

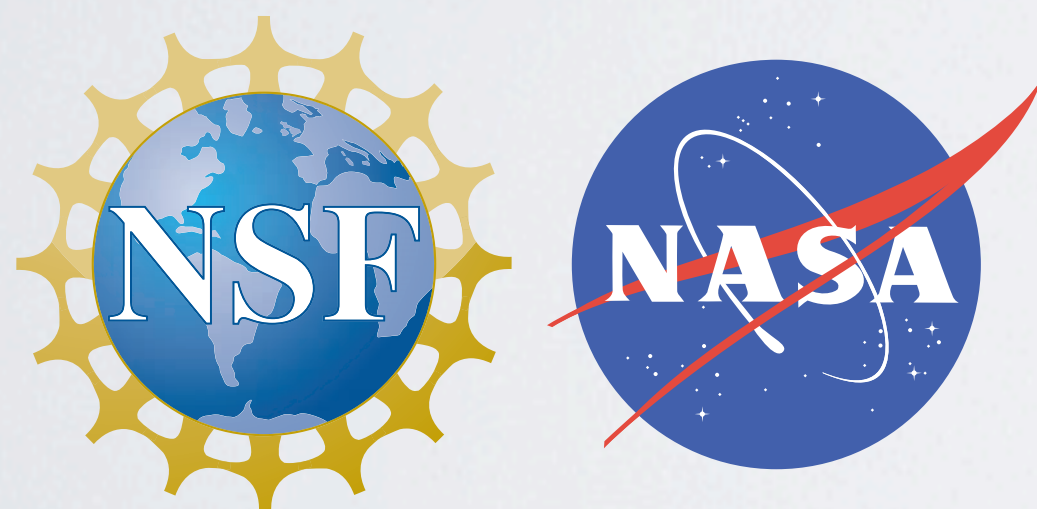
UNAVCO



STATUS OF PBO AND THE TRANSITION TO GAGE FOR 2013-2018

Glen S. Mattioli, Ph.D.

Director of Geodetic Infrastructure and
PBO/SAFOD Director

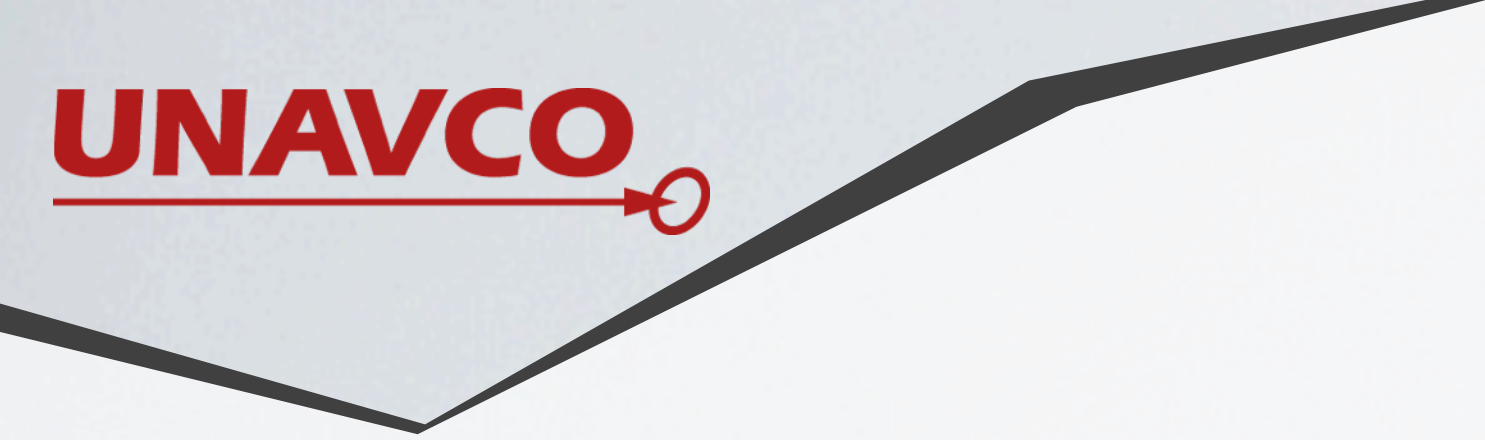


CSRC Meeting, Oct. 24, 2013 - UCSD-SIO, La Jolla, CA

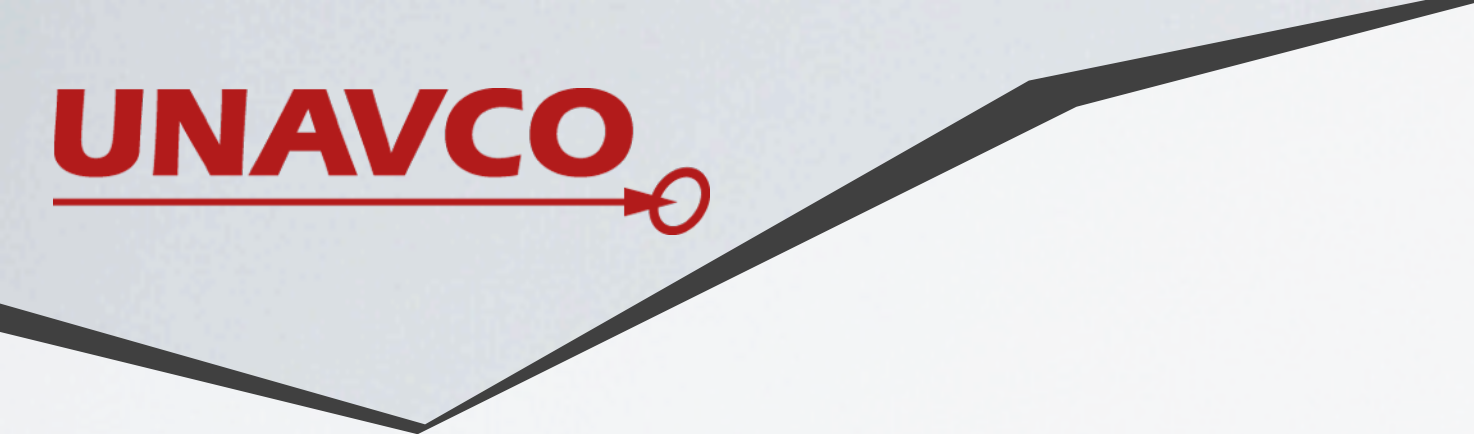


TALK OUTLINE

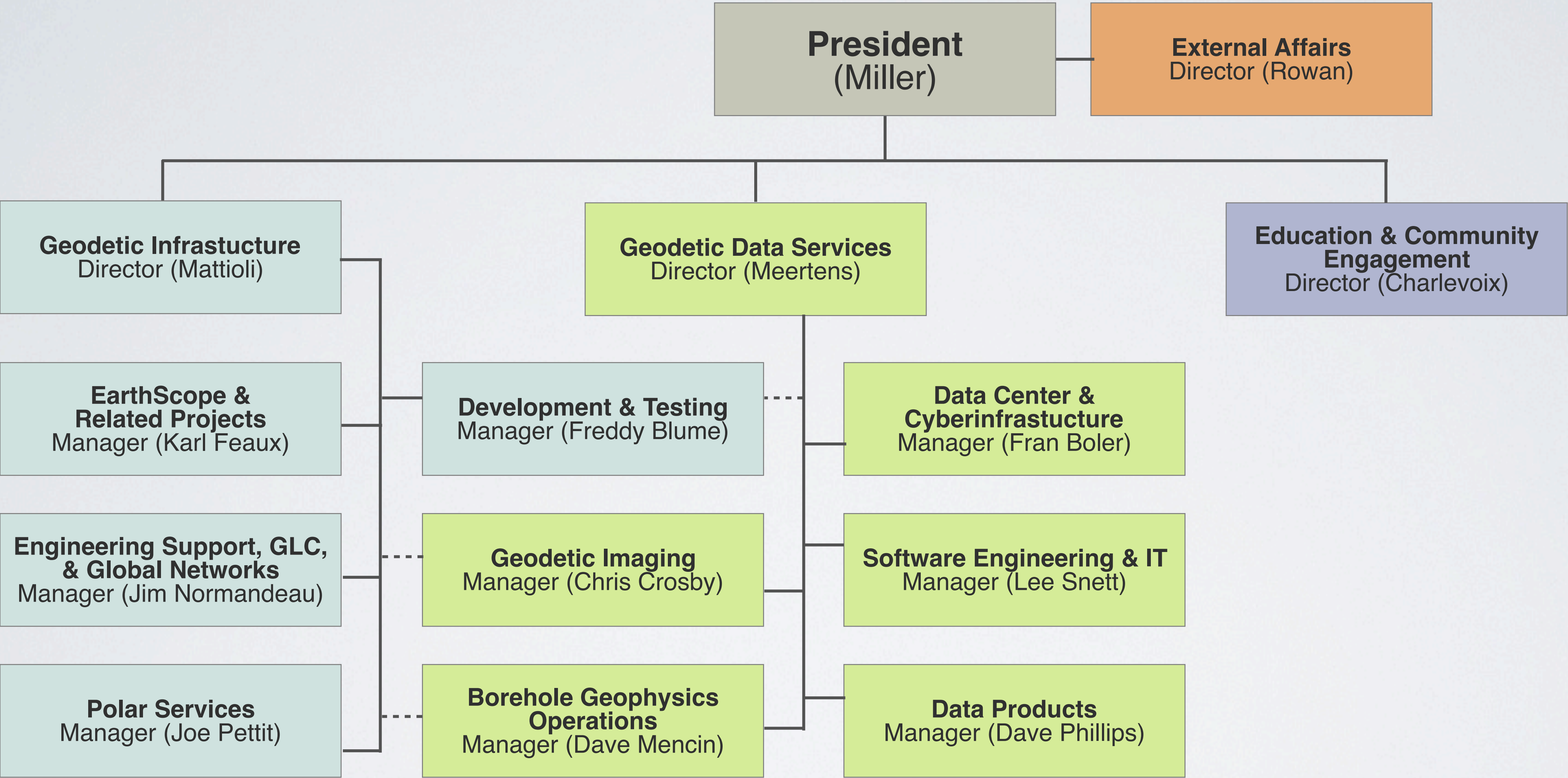
- Overview of GI program and PBO staff in GAGE
- EarthScope overview: PBO and data products
- Impacts of partial government shutdown on UNAVCO and PBO
 - Issues with permitting - unfunded liabilities going forward
- RT-GPS and GPS-Seismology in PBO
- Recent PBO Highlights: Multi-monument study, PBO East, and YNP Norris Ridge GTSM install
- PBO-related special projects: COCONet, TLALOCNet, and GeoGONAF
- Codependencies and challenges going forward...



UNAVCO ORGANIZATIONAL STRUCTURE

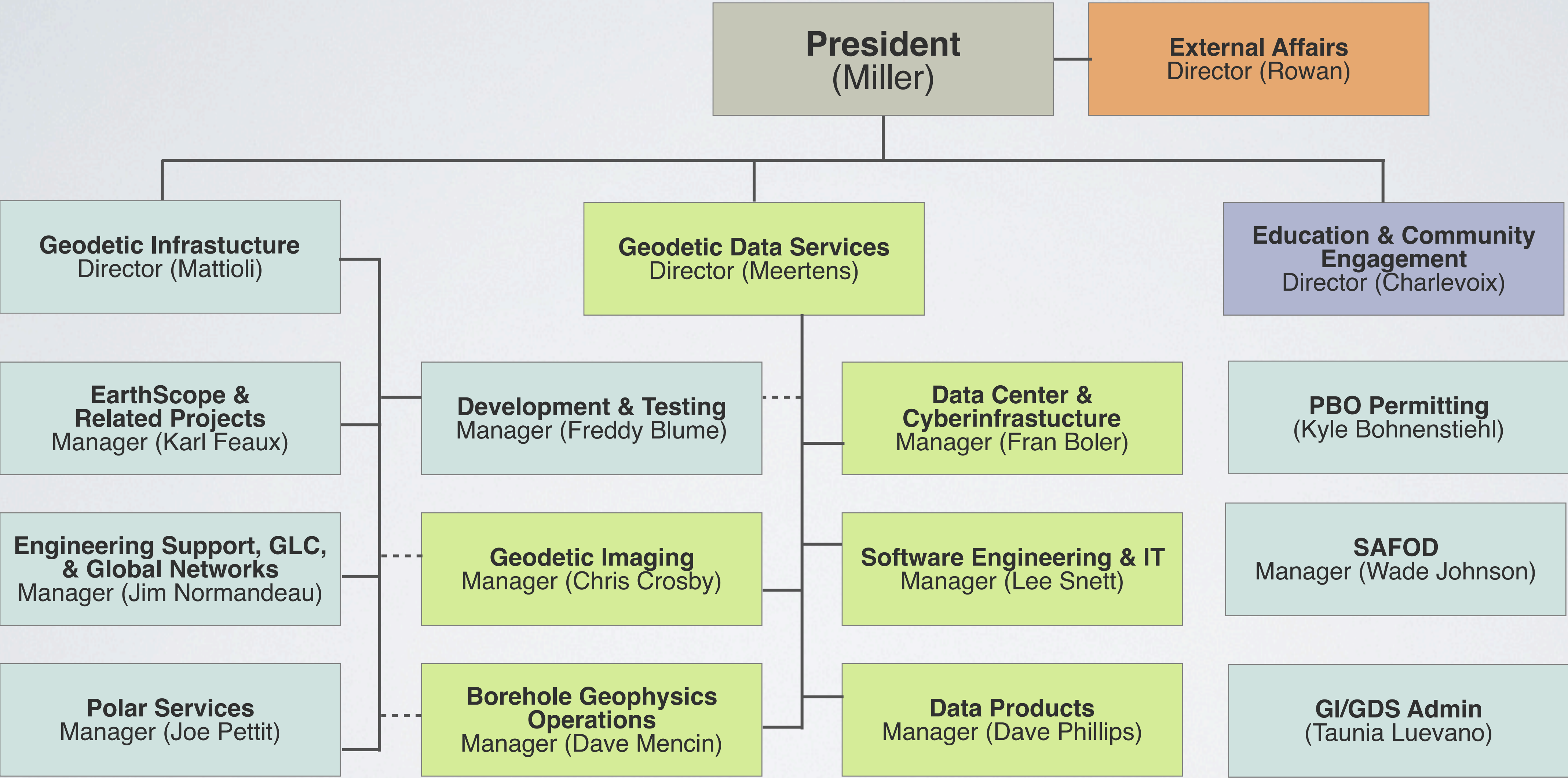


UNAVCO ORGANIZATIONAL STRUCTURE

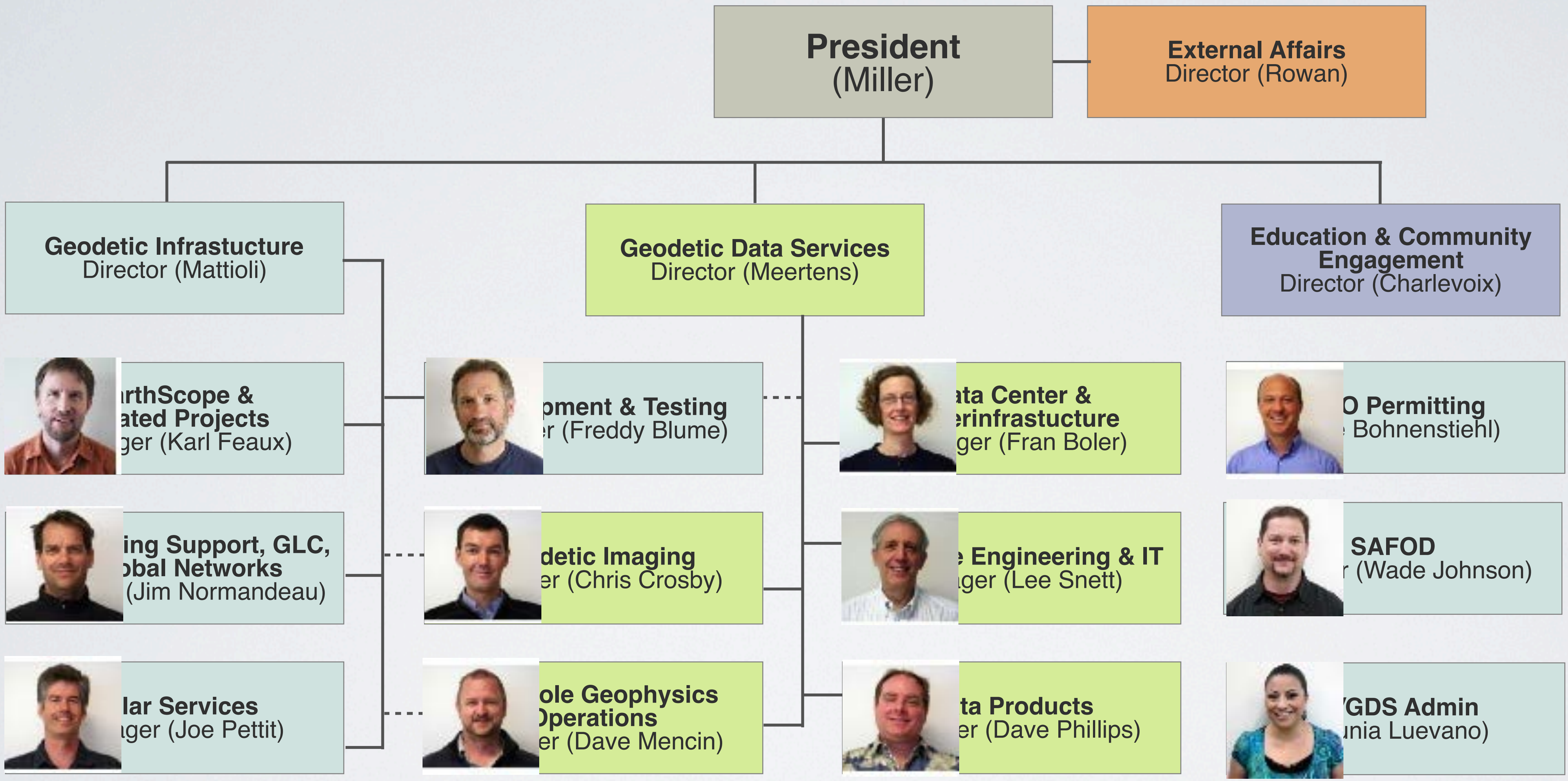




UNAVCO ORGANIZATIONAL STRUCTURE



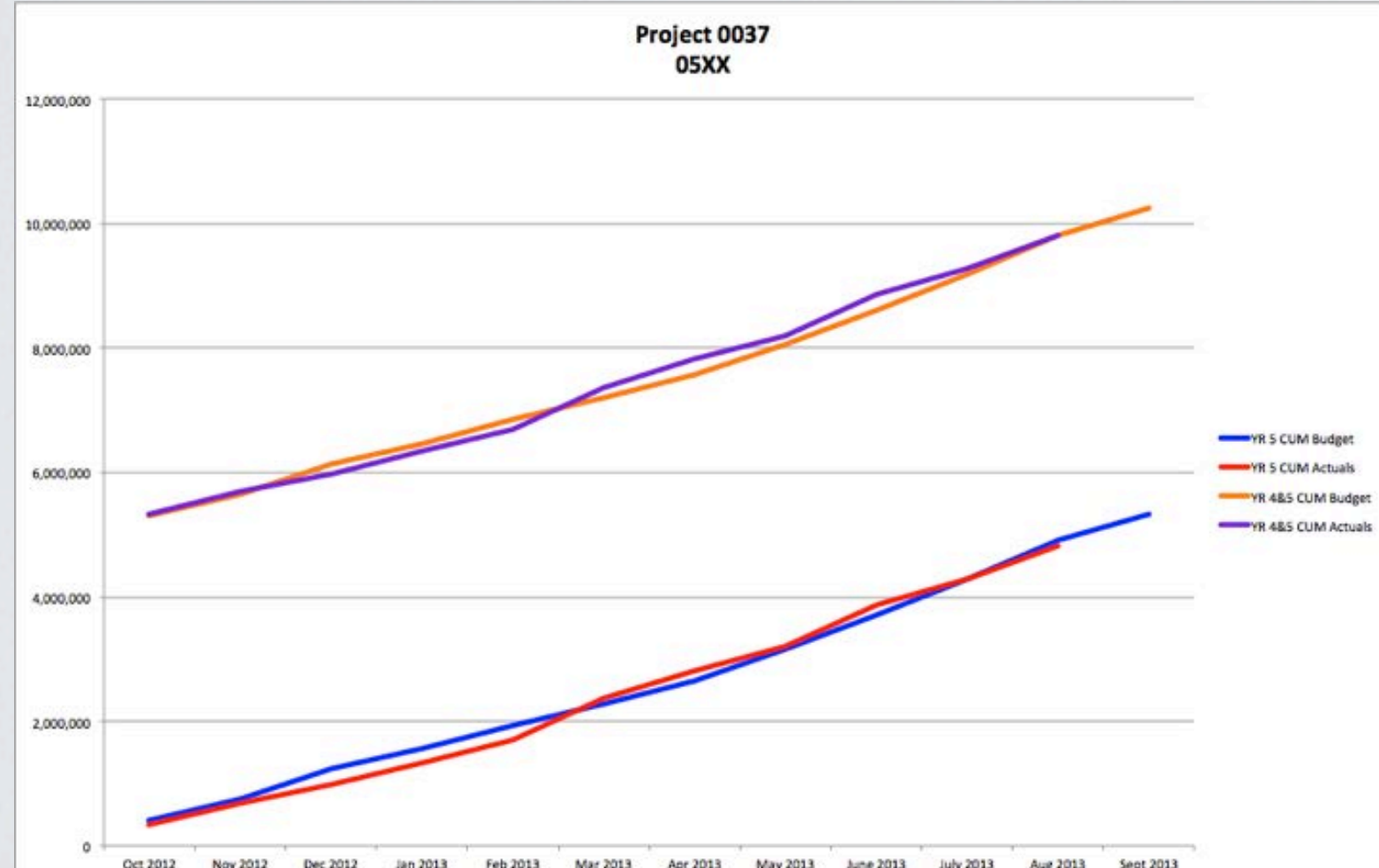
UNAVCO ORGANIZATIONAL STRUCTURE



PBO FACILITY HIGHLIGHTS



Game of Strategic Chicken...?



