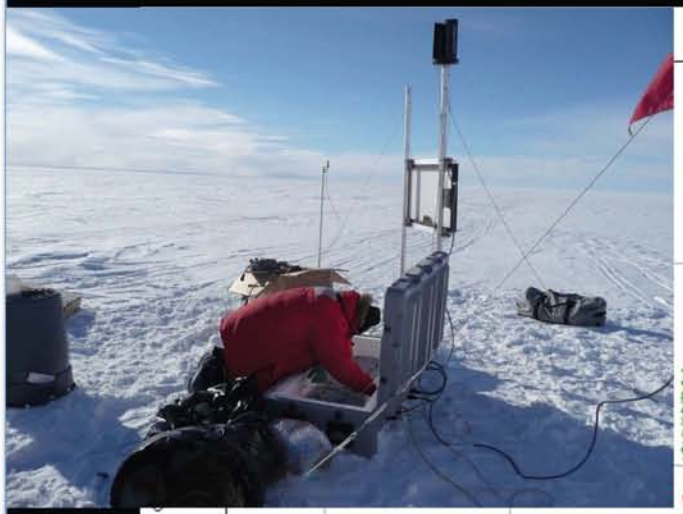


UNAVCO

Antarctica Minna Bluff POLENET and Prototype Site

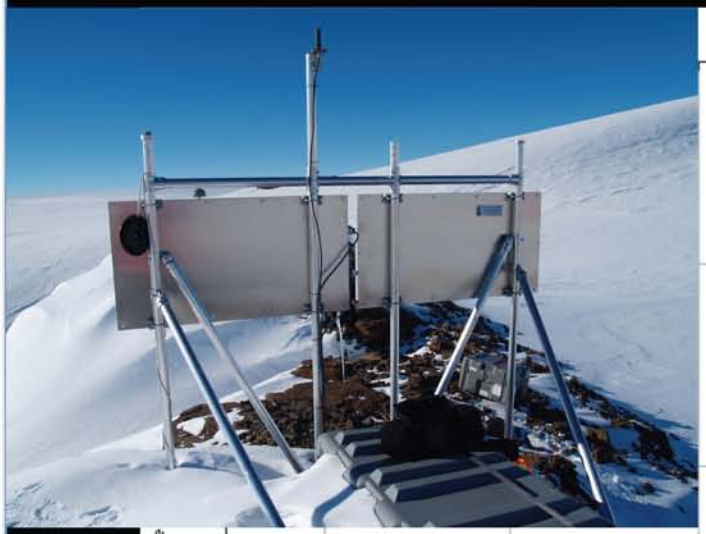
Prototype GPS station at Minna Bluff (POLENET – MIN0)
Near continuous GPS data retrieval via Iridium since January 2007
Lessons learned: Wind turbine potential and vulnerability, fickle Iridium communications, solar and battery bank validation

Whillans Ice Stream – subglacial lakes



GPS station WHL1 at 85 deg S, 100m ASL
Installed by Slawek Tulaczyk
Unattended operation and near-continuous GPS data retrieval via Iridium since December 2007

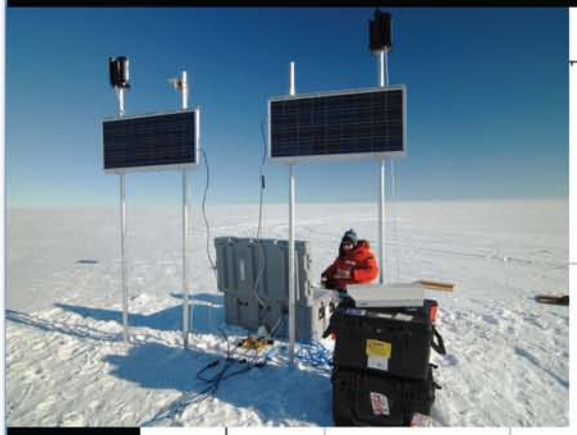
POLENET – Pecora Escarpment and Cordiner Peak



GPS stations CRDI 83 deg S, 900m ASL, PECE at 86 deg S, 1500m ASL
Installed in January 2008
Lessons learned: Wind turbine shaft,
wind turbine regulation, static