PBO GPS Ops <0.07% variance

PBO Station Location Map

Searching Station Meta Data

● Nominal ● Warning ● Failure ● Manual

1479 Stations Found

Terrain Satellite

Greenland

Northwestern Passages

Hudson Bay

Canada

Y.T. NT AB BC SK MB ON QC

Bering Sea

Gulf of Alaska

States

ND SD MN WI MI IL IN OH PA VT ME NE MA RI CT NJ DE MD VA WV KY TN MS AL GA FL

Gulf of California

Mexico

Gulf of Mexico

Cuba

Puerto Rico

Caribbean Sea

search the map

Search

Map data ©2013 Google, INEGI - Terms of Use

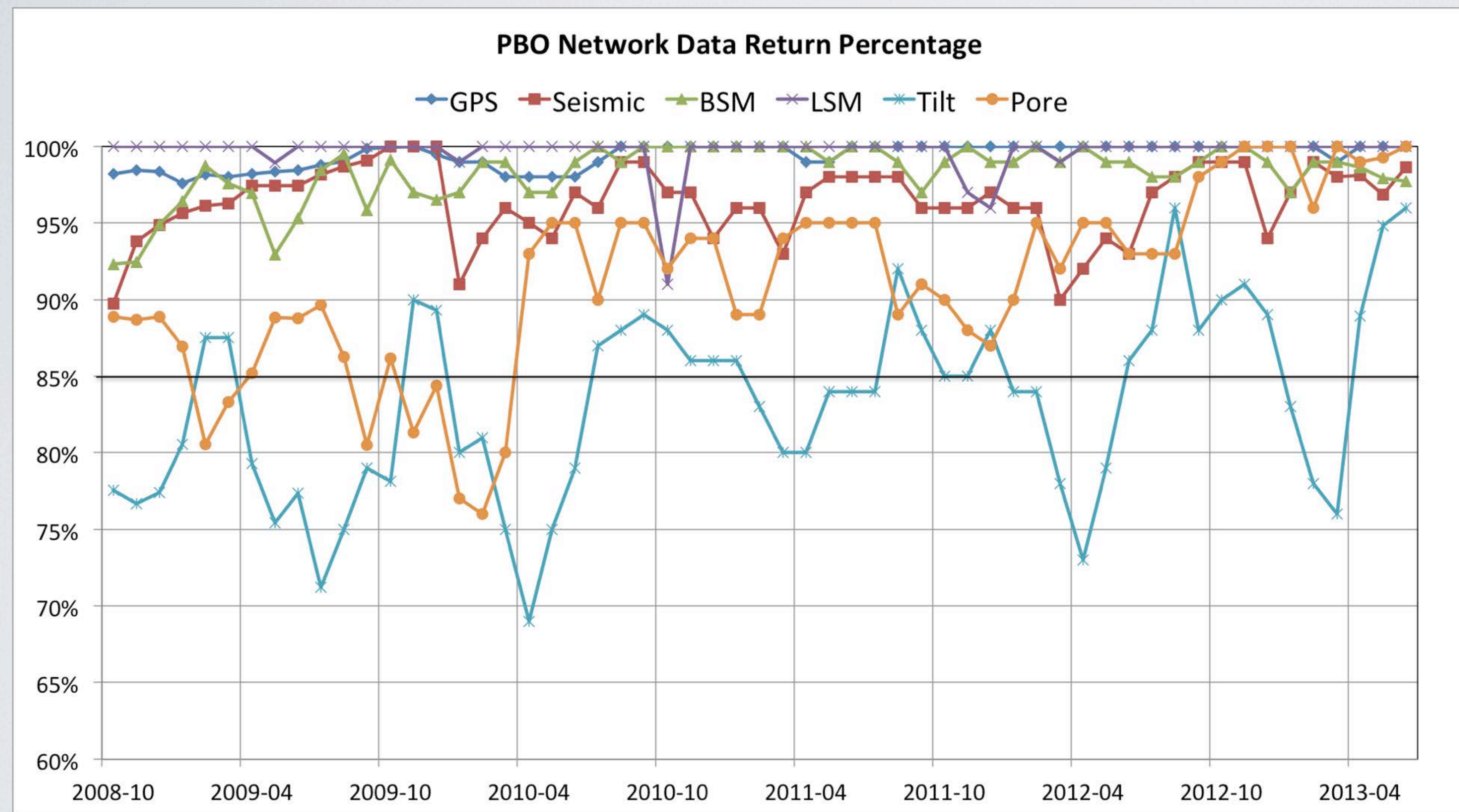
1100 station cGPS network at 96% uptime

PBO is the geodetic component of EarthScope:
1100 cGPS, 78 BSM, 6 LSM, 26 tiltmeters, 122 metpacks

PBO CA (in NCE to 9/30/14) has **0.6% (~\$300K) under run...**

An analog clock with a white face and black numbers. The hour hand is between 10 and 11, and the minute hand is at 2. The clock is labeled "sapling" in the center.

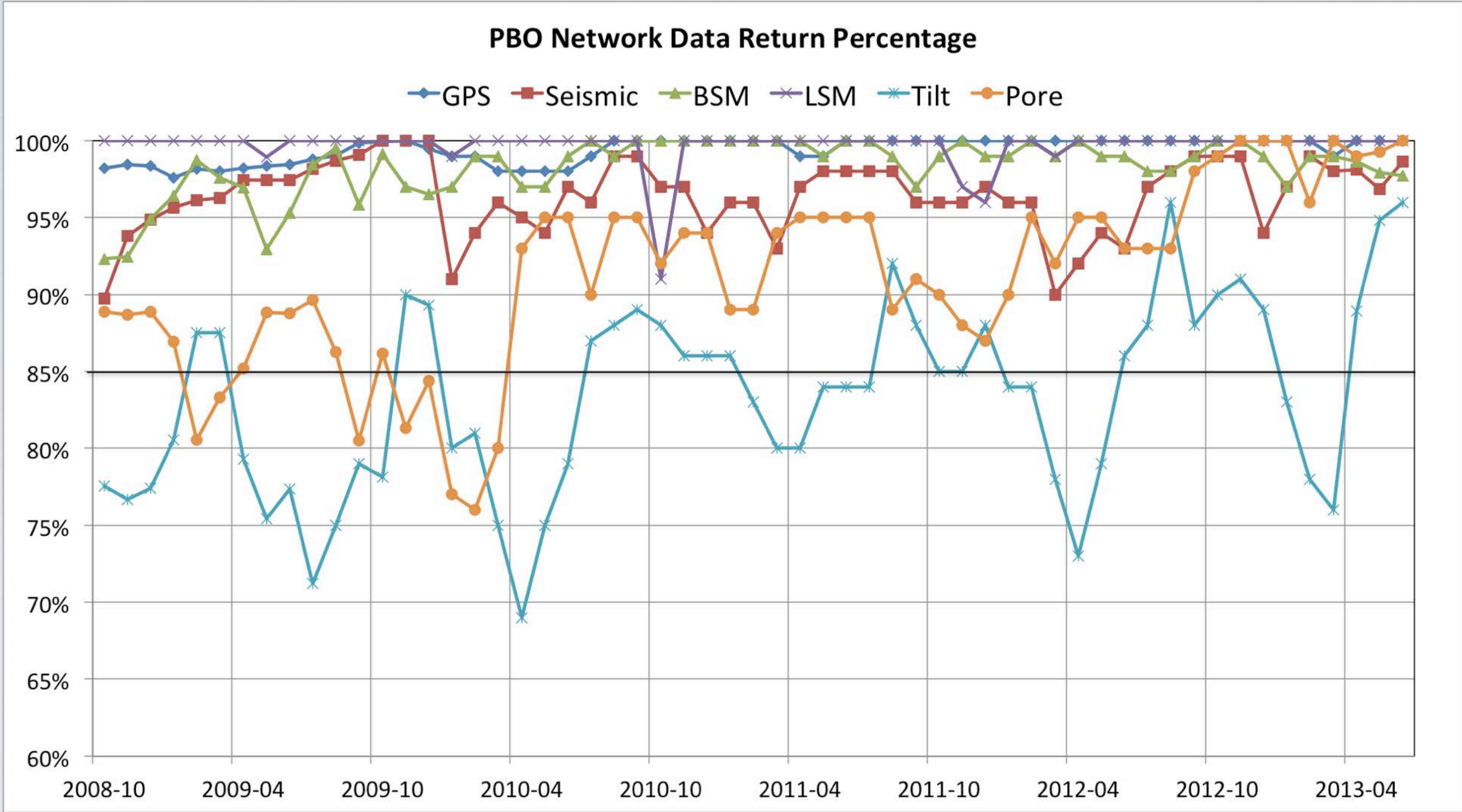
Time may not be on "our side"..



Metrics complete through June 30, 2013 (YR5Q3)



PBO SENSOR UPTIME

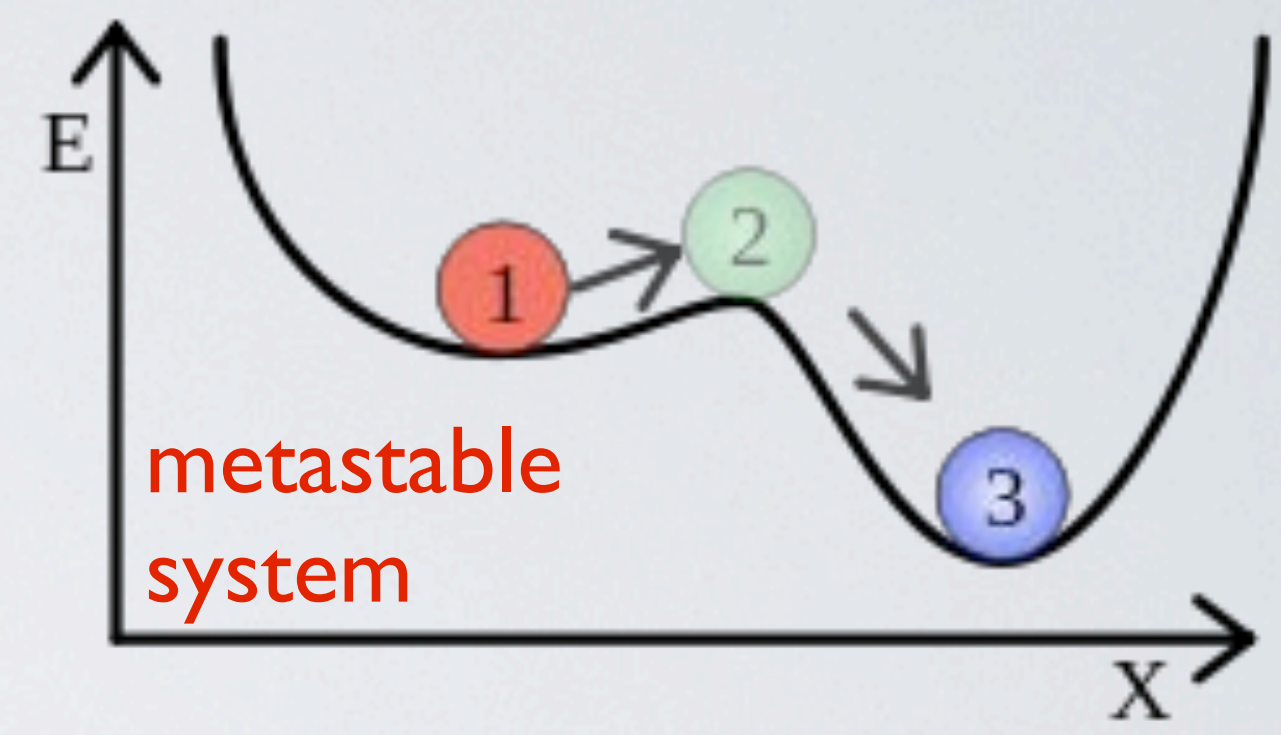
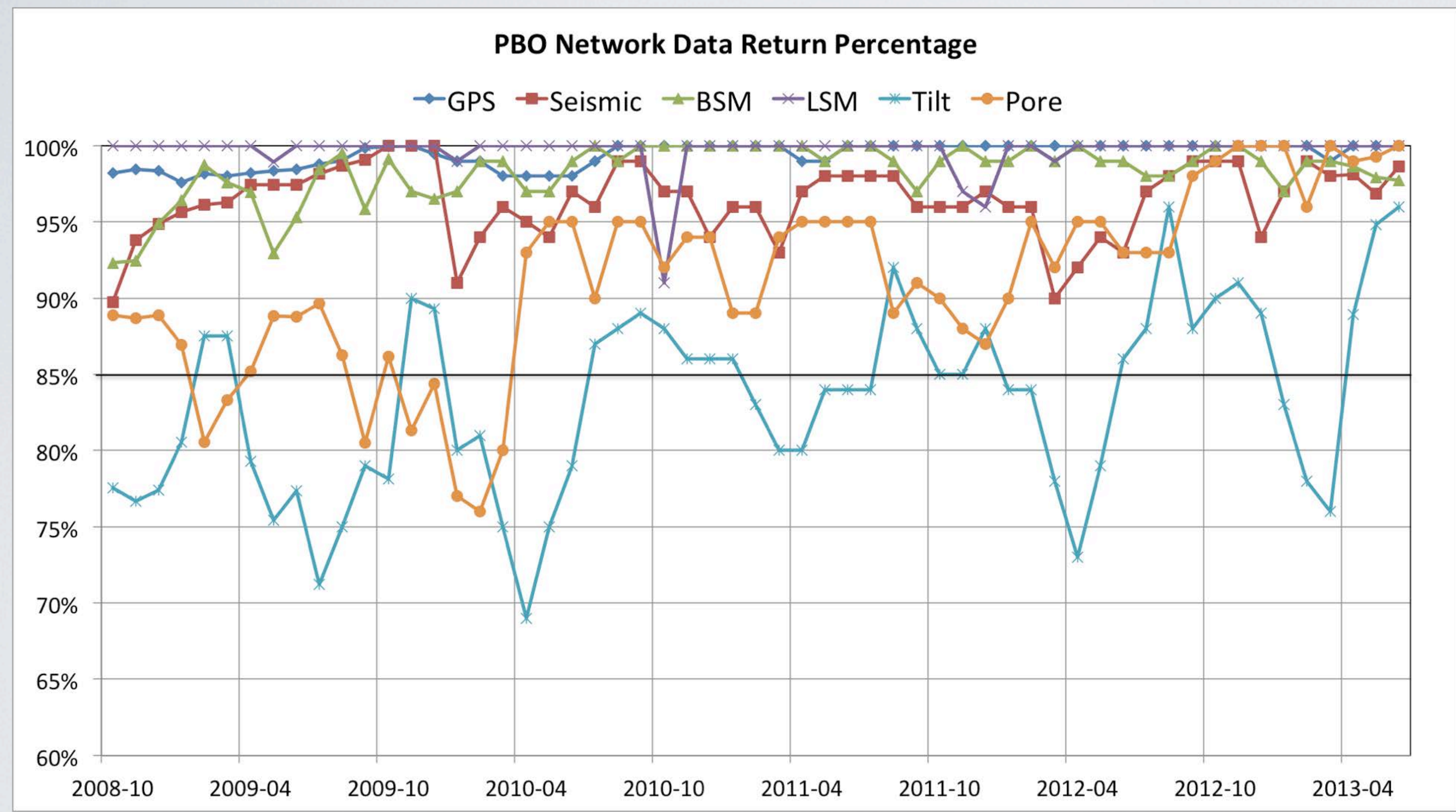


Cumulative data return for the PBO network since the beginning of the O&M period (FY2009) is:

- 97% for GPS/Met
- 93% for seismic
- 92% for BSM
- 99% for LSM
- 92% for pore pressure
- 93% for tilt.

Metrics complete through June 30, 2013 (YR5Q3)

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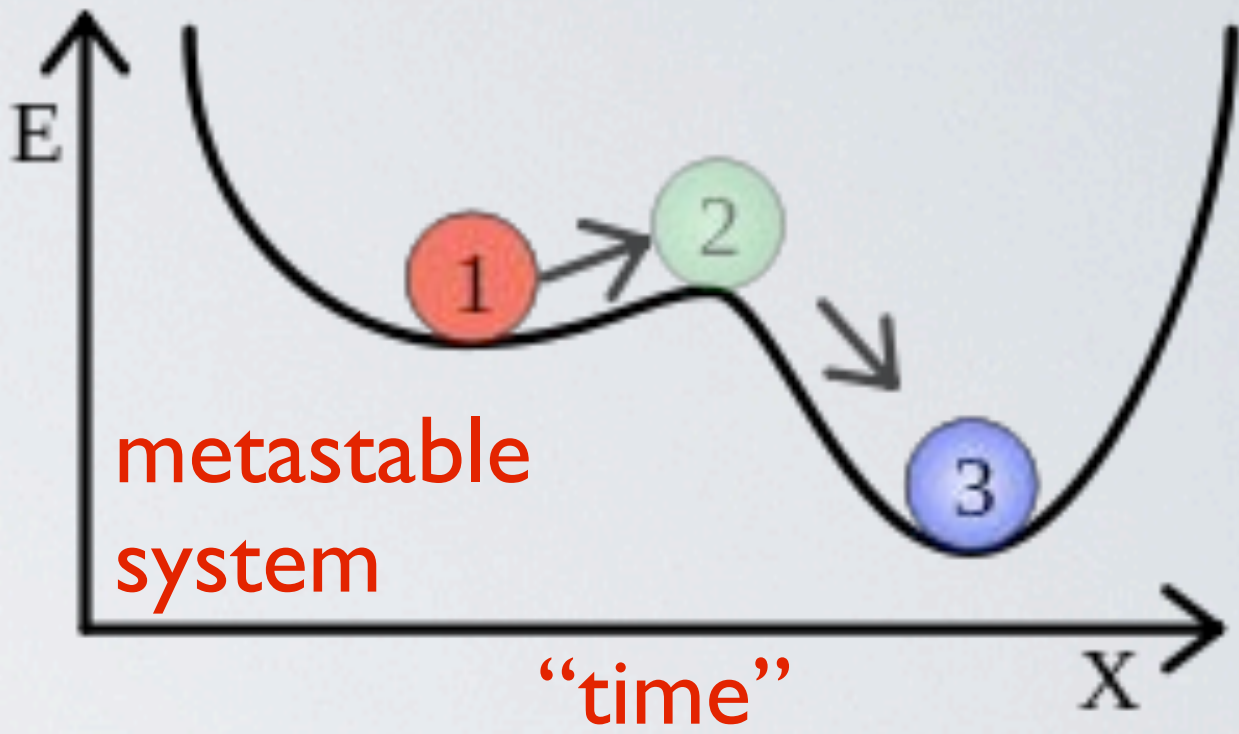


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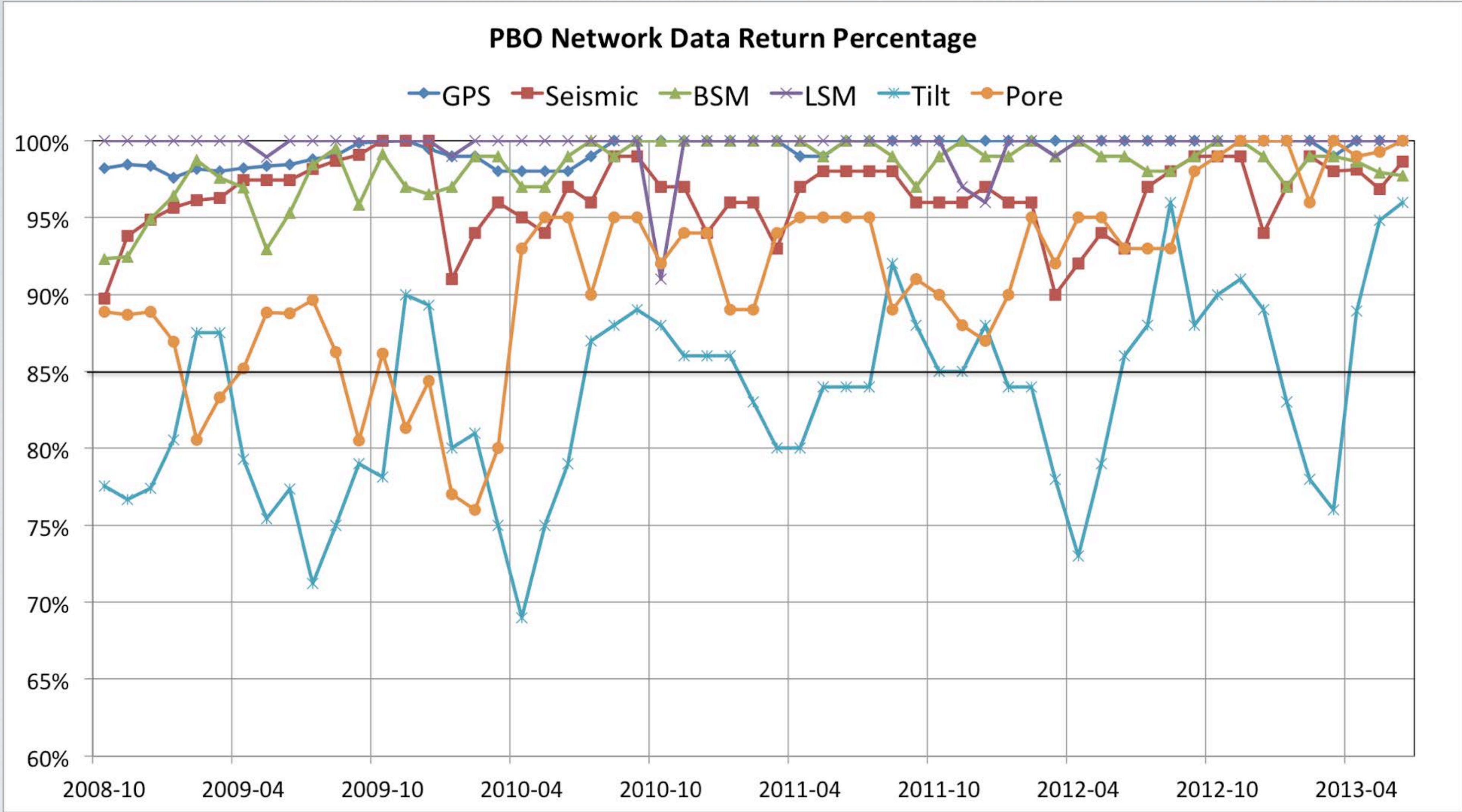
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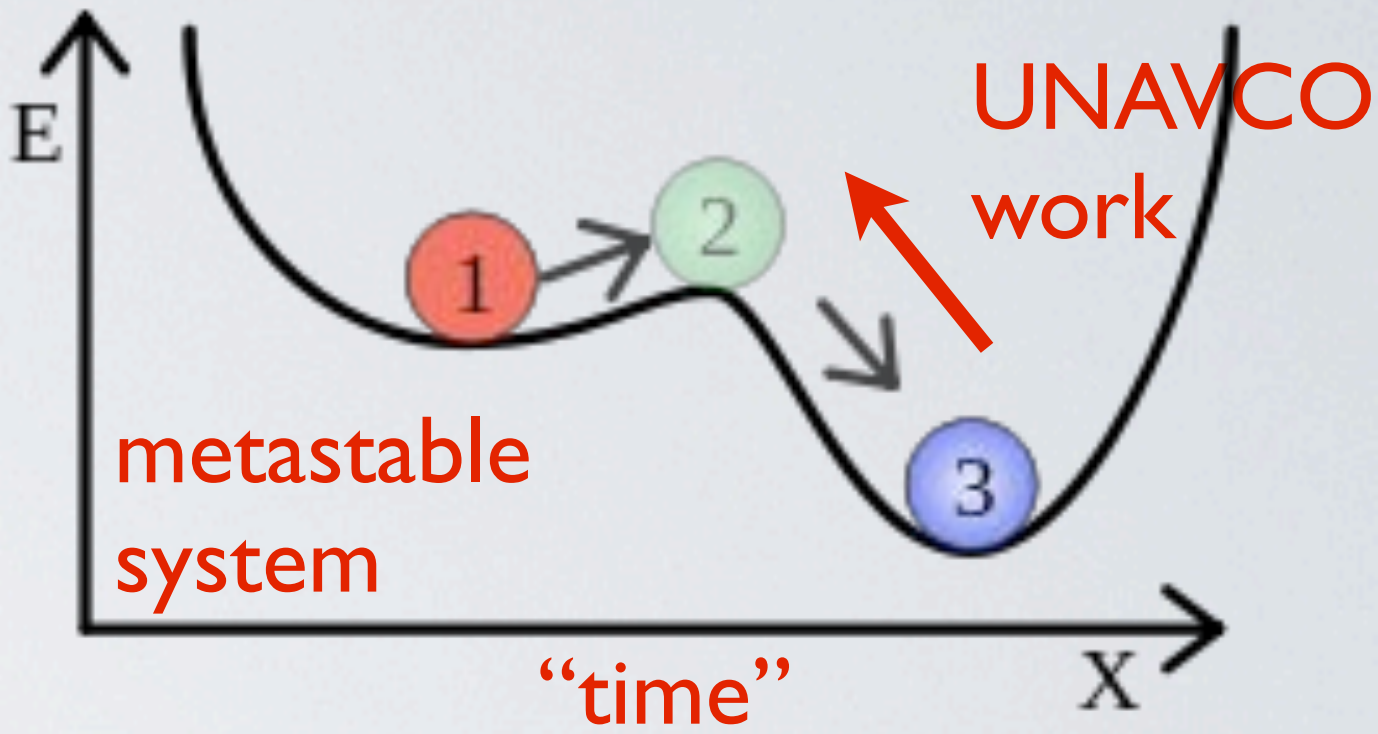
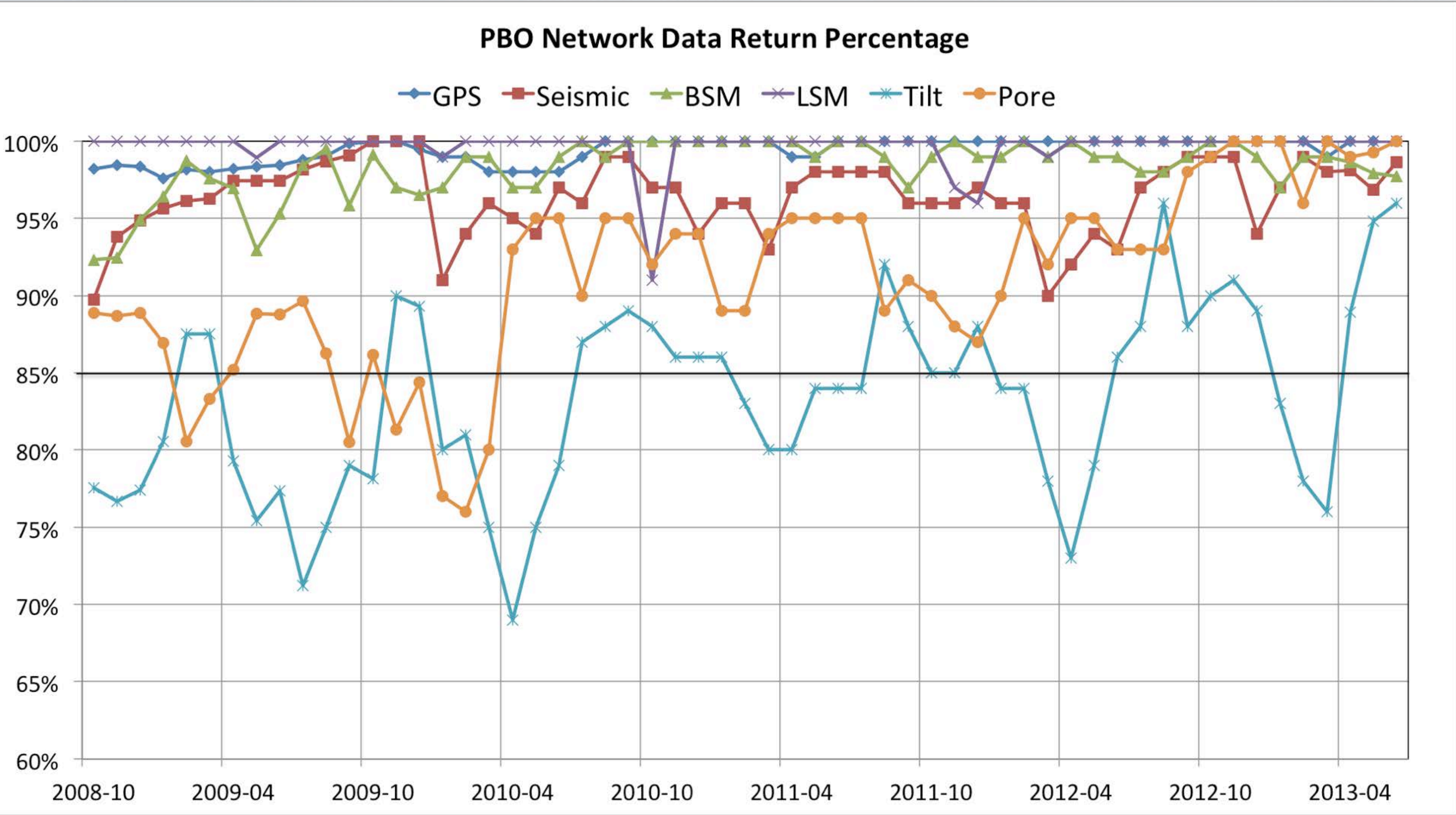


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Metrics complete through June 30, 2013 (YR5Q3)



Impacts of Government Shutdown on PBO O&M

- Critical non-NSF stakeholders, including NASA, NOAA, USGS, and commercial sector use PBO real-time data, archived data, and higher-level data products (position and velocity estimates, corrected and calibrated strain) to meet **mission objectives** - these will be compromised; PBO borehole seismic network is integrated into regional and national seismic arrays used for hazard assessment and mitigation.
- UNAVCO is responsible to maintain PBO and other NSF-sponsored geodetic data in perpetuity in its data center and its backups thereof (off-site and cloud-based). PBO was envisioned as scientific experiment within EarthScope, *not a fail-safe distributed sensor network and data system*. **The system was not designed for shutdown!**
- UNAVCO is responsible to assure the health and safety of its personnel and to protect all US government assets; if remote communications are severed, SOH data are not available and we cannot be certain as to the disposition of the deployed resources. Remote resources, including cached materials, instruments, and trucks must be secured.
- PBO is designed to have sensor data buffered on-site for periods of several weeks to months; most sites are DC, but some sites (<5%) use AC and therefore could fail if local utility bills are unpaid.



Impacts of Government Shutdown on PBO O&M

- PBO data flow and archiving can be shutdown, but in order to assure that all data and metadata are properly synched across primary and back-up systems, this must be done in an orderly way to facilitate restoration after resumption of normal operations.

- Failure to put cellular, VSAT, and BGAN channels into “suspended” mode, could result in loss of “provisioning” to remote devices, requiring on-site visits to re-establish.
- Compute, database, and storage infrastructure in UNAVCO data center may experience significant failure (up to 20%) after being powered down.
- Important to notify all stakeholders of timing and extent of shutdown plan to allow contingency planning as needed.
- UNAVCO staff are required to assure a smooth and orderly shutdown, so process must begin well in advance of final day of operations.

- **The plan was to notify the UNAVCO community and all known stakeholders of PBO and UNAVCO shutdown timeline by Oct. 18, 2013** - this assumes that NSF appropriation is not restored by Oct. 21 to allow UNAVCO to ameliorate its current cash-flow challenge

- All routine field maintenance to PBO sensors stopped - Oct. 11
- Notification of intent to shutdown announced by email - Oct. 18
- PBO communications are suspended and sensor data-flow is shut down - Nov. 1
- PBO Analysis Centers (CWU & NMT) and ACC (MIT) terminate all data processing - Nov. 1
- UNAVCO archive access (ftp-out) is suspended - Nov. 8
- UNAVCO website shutdown and all staff furloughed - Nov. 15

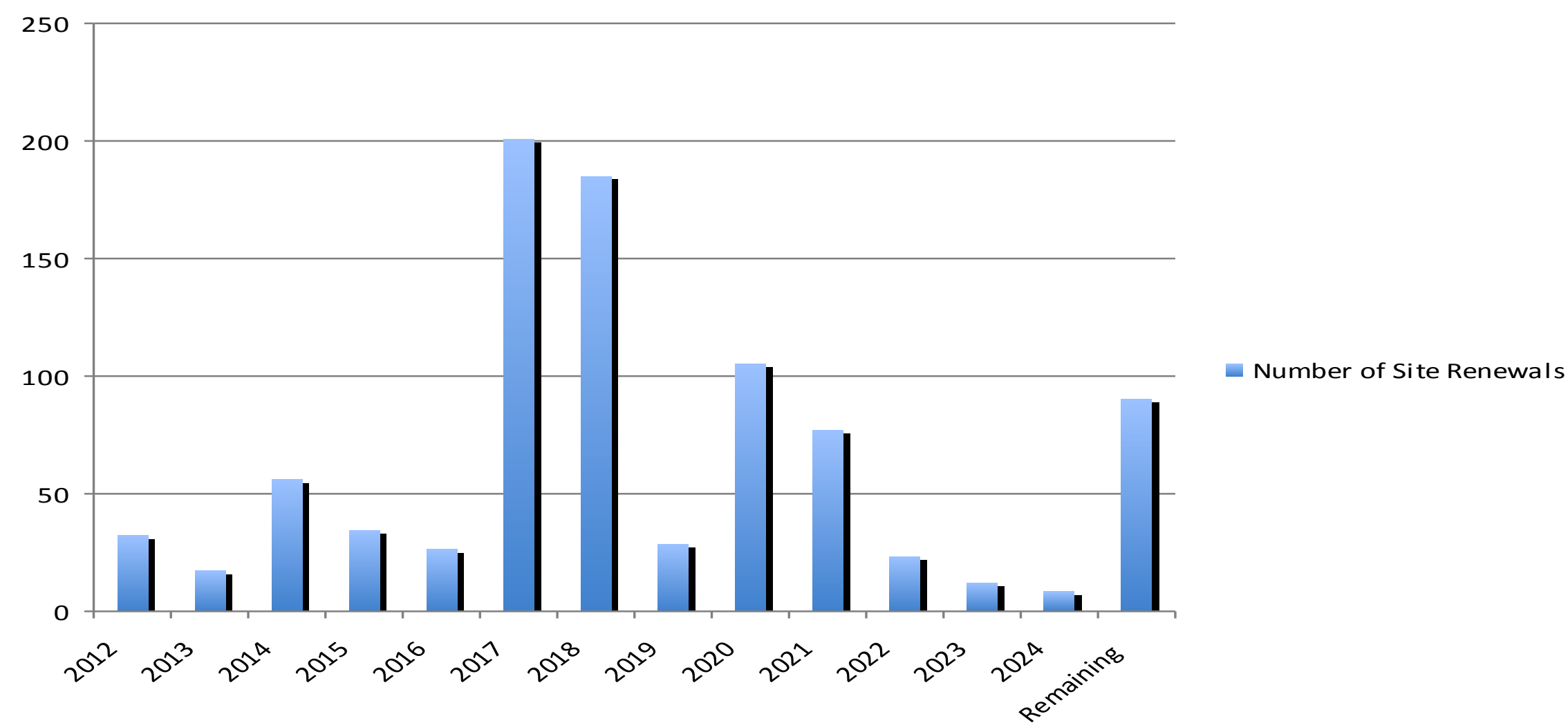


PBO PERMITTING STATUS & CONCERNS

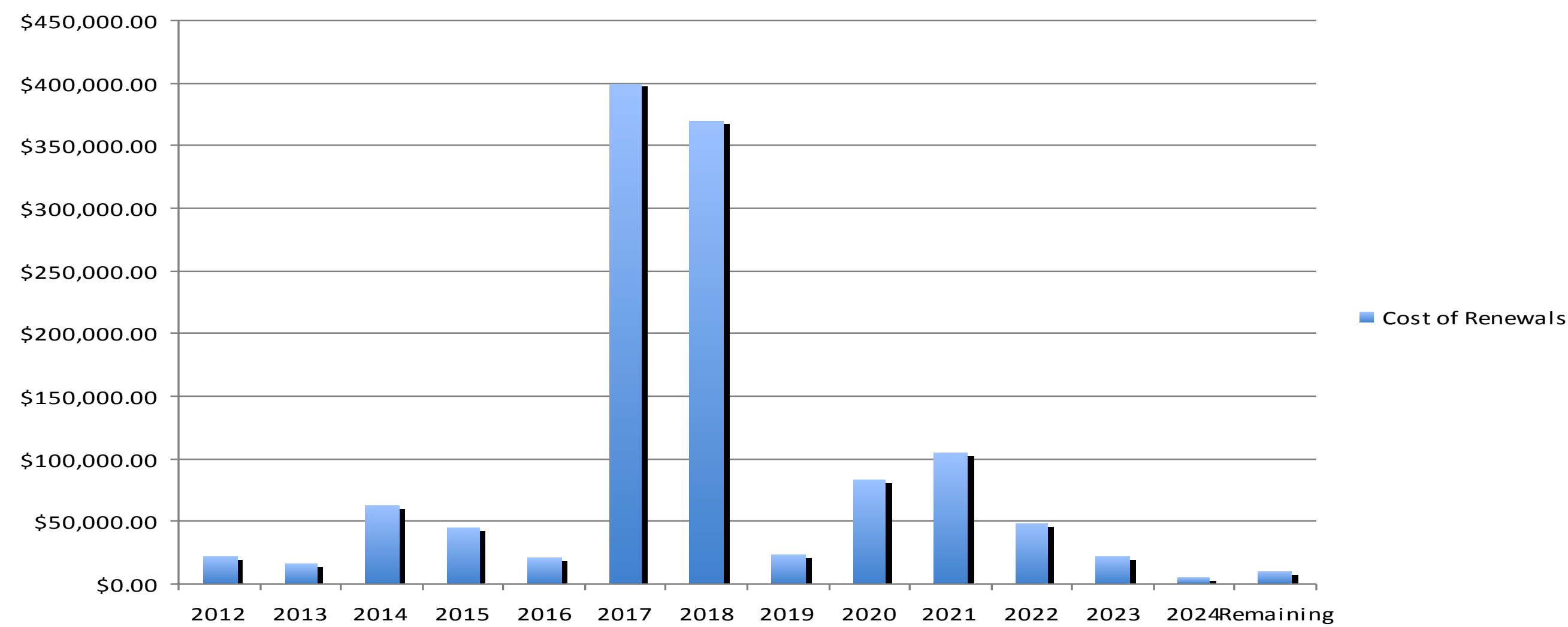
- An experienced Permitting Assistant resigned in September, 2012; backfilled the position with a part-time staff member from AK. Training to occur over next year.
- Current permitting FTE level for PBO is 1.00 and 1.50 for all GI activities. Staff retention is a concern because of the legacy knowledge needed to maintain permits and relationships landowners