UNAVCO

Pine Island Glacier Dynamics



Installed in January 2008 – PIG1 90% data return, PIG2 100%

Lessons learned: Wind turbine shaft, wind turbine regulation

Miller Range POLENET and prototype site

GPS station IGGY at 83 deg S, 1900m ASL

Installed by UNAVCO in January 2008 – full data retrieval after January 2009 visit

Lessons learned: Wind regulation, fickle Iridium communications

UNAVCO

Antarctic Plateau - Recovery Subglacial Lakes

GPS station REC1 at Recovery Lakes 83 deg S, 2500m ASL
Installed by Ted Scambos from Norway-US IPY Traverse
Unattended operation and continuous GPS data retrieval via
Iridium since January 2009

Mt. Erebus volcano deformation

GPS station MACZ at 78 deg S, 3300m ASL

Installed by UNAVCO in February 2008

Annual visits and lessons learned: Wind improvements,

solar panel frame fatigue, better radio modem power efficiency

LARISSA – Antarctic Peninsula GIA

GPS station DUPT installed from LM Gould via zodiac

Continuous unattended operation since April 2009 installation

Evolving Best Practices

Lessons learned are applied to current system design:

- Simple un-insulated systems are often adequate
- Wind turbine needs hardening
- Micro-turbine needs power regulation
- Iridium modems are prone to cold failures
- Iridium modems can be fickle
- Frame vulnerable to fatigue failure
- Electronics vulnerable to static
- Subtle barriers to achieving adequate system grounding
- The list goes on…

Adaptable Design

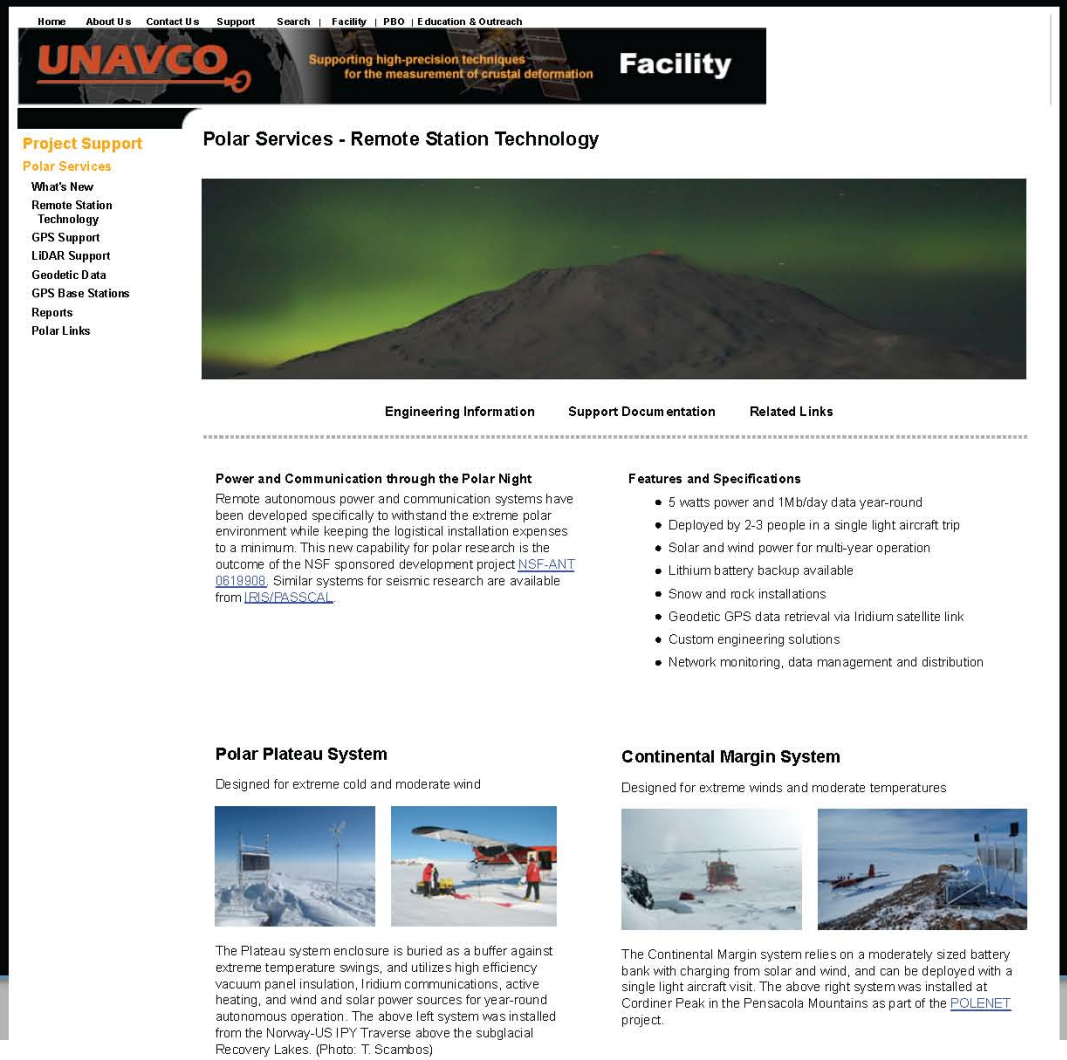
A la carte menu for custom integration based on environment and requirements:

Component	Weight	Cost
Rock mount structure	Medium	Low
Snow mount structure	Medium	Low
Solar panels	Low	Low
Small wind turbine	Low	Medium
Large wind turbine	Low	Medium
Lead acid batteries	High	Medium
Lithium batteries	Low	High
Satellite modem	Low	High
Radio modem	Low	Low
Weather station	Low	Medium
Etc…		

Accessible Documentation

Open design with best practices at

www.unavco.org/polartechnology



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UNAVCO Supporting high-precision techniques for the measurement of crustal deformation **Facility**

Project Support

Polar Services

- What's New
- Remote Station Technology
- GPS Support
- LiDAR Support
- Geodetic Data
- GPS Base Stations
- Reports
- Polar Links

Polar Services - Remote Station Technology

Engineering Information **Support Documentation** **Related Links**

Power and Communication through the Polar Night

Remote autonomous power and communication systems have been developed specifically to withstand the extreme polar environment while keeping the logistical installation expenses to a minimum. This new capability for polar research is the outcome of the NSF sponsored development project NSF-ANT 0619908. Similar systems for seismic research are available from IRIS/PASSCAL.

Features and Specifications

- 5 watts power and 1Mb/day data year-round
- Deployed by 2-3 people in a single light aircraft trip
- Solar and wind power for multi-year operation
- Lithium battery backup available
- Snow and rock installations
- Geodetic GPS data retrieval via Iridium satellite link
- Custom engineering solutions
- Network monitoring, data management and distribution

Polar Plateau System

Designed for extreme cold and moderate wind

The Plateau system enclosure is buried as a buffer against extreme temperature swings, and utilizes high efficiency vacuum panel insulation, Iridium communications, active heating, and wind and solar power sources for year-round autonomous operation. The above left system was installed from the Norway-US IPY Traverse above the subglacial Recovery Lakes. (Photo: T. Scambos)

Continental Margin System

Designed for extreme winds and moderate temperatures

The Continental Margin system relies on a moderately sized battery bank with charging from solar and wind, and can be deployed with a single light aircraft visit. The above right system was installed at Cordiner Peak in the Pensacola Mountains as part of the POLENET project.

Last modified Tuesday, 16-Feb-2010 18:56:46 UTC

Systems delivered as kits

15 independent PI projects supported - most recent:

Greenland – Jakobshavn – Ginny Catania/Tom Neumann/Matt Hoffman

Greenland - Nuuk Fjords – Martin Truffer

Alaska – Hubbard Glacier – Dan Lawson

May 2010 >>

On-going development

Including:

Iridium direct IP connectivity

Ruggedized micro-turbines

Expanded use of larger wind turbines

Talks tomorrow

South Pole

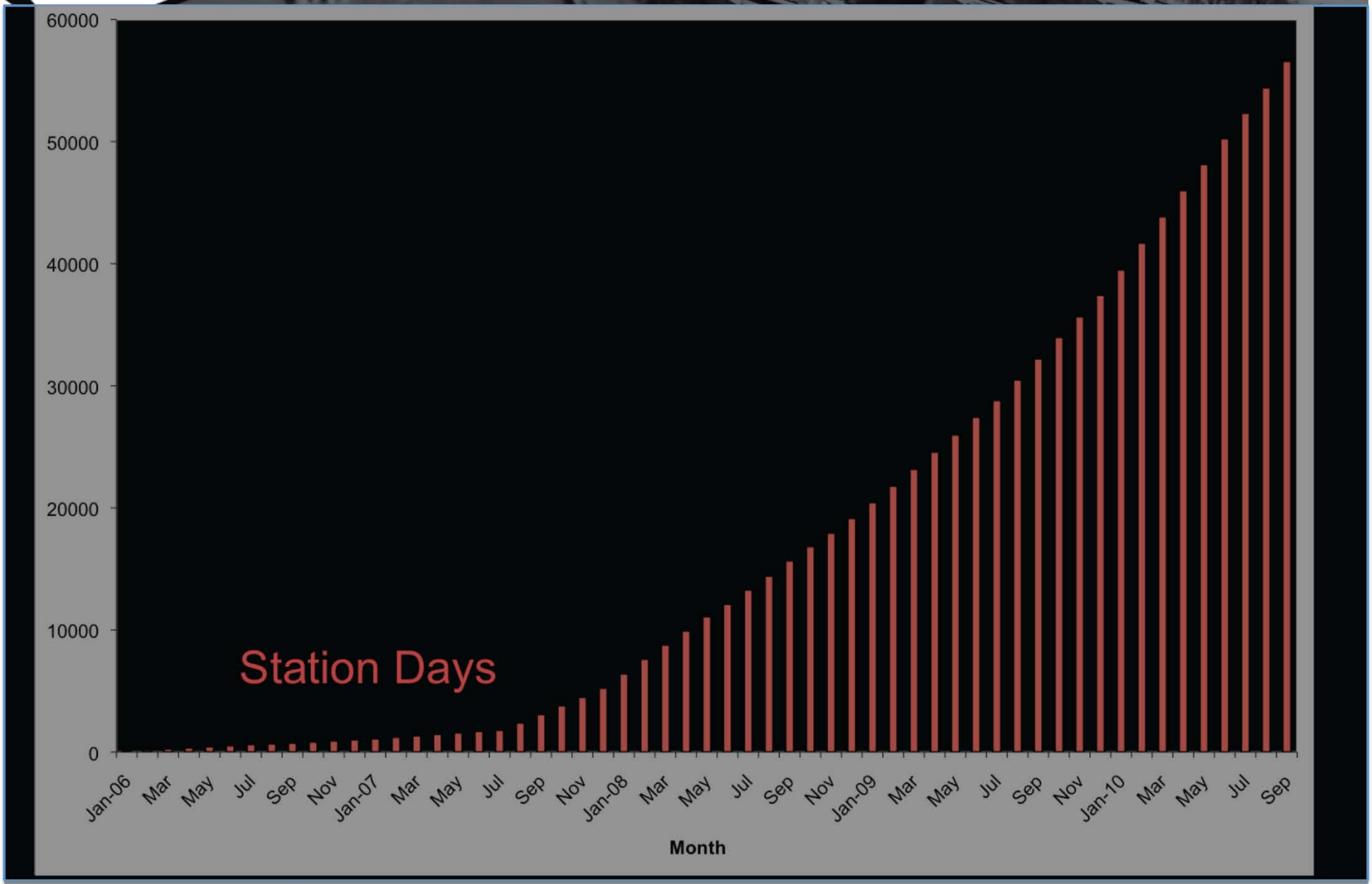
Niwot Ridge, Colorado

Data Handling

Scalable network support services include:

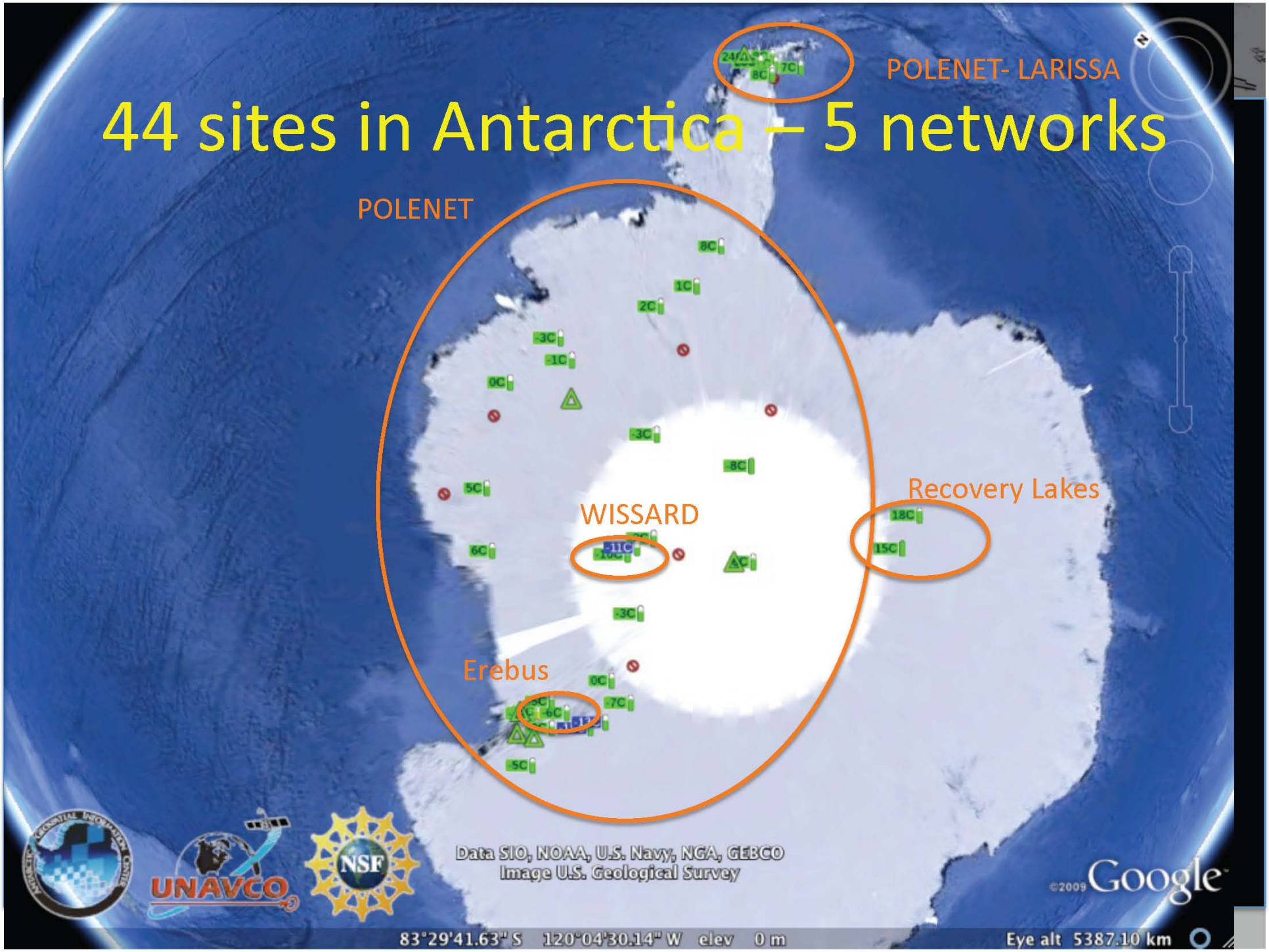
- Iridium hub for data retrieval
- Dataflow monitoring and management
- State-of-health monitoring
- Equipment tracking
- Data and meta-data archival per global standards and policies
- Open data access

Cumulative data holdings 2006-2010



GNET: 39 sites in Greenland

(Michael Bevis)


POLENET- LARISSA
44 sites in Antarctica – 5 networks
POLENET
WISSARD
Recovery Lakes
Erebus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image U.S. Geological Survey
©2009 Google
83°29'41.63" S 120°04'30.14" W elev 0 m
Eye alt 5387.10 km

Network Performance – all sites 2006-2010