- The average number of renewals during the period 2009-2012 has been about 35 per year. This will increase to near 200 per year during 2016-2018.
- Difficult to budget for some renewals: will landowners want to be paid again and at the same rate?
- It is difficult to spread renewal activity out as renewals need to be handled 3-9 months before expiration.

Number of Site Renewals



Cost of Renewals



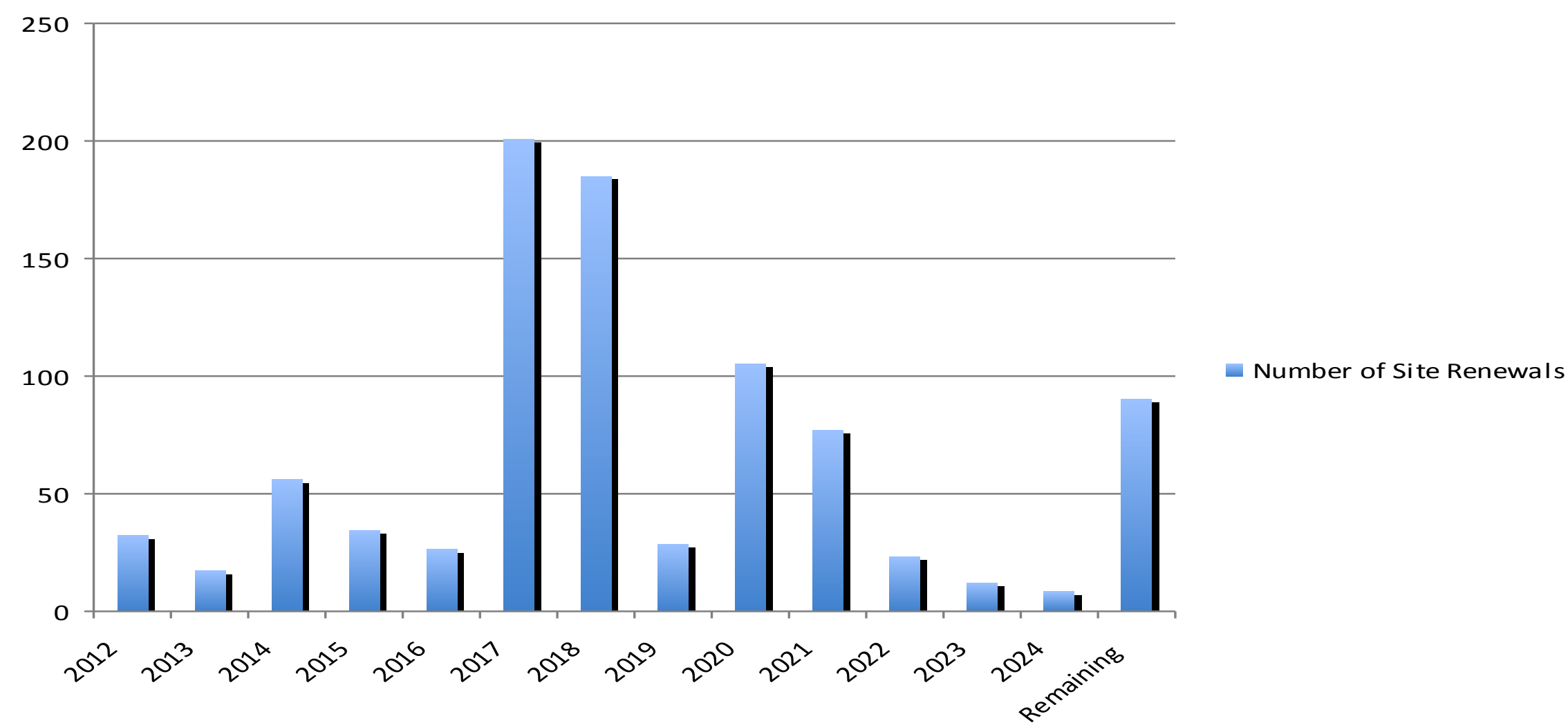


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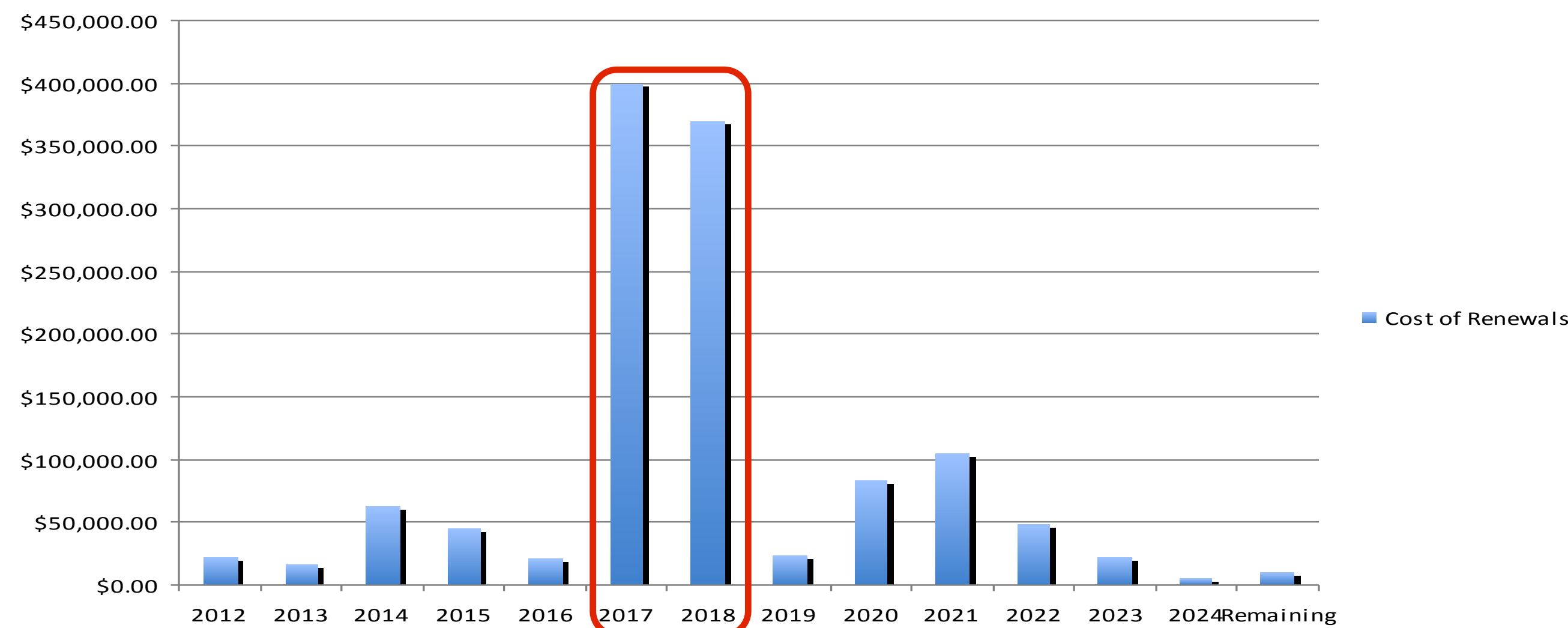
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PBO REAL-TIME GPS/GNSS STATUS

UNAVCO PBO RT-GPS Network

348 Real-time stations

243 are Archiving data

Network Latency is 570ms

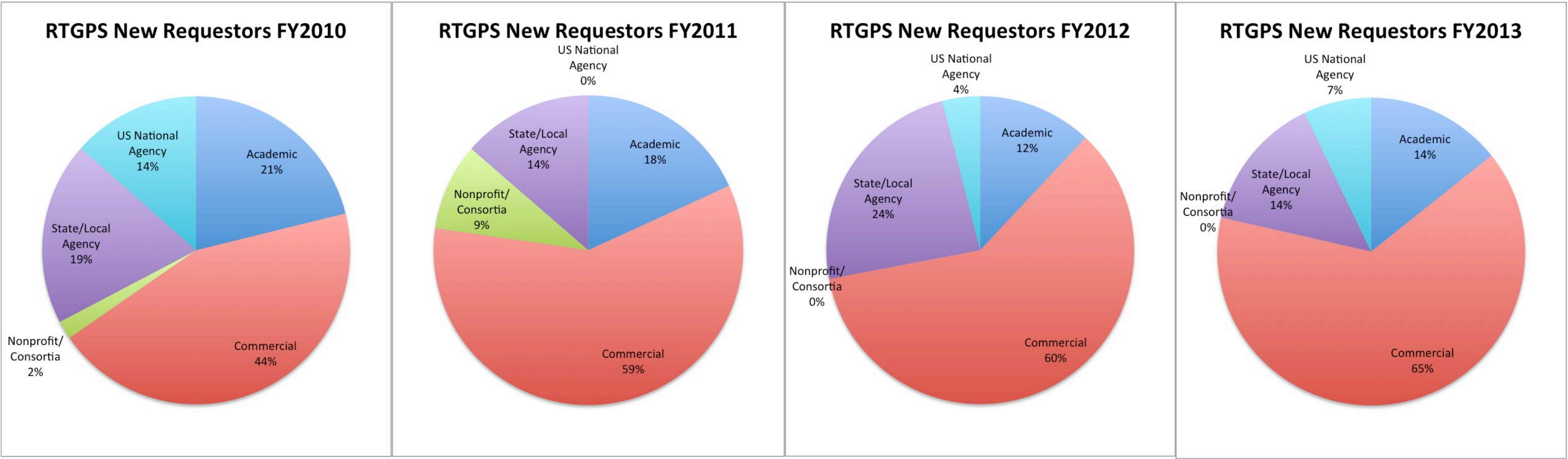
Network Completeness is 86%

724 Active Connections

1044 Mount Points



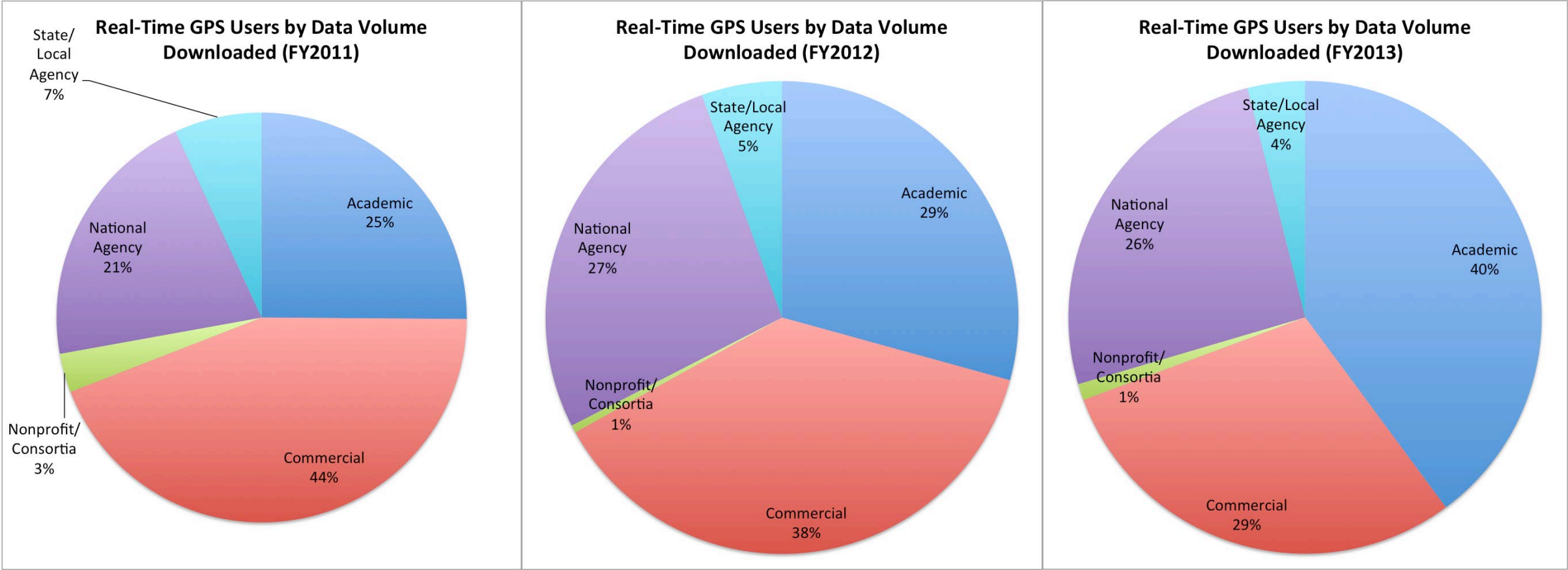
PBO REAL-TIME GPS/GNSS USERS



ABOVE: Based on the NUMBER OF NEW USERS (new requestors) per year, the percentage of commercial users relative to academic and agency users has increased consistently over the past four years.

BELOW: Based on the VOLUME OF DATA DOWNLOADED per year, the percentage of commercial users relative to academic users has decreased consistently over the past several years.

Interpretation: there are more commercial users than academic users of RTGPS data, but academic users access larger volumes of data.

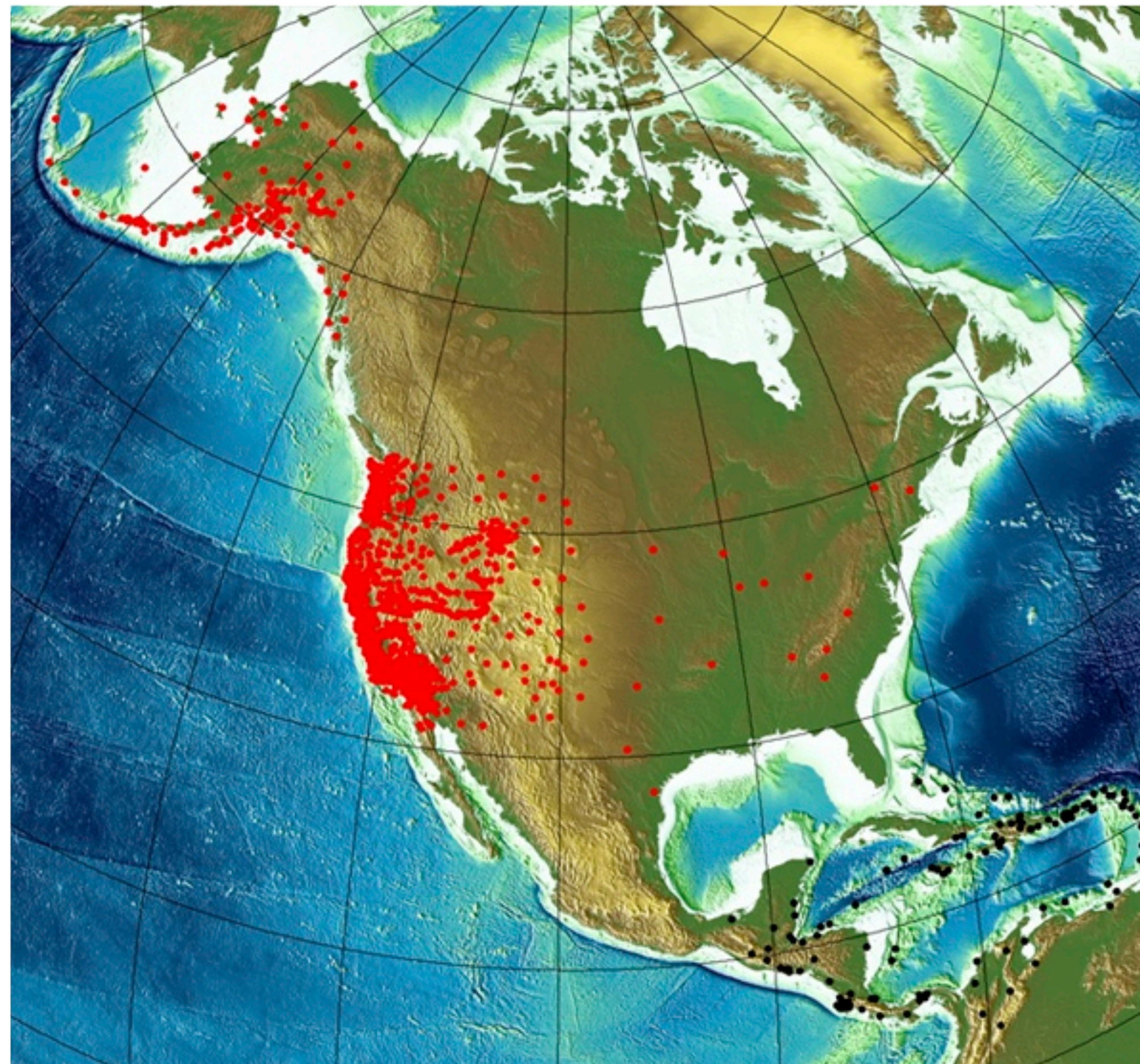


Trends in PBO RT-GPS usage:

Increase in the number of new commercial sector users from 2010 to 2013

Increase in the amount of RT-GPS data downloaded by academic groups

GAGE: REAL-TIME GPS/GNSS UPGRADE PLAN



●
Real-Time
Stations

Governance and
Community

GAGE
Impact

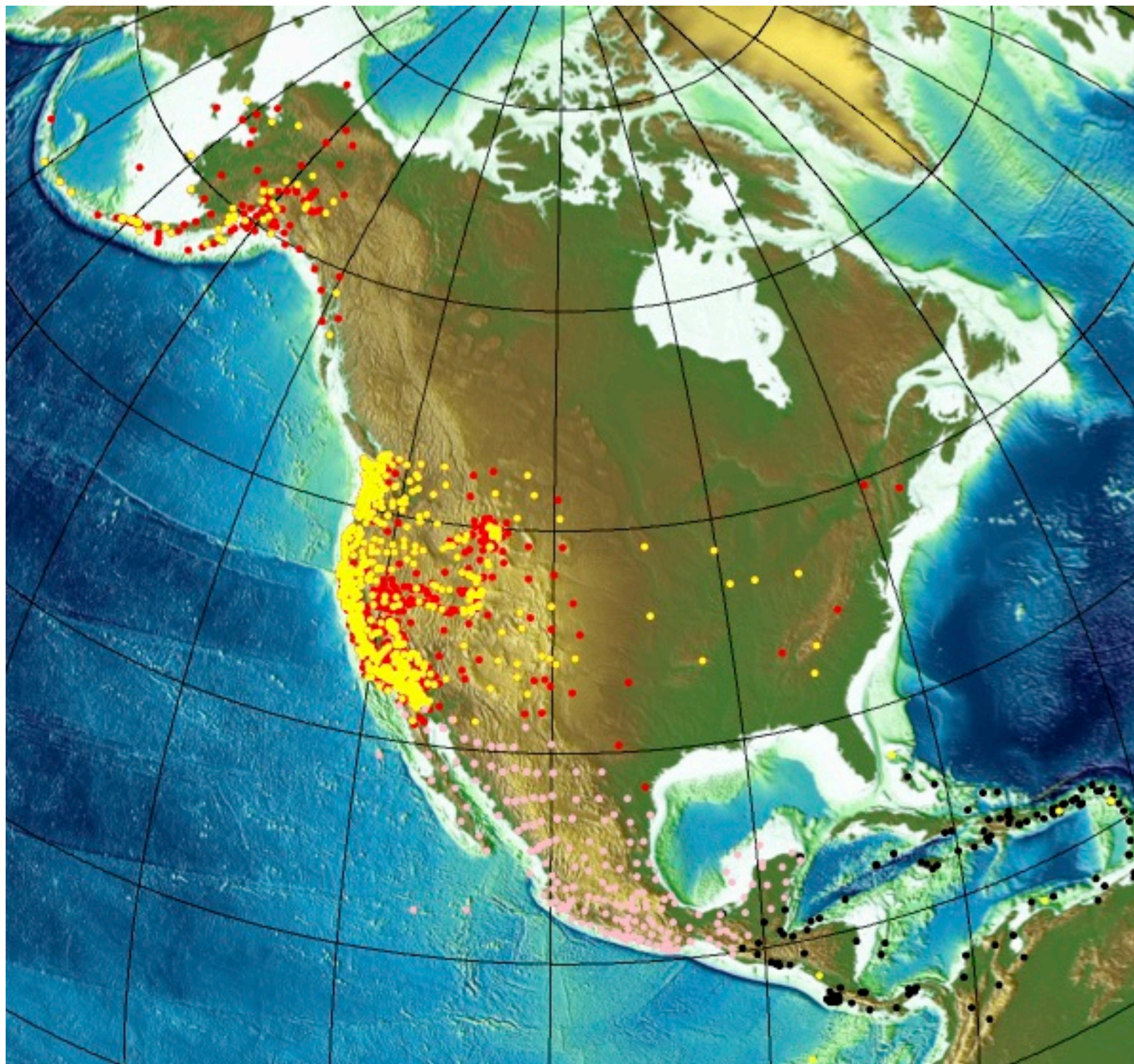
Geodetic
Infrastructure

Geodetic Data
Services

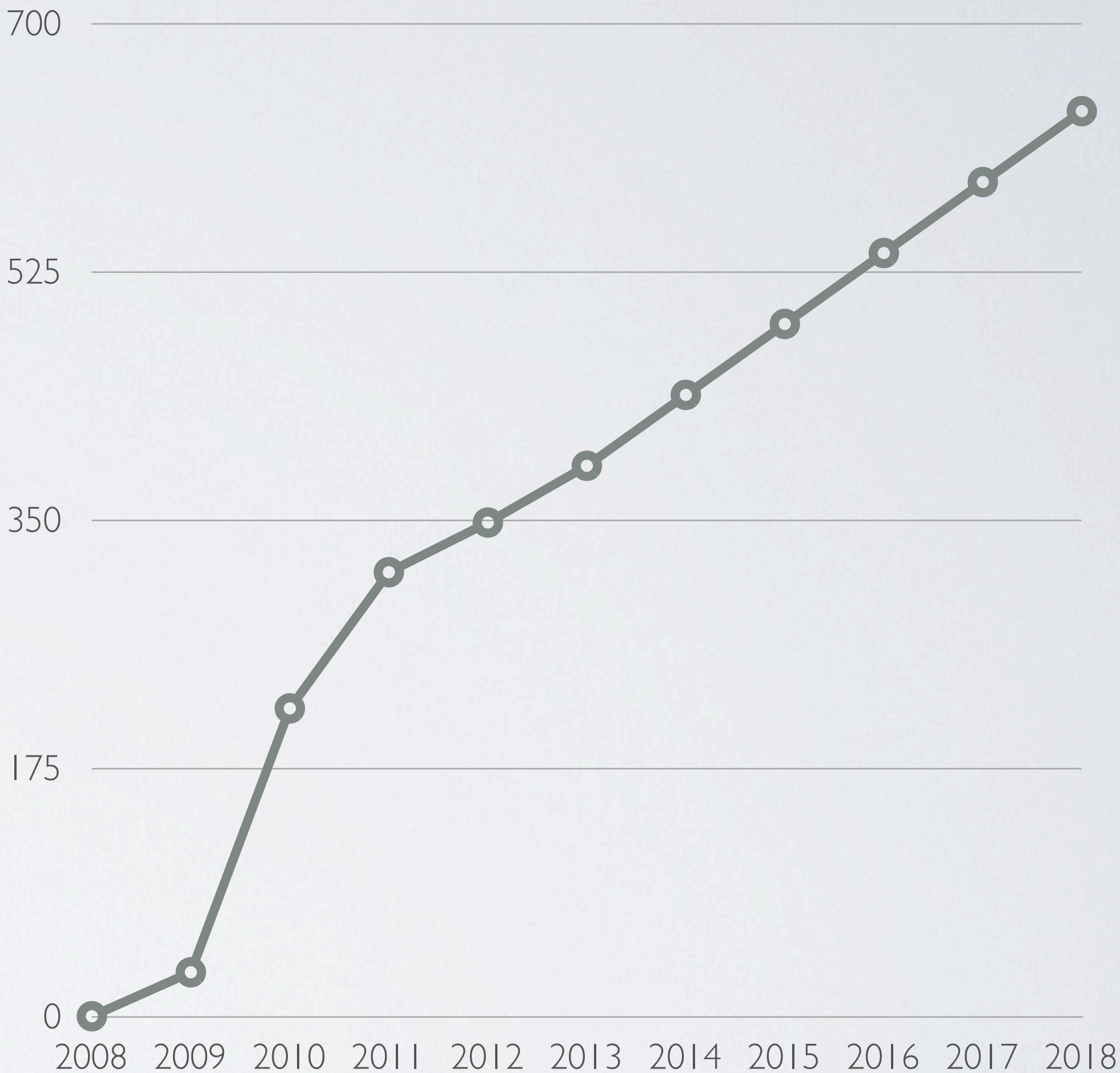
Education &
Community
Engagement

Beyond 2018

GAGE: REAL-TIME GPS/GNSS UPGRADE PLAN



●
Real-Time
Stations



Governance and
Community

GAGE
Impact

Geodetic
Infrastructure

Geodetic Data
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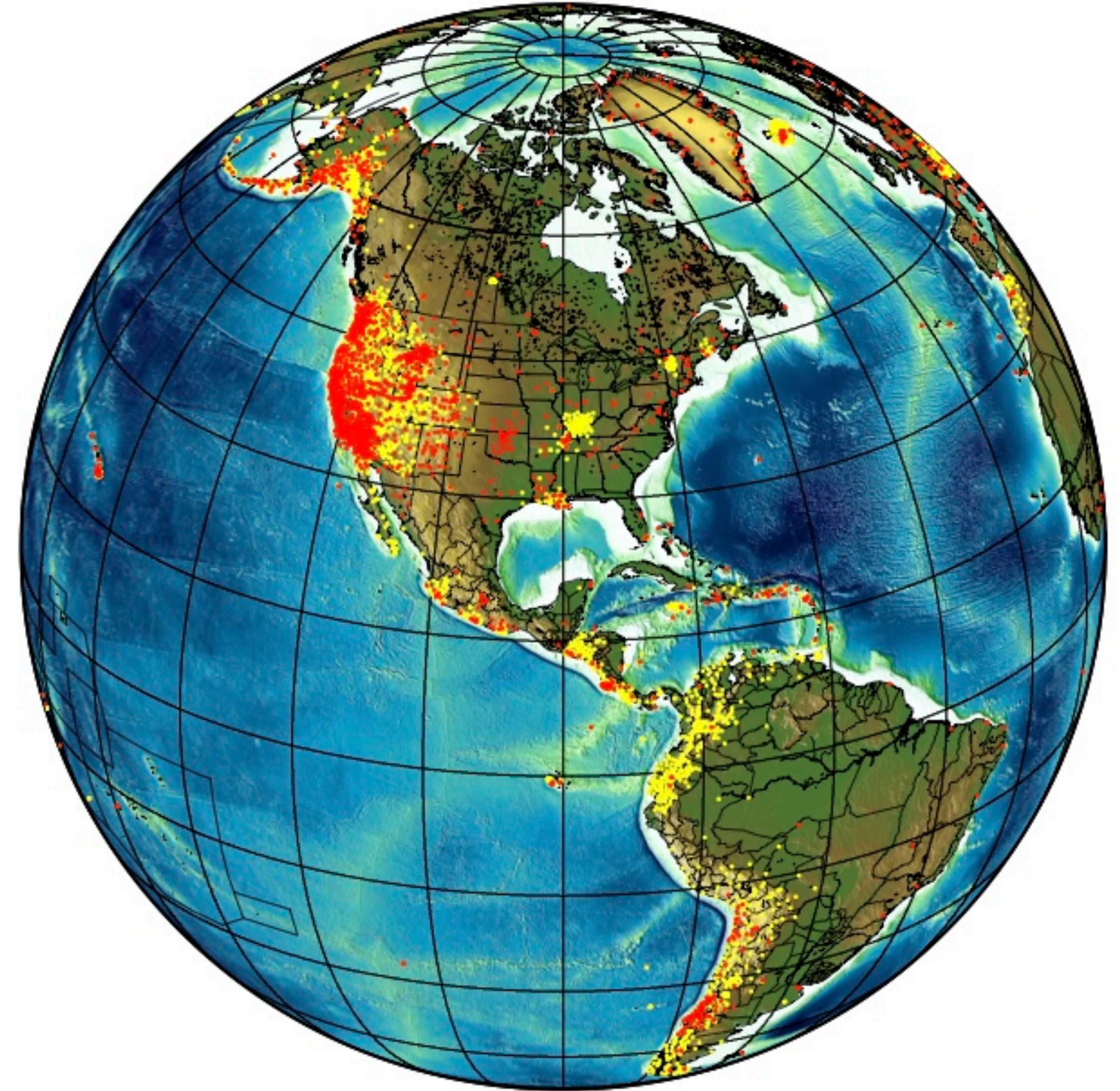
Education &
Community
Engagement

Beyond 2018



PBO REAL-TIME GPS/GNSS GOALS

- 500+ Real-time stations
- 10 servers with 30-40 VMs
- Efficient load distribution
- Network Latency is 570ms
- Network Completeness is 95%
- 1000+ Active Connections
- 1600 Mount Points
- Synchronized Databases
- Redundant Casters
- Positions and Archiving data
- Expansion capability to 1000 stations

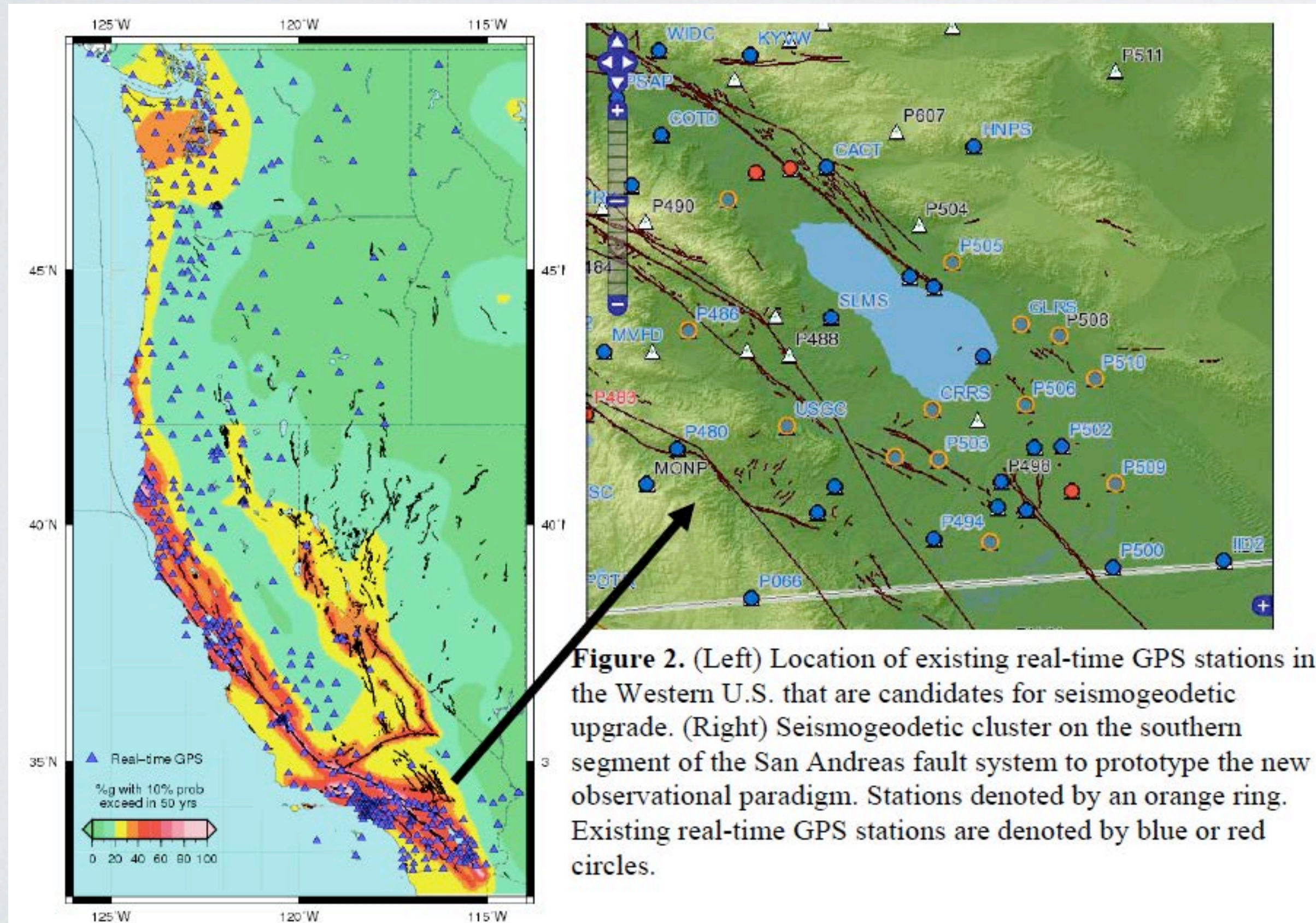


*image is only representative

PBO FACILITY HIGHLIGHTS

- **GPS Seismology Test Bed Project with SIO-UCSD**

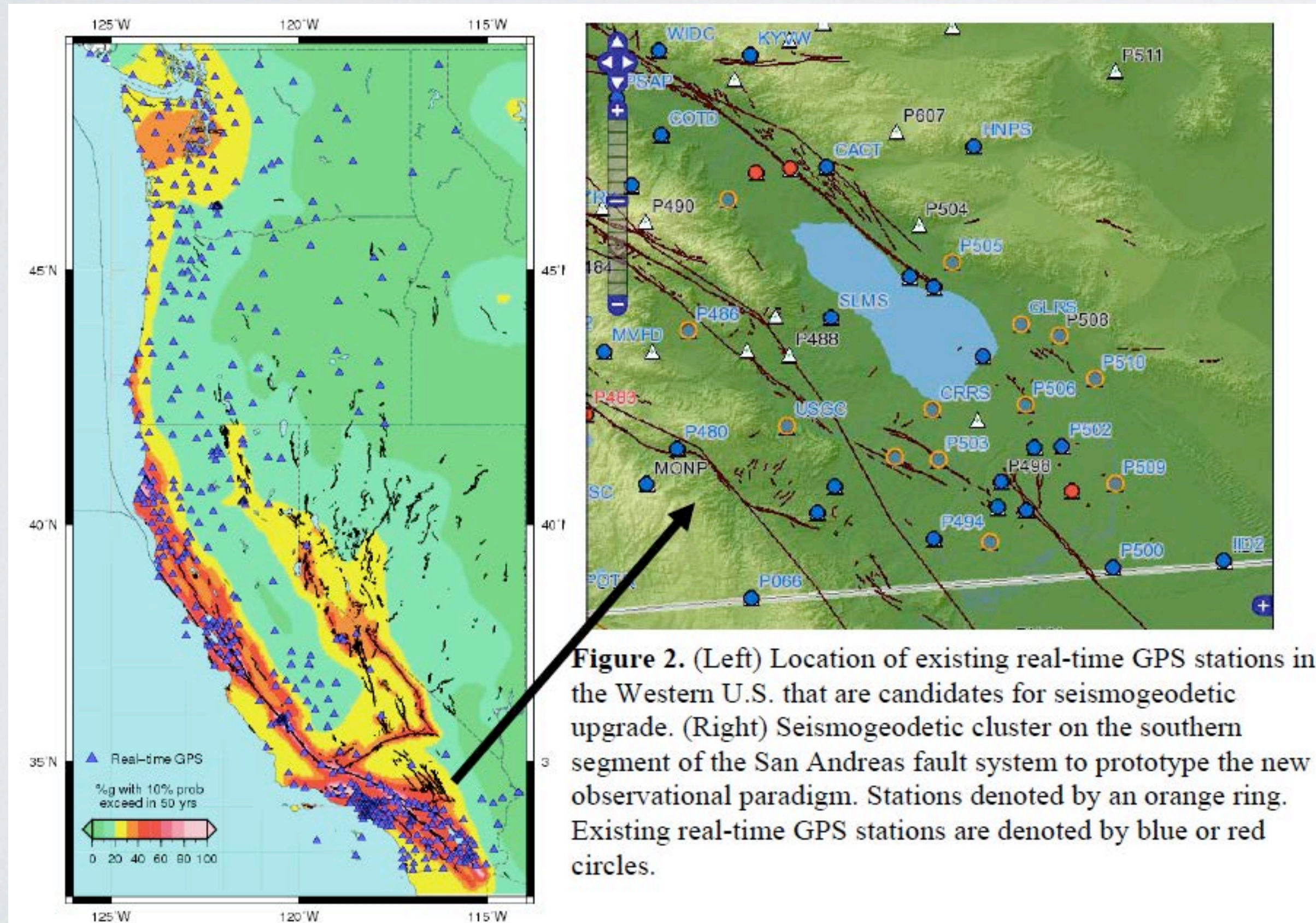
- Upgraded 8 sites with new SIO MEMS accelerometer units - plan to upgrade 8-10 more...
- **Scientific focus is on southern SAF and SJF systems**
- Project funded by EAR Geophysics and IF programs
- Leverages development under NASA awards to Y. Bock at UCSD and NSF investment in PBO
- Some technical issues remain because of aging GPS infrastructure in PBO and Trimble EOL policy for NetRS receivers



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- **Multi-monument Change Order 35**
 - Plan to add two additional cGPS monuments at five existing PBO sites
 - \$150K budget was approved by EMT in May 2012
 - Final site construction completed this summer 2013 - data being analyzed by UNAVCO D&T staff and the PBO ACs and ACC
 - Sites selected to evaluate response of different geological conditions:

	Pnum	Monument	Installation
The Rock, GA	P804	DDBM	2012
Granite	P805	SDBM	2012
	P806	Mast	2012
Wilbur, WA	P453	DDBM	2005
Basalt	P813	Mast	2013
	P814	SDBM	2013
Forks, WA	P401	DDBM	2005
Clay Substrate	P815	Pillar	2013
	P816	Augered SDBM	2013
Delano, CA	P565	DDBM	2005
Clay/Silt/Sand	P809	Pillar	2013
	P810	Augered SDBM	2013
California City, CA	P591	DDBM	2005
Sand	P811	Pillar	2013
	P812	Augered SDBM	2013



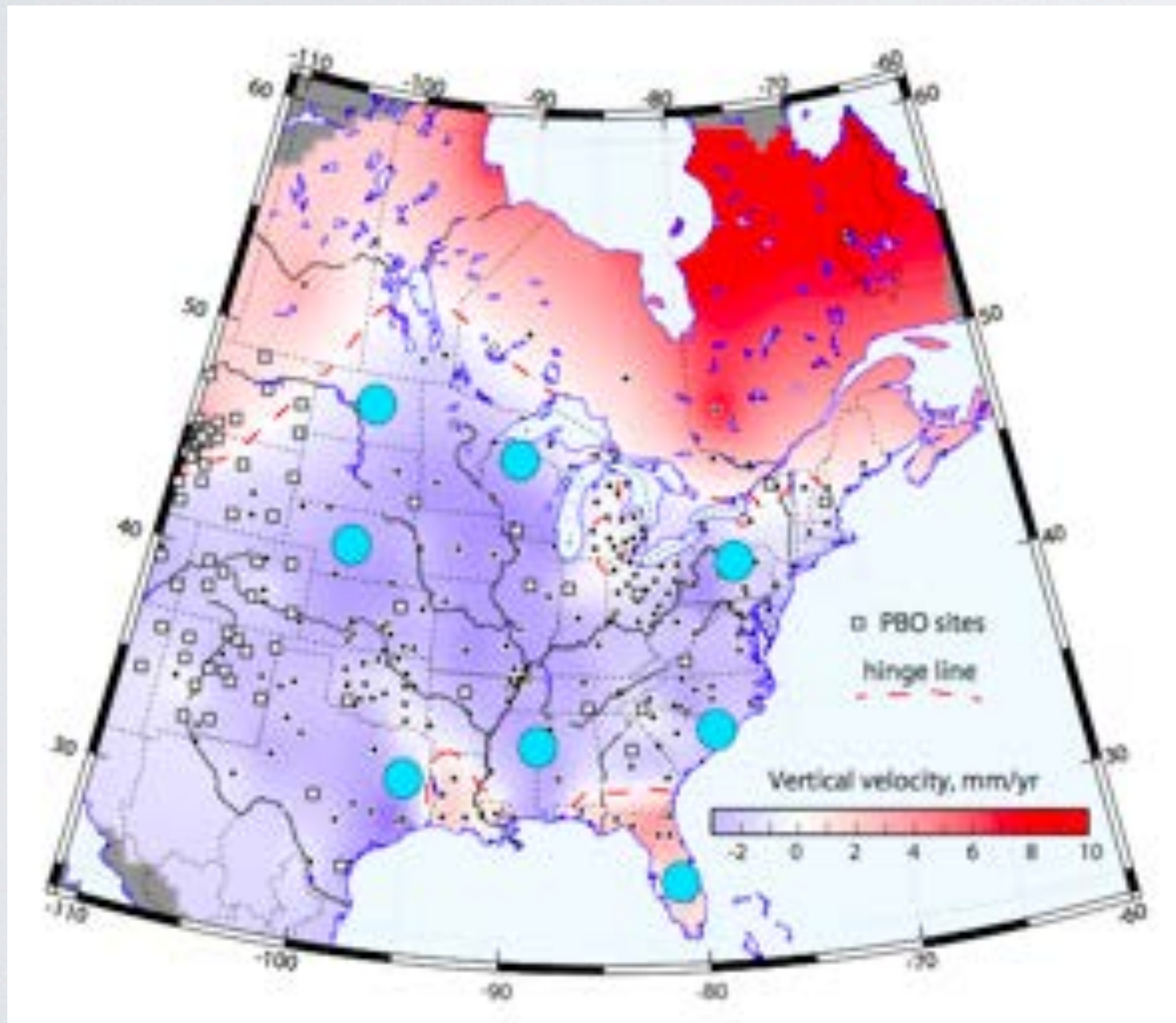
Wilbur, WA site: P453/P813/P814

PBO FACILITY HIGHLIGHTS

- **Eastern US upgrades and new sites**

- Plan to upgrade three poorly performing PBO sites (in GA, TX, and NY) and install three new sites
- **New sites in Mandan, ND, Mellen, WI, and Bedford, PA**
- \$150K budget was approved by EMT in May 2012
- Final site construction in PA completed this September 2013
- Sites selected to improve NAM reference frame realization and GIA models

SDBM near Bedford, PA - Installed in September 2013



PBO FACILITY HIGHLIGHTS

- **Installation of new GTSM, seismometer, and tiltmeter at Norris Ridge in Yellowstone National Park**
- Original BSM site was damaged by lightning strike in 2011 - difficult and laborious negotiations with NPS to obtain permit for new installation
- \$140K drilling budget planned, which included all contingency funds
- First hole was abandoned because of hot, aqueous fluid flow at original target depth; second hole successfully completed under budget
- UNAVCO staff worked with Tacoma Pump and Drill and YNP NPS staff to complete site during partial government shutdown and severe weather



COCONET UPDATE

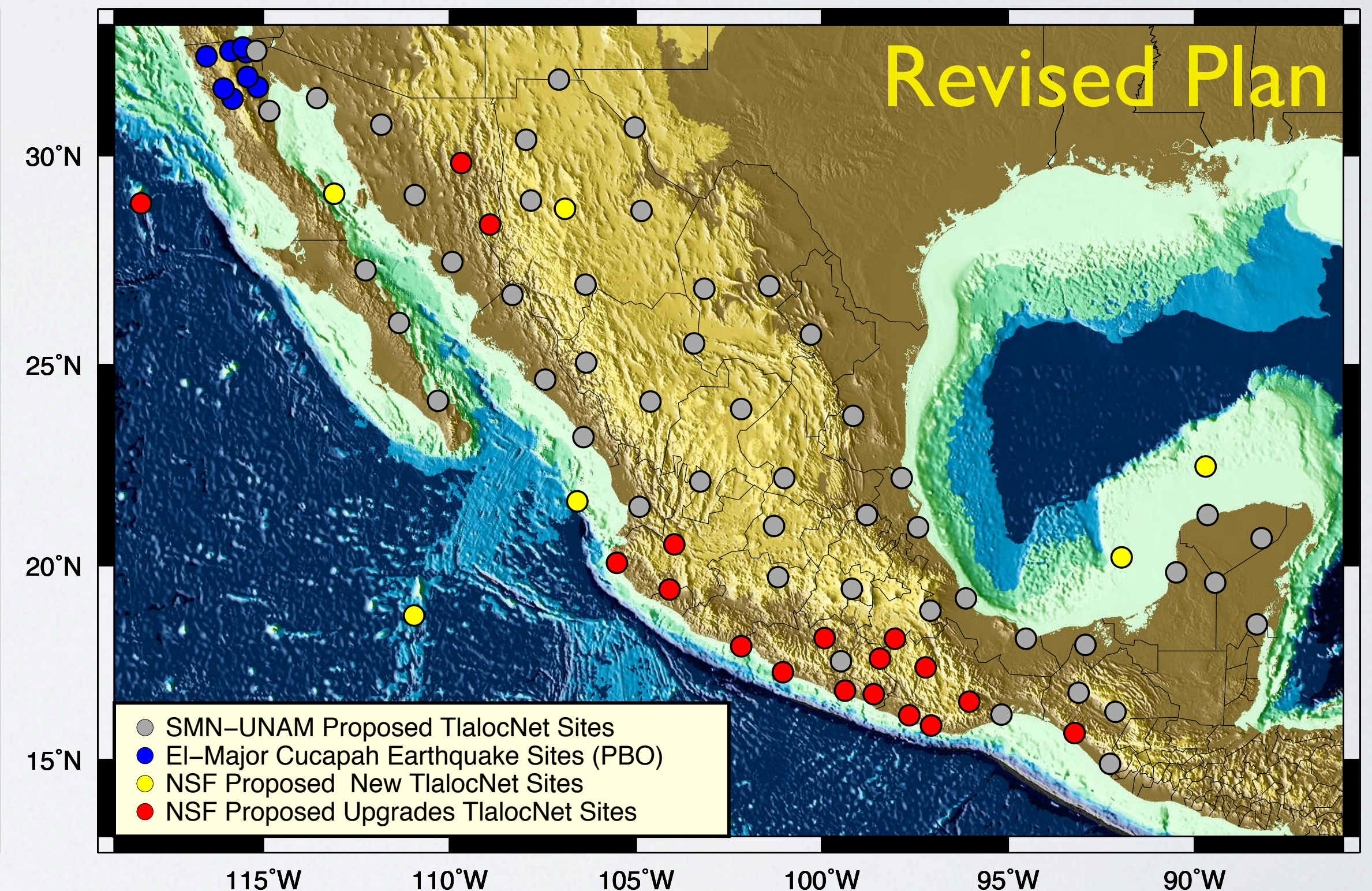
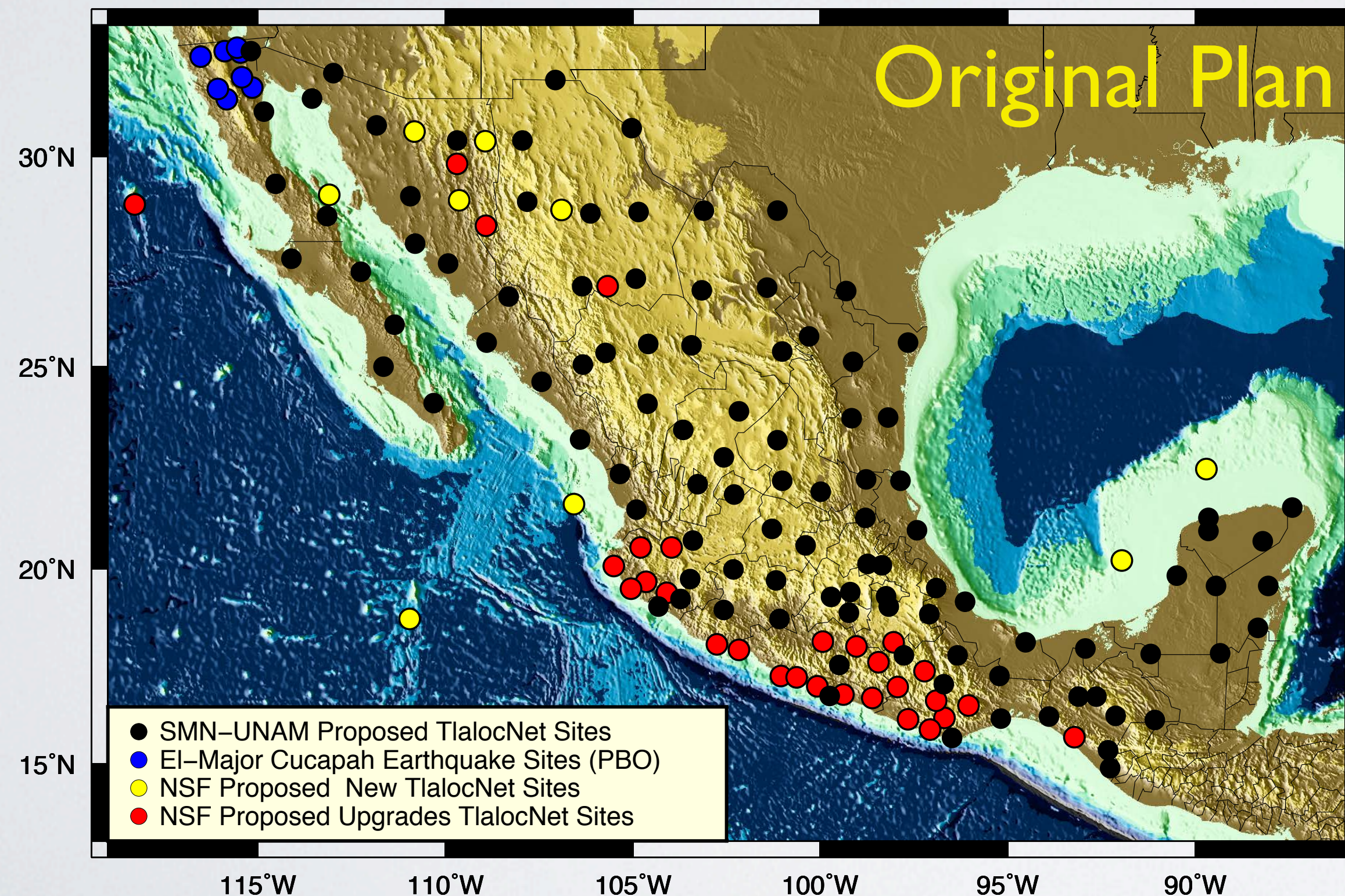
- Current network construction status: 63 reconnaissance completed, 56 permits accepted and 44 stations built or refurbished. Work remaining: 27 new or refurbished stations, 2 tide gauge installations
- In August 2013, two students from Venezuela worked with PBO engineers in the Pacific Northwest to learn how to install PBO-style GNSS stations.
- The COCONet Regional Data Center Request for Proposals (RFP) was announced in August 2013. Final selection of awardees is expected this week.
- Finalizing the permits with Cuban customs for importation of GPS/met equipment into the country.
- The five COCONet Fellowship Award winners were announced in late August (<http://coconet.unavco.org/science/coconetfellowship2013.html>).
- Upcoming installations in Guatemala - COCONet will add 6 meteorological instruments for access to data from Guatemalan GPS network.



New or Refurbished Stations Completed: 44 ●
Stations To Be Completed: 27 ●

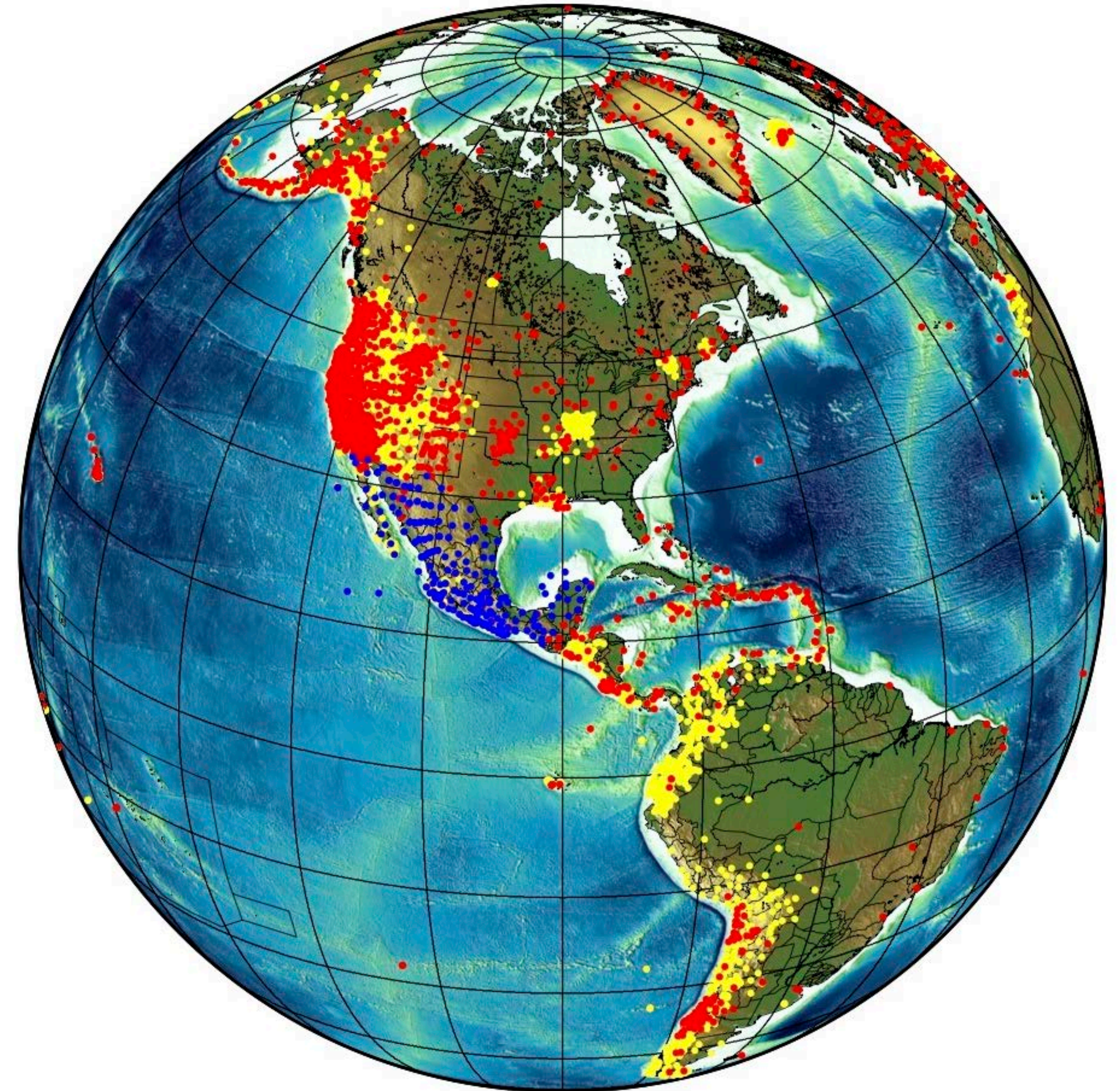
TLALOCNet - Development of a continuous GPS-MET array in Mexico for atmospheric, climatic, and seismotectonic research in the Americas:

- Four-year MRI Instrument Development (Track 2) proposal funded for \$1.50M with Sept. 1, 2013 start date
- 30% cost-share from UNAM (13 sites) and possibly SMN (original partner with World Bank funding) - total project cost of \$2.14M
- Original plan was for 9 new and 29 upgraded sites (\$1.95M); revised plan calls for 6 new and 18 upgraded sites (\$1.50M)
- One additional FTE in Field Engineering will be supported through MRI (i.e. above GAGE core support)
- Kickoff telecon on Oct. 11th; first PI and stakeholder meeting planned for late November in Boulder, CO

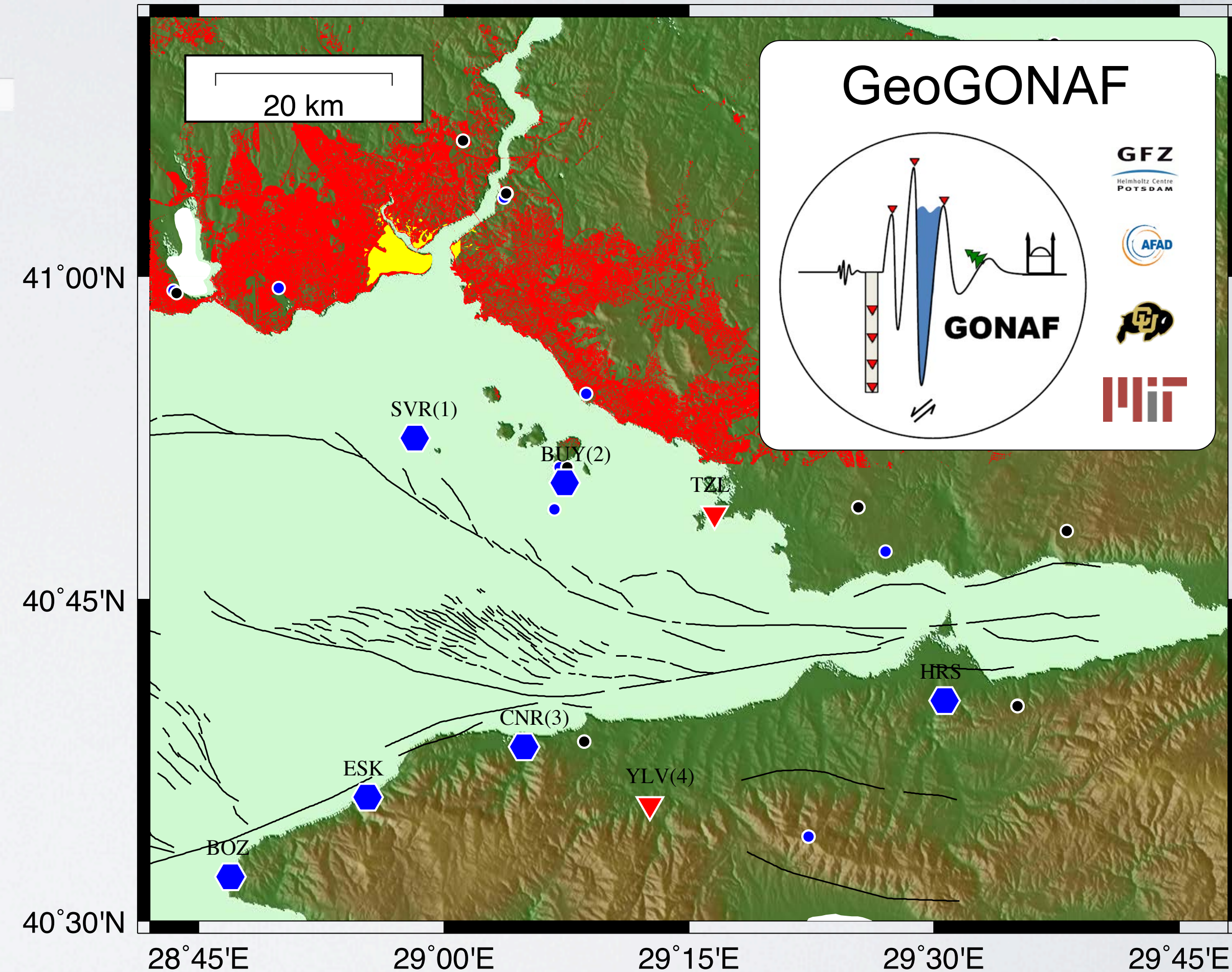
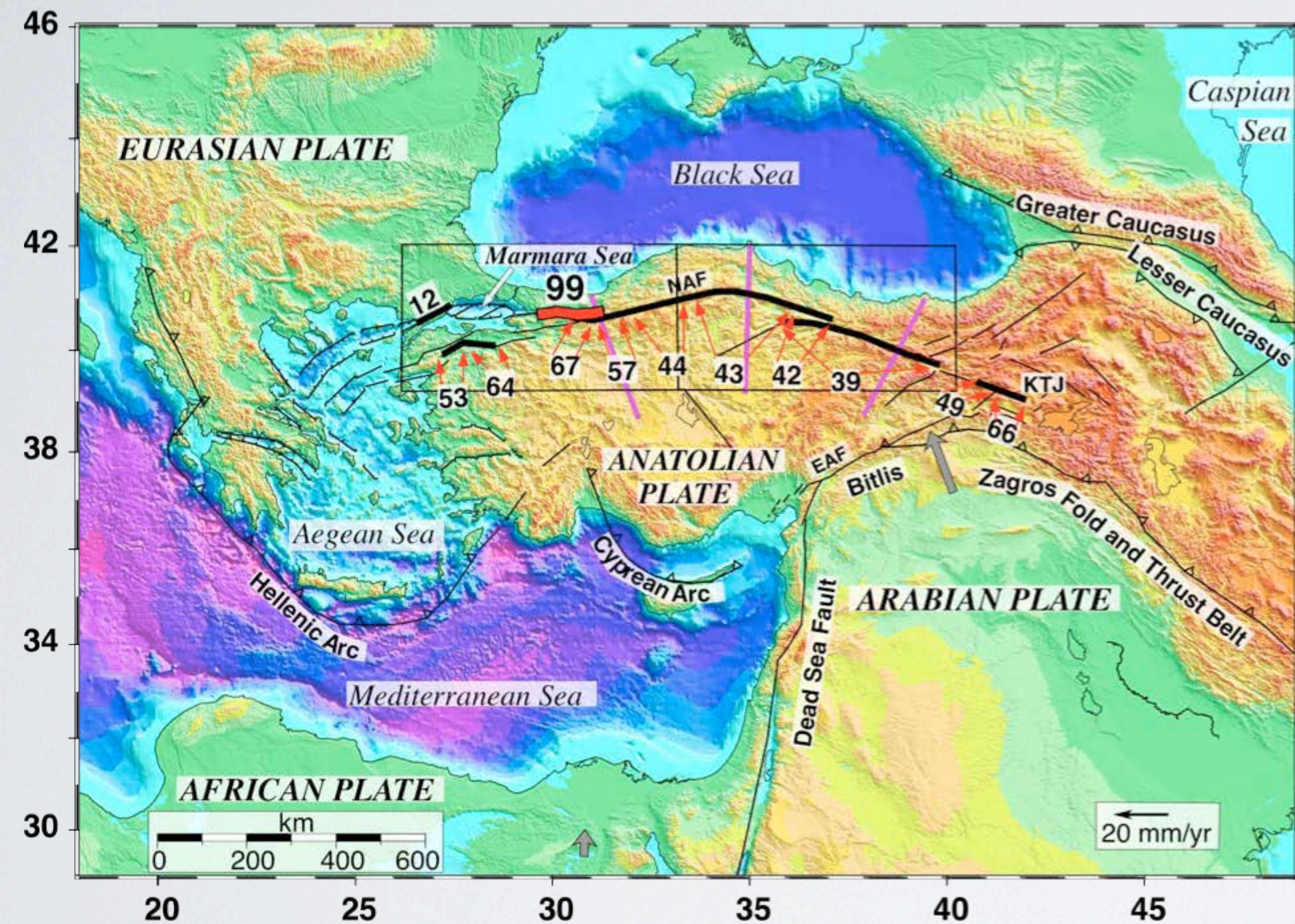


A Global Network of Geodetic Networks

- Interdisciplinary & international leverage for multi-hazards observatories
- Proliferation of geodetic monumentation in multi-purpose networks
- International federations linking networks across borders
- Disseminated archives for shared capacity
- Provide leadership for the “Next Big Thing”

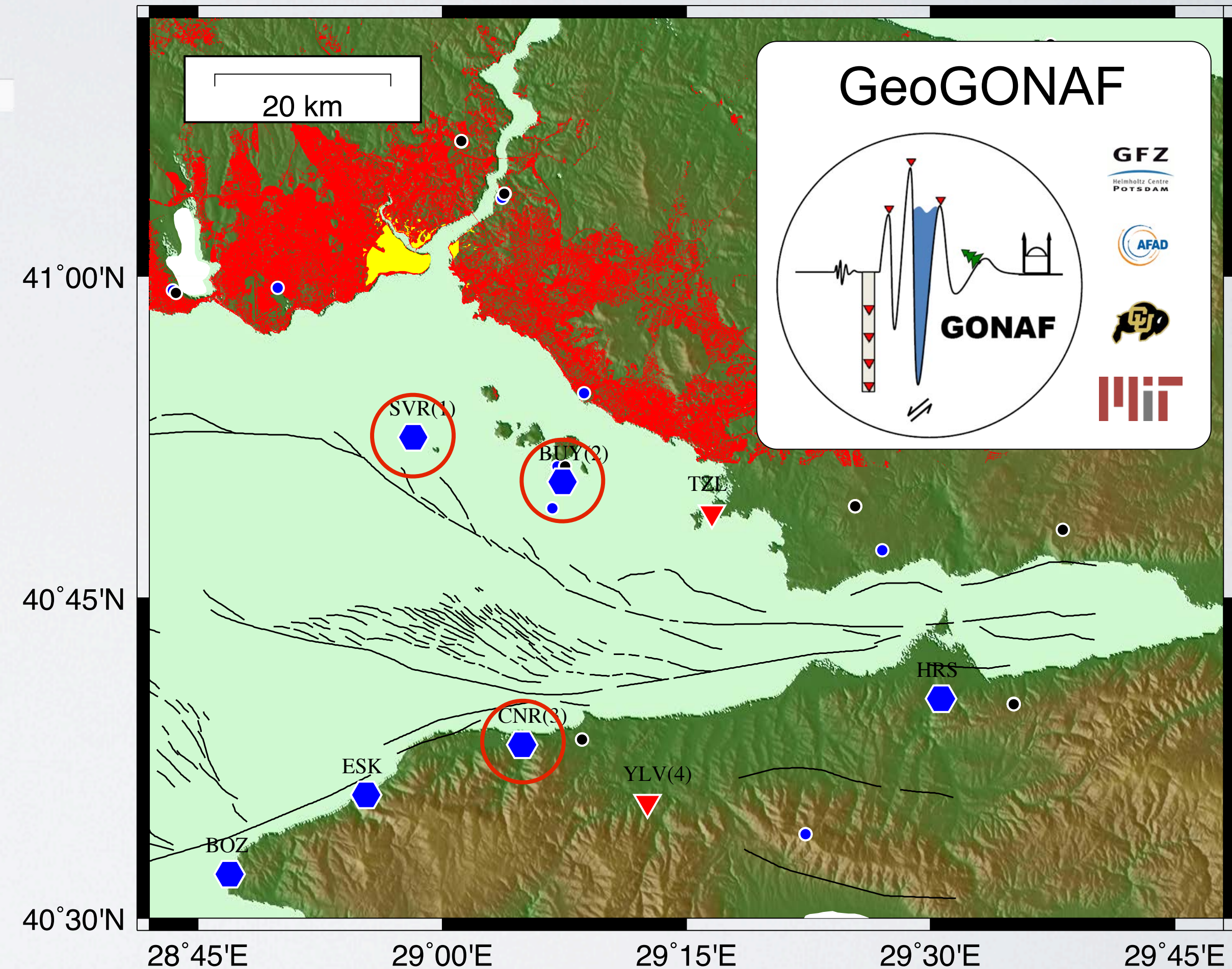
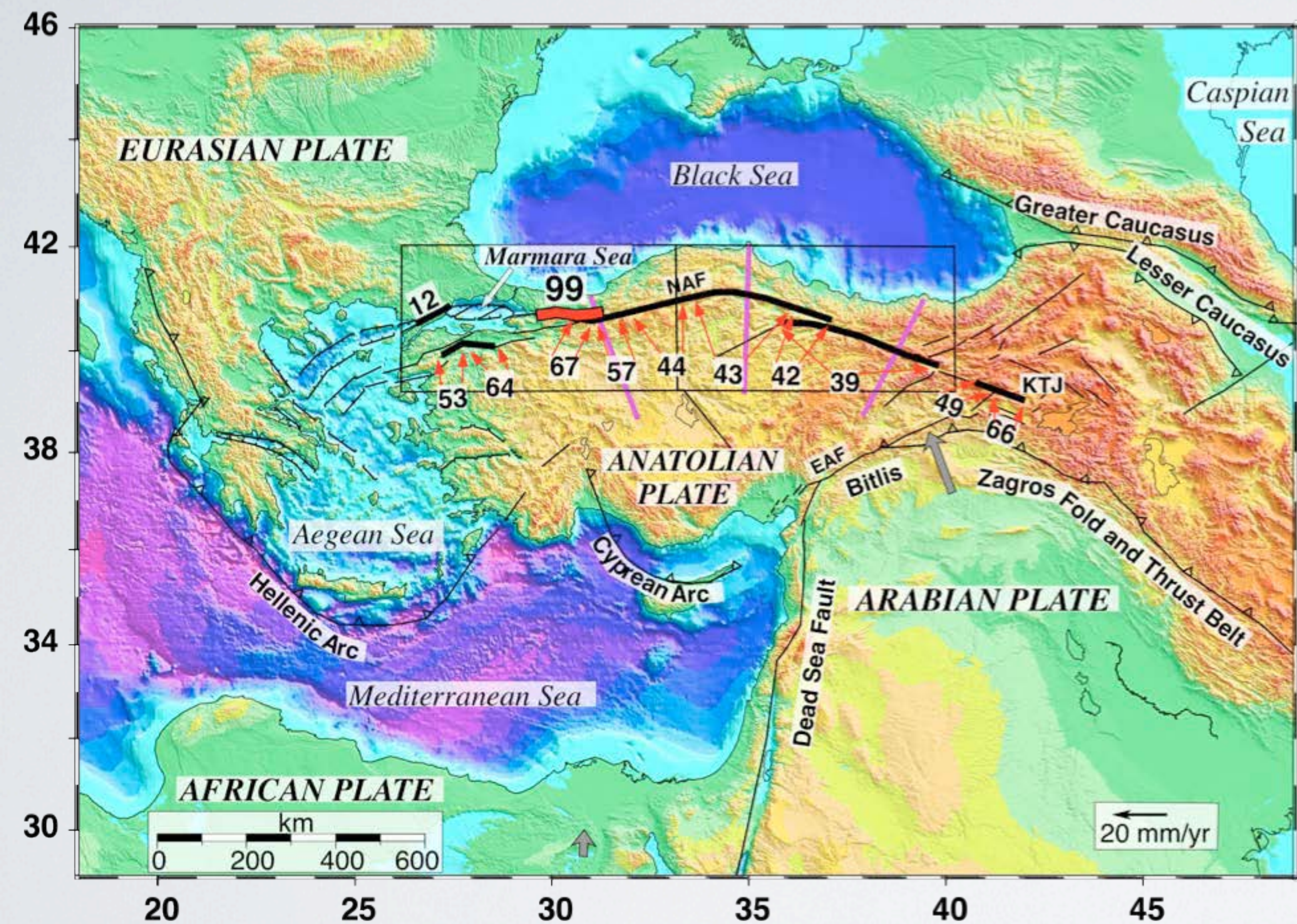


GEOGONAF (THE GEODETIC COMPONENT OF THE GEOPHYSICAL OBSERVATORY ON THE NORTH ANATOLIAN FAULT)



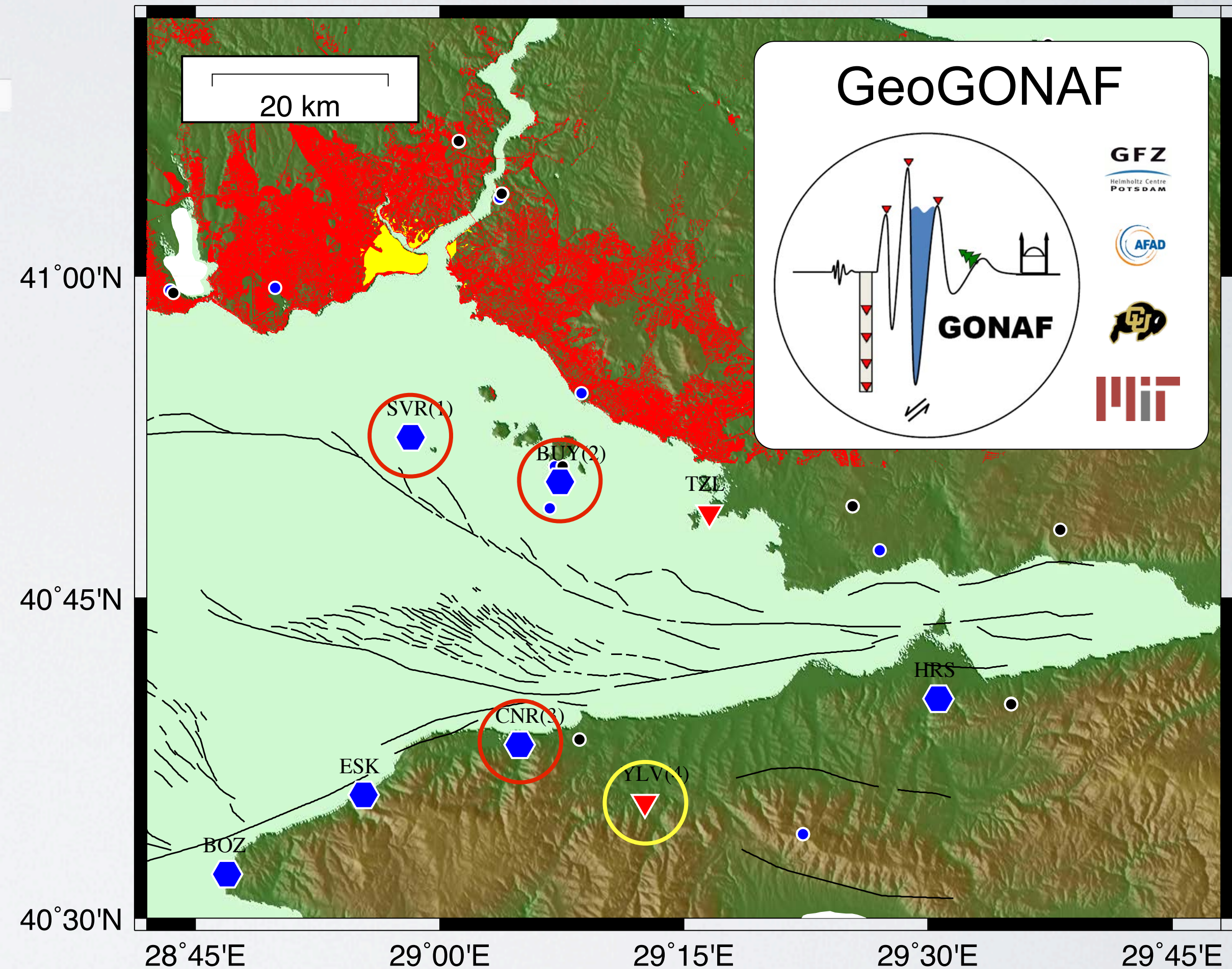
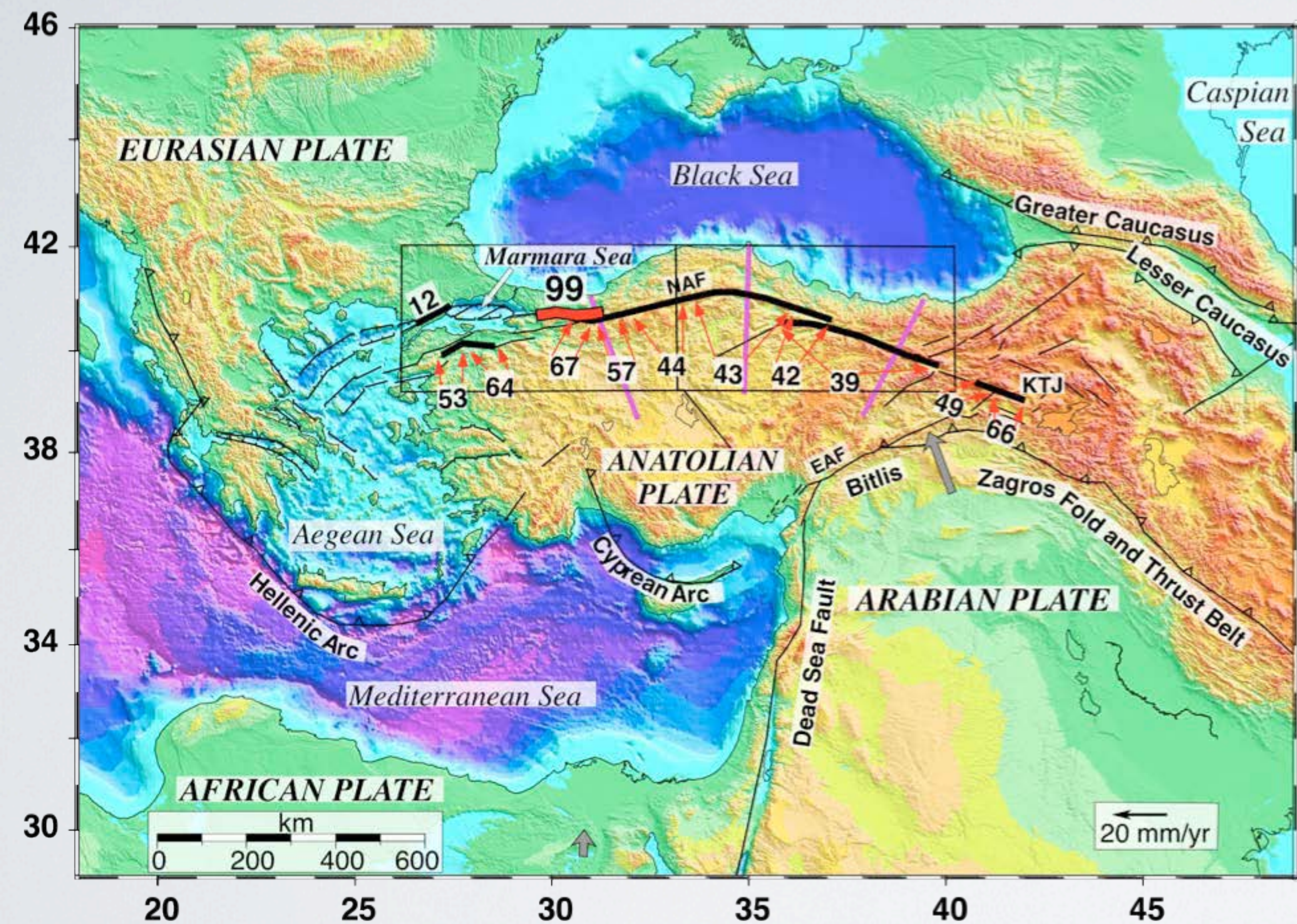
NSF Geophysics program RAPID award funded with Sept. 1, 2013 start date (\$130K to UNAVCO). As part of GeoGONAF, UNAVCO will install three GTSM-BSM instruments (from ES pool) at blue hexagons (both primary and secondary sites shown).

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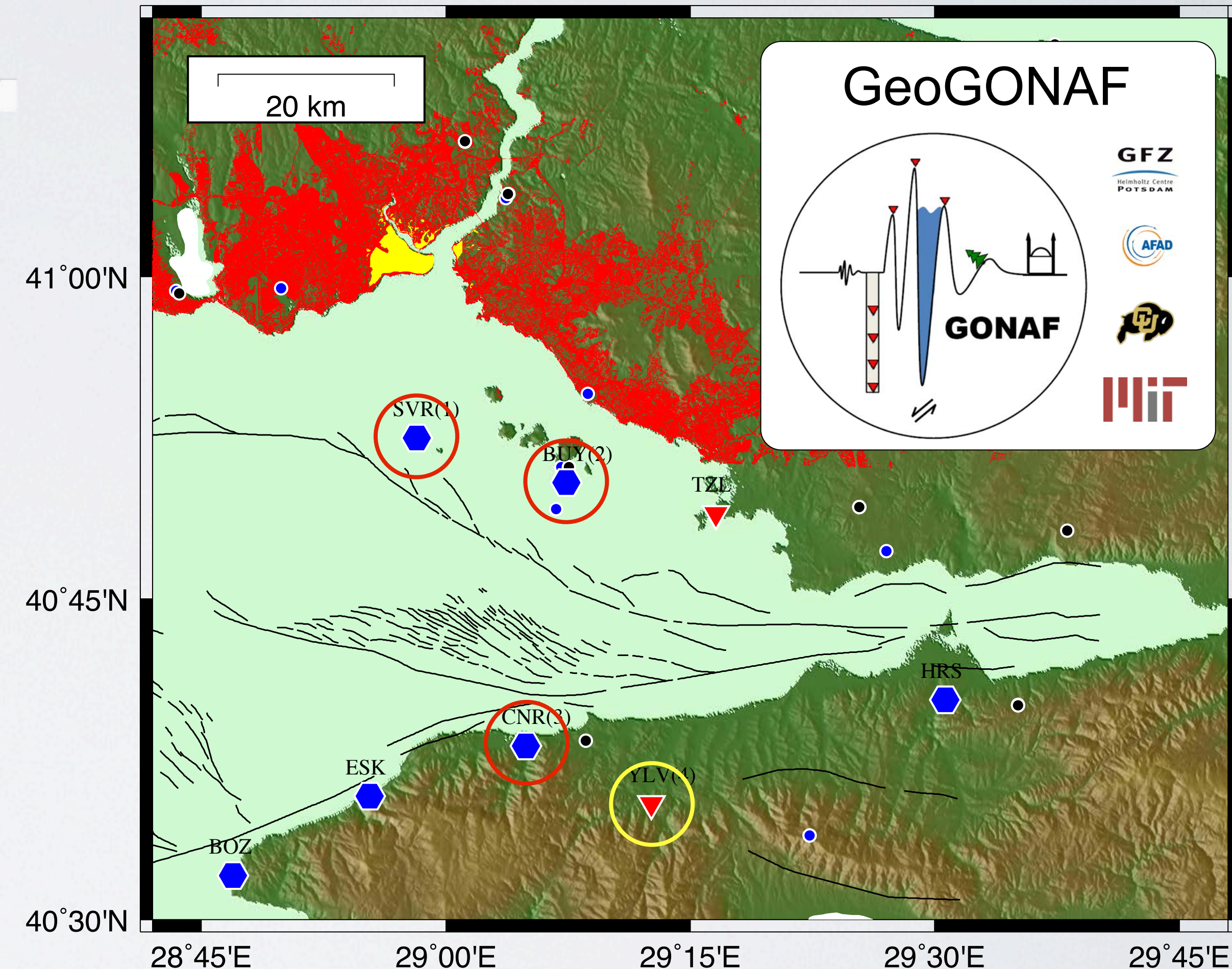
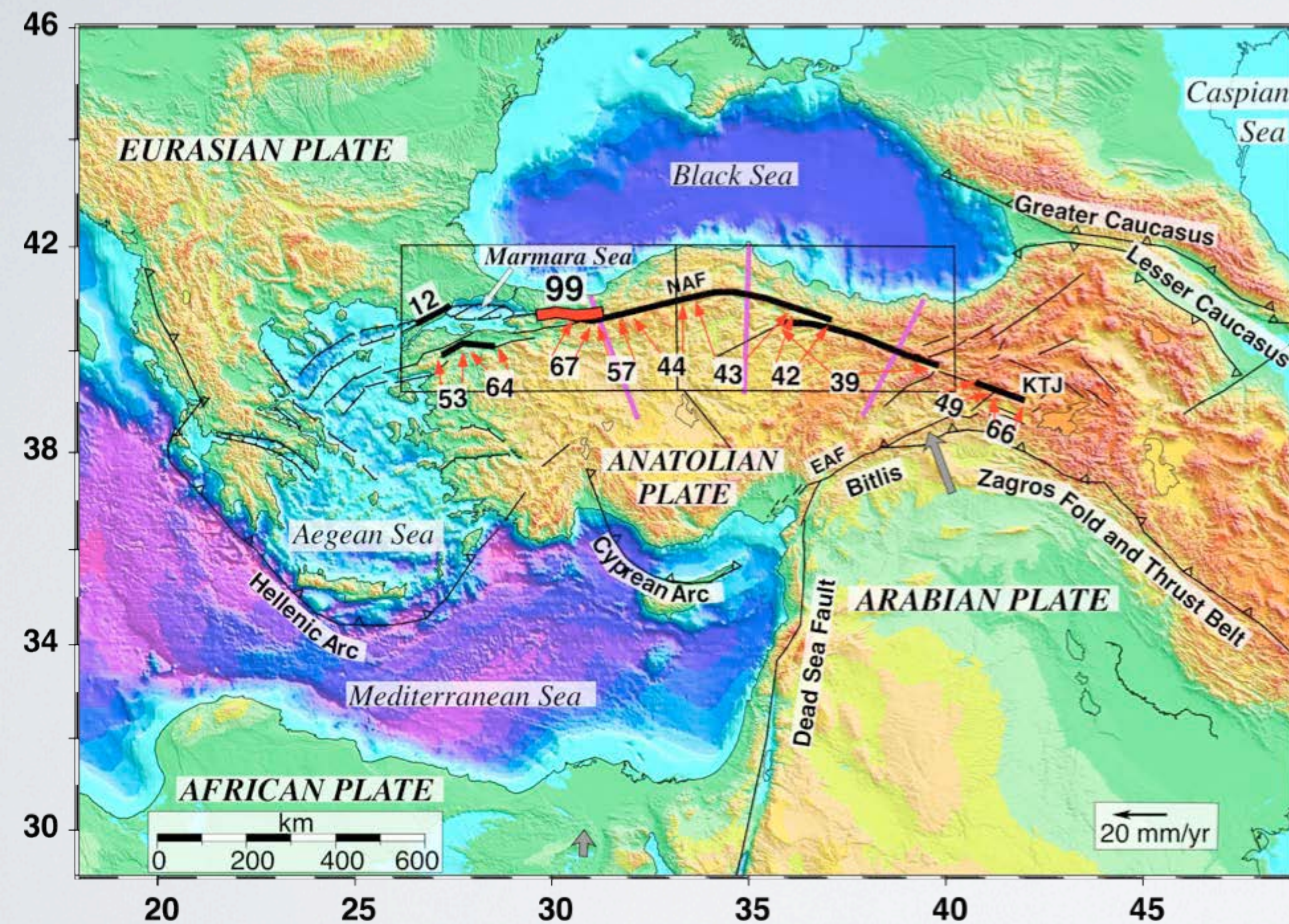
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Project on hold due to partial government shutdown

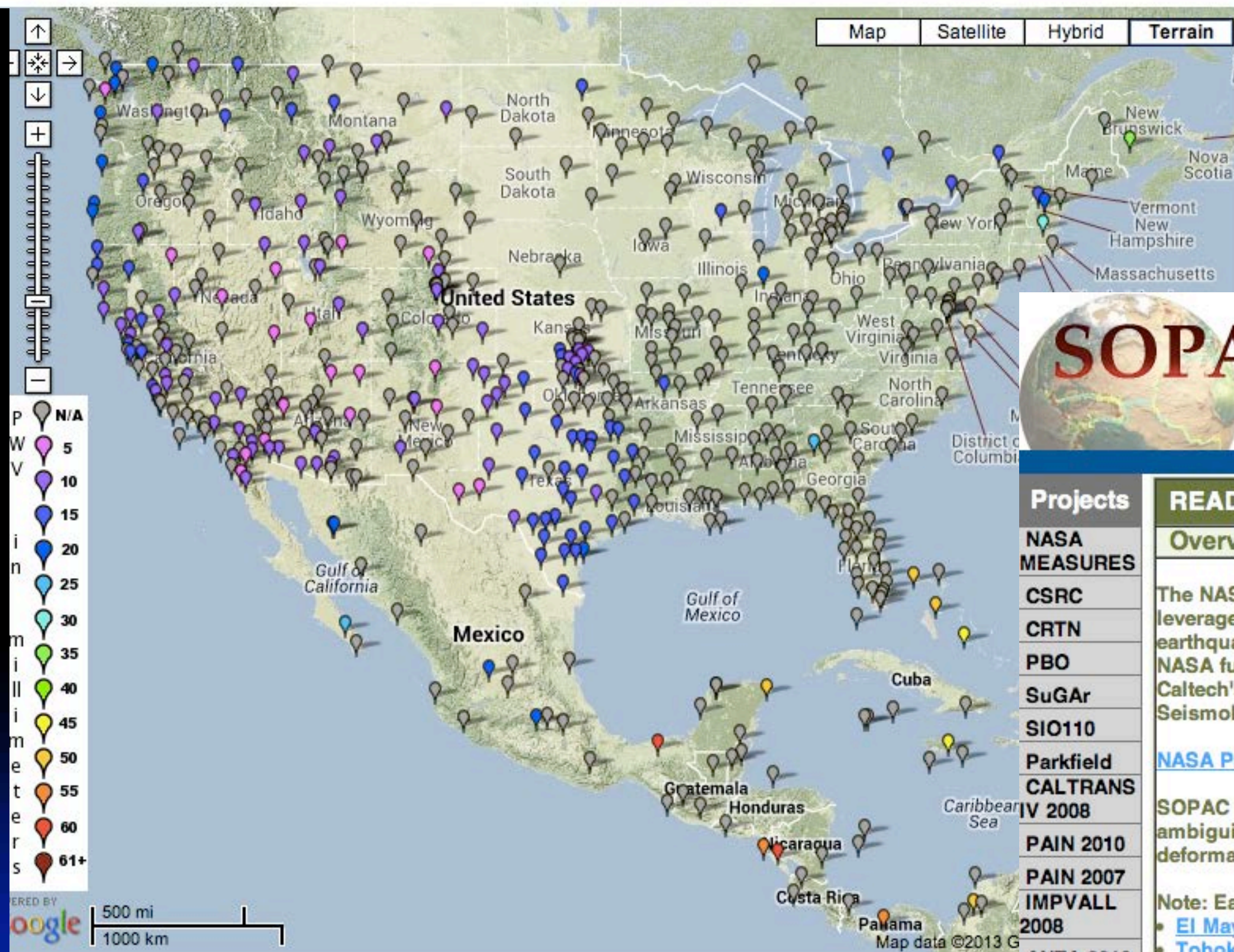


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FUTURE OF PBO - HOW TO WE MOVE FORWARD?



Current Precipitable Water Vapor - US Global Sites with Delay or PWV Estimates



Home | Site Map | Contacts | Forums

scripps orbit and permanent array cent

Data Archive Processing Projects Sites Maps Other
NASA MEASURES | CSRC | CP

Projects

NASA MEASURES
CSRC
CRTN
PBO
SuGAr
SIO110
Parkfield
CALTRANS IV 2008
PAIN 2010
PAIN 2007
IMPVALL 2008
ANZA 2010
ANZA 2011
Imperial Valley 2010
Ocotillo Wells 2011
SENDAL 2011
XML Site Logs
CCID
GPS
Meteorology

READI: Real-time Earthquake Analysis for Disaster Mitigation Network

Overview

The NASA-supported Real-time Earthquake Analysis for Disaster Mitigation Network is a research project that leverages the 500+ station real-time GPS network in Western North America to prototype an accurate and timely earthquake and tsunami early warning system using GPS (GNSS) technology as well as GPS/seismic integration. NASA funds real-time GPS projects at UCSD's Scripps Institution of Oceanography, Central Washington University, Caltech's Jet Propulsion Laboratory, and University of Nevada Reno. Collaborators include UC Berkeley's Seismological Laboratory and Caltech's Seismological Laboratory.

[NASA Press Release](#) | [DataSources](#) | [References](#) | [Western U.S. Map](#)

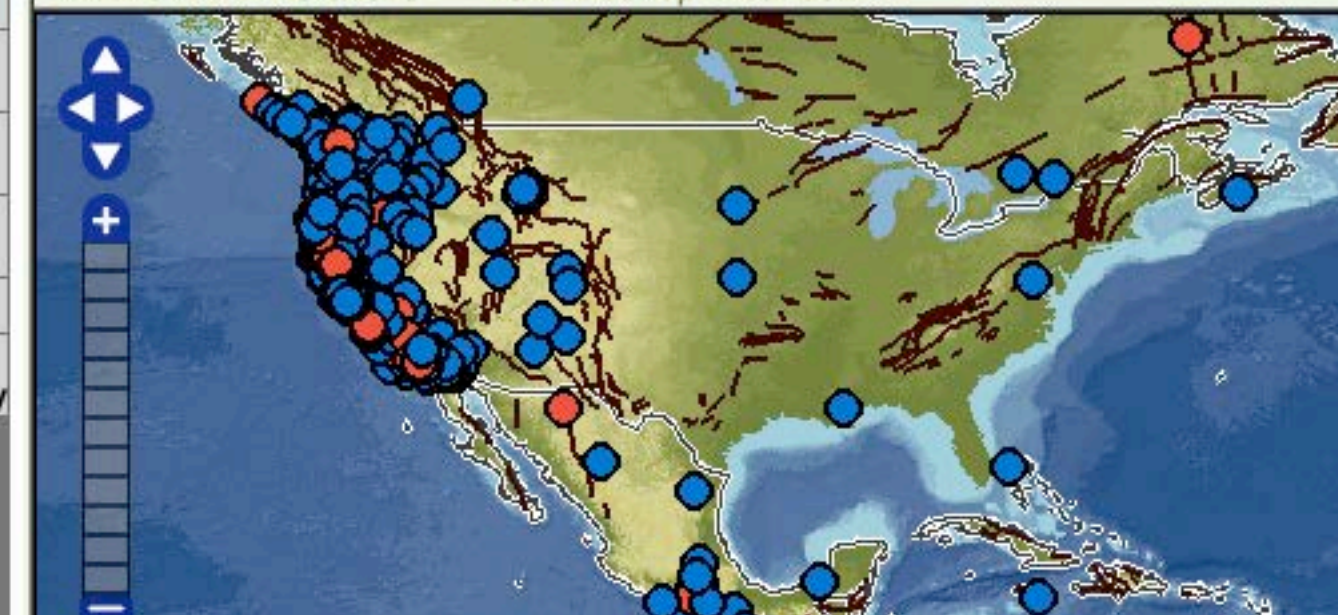
SOPAC computes real-time GPS satellite clocks and fractional-cycle biases for use in precise point positioning with ambiguity resolution using real-time data from GPS stations in North America (outside the zone of active tectonic deformation in the Western U.S. and British Columbia). See interactive map below.

Note: Earthquake information available in GPS Explorer:

- [El Mayor-Cuapah \(2010-04-04\)](#)
- [Tohoku-oki \(2011-03-11\)](#)
- [Brawley Swarm \(2012-08-26\)](#)

Map - Current READI Status (Updates automatically every 5 minutes)

Active READI Stations - Dark Blue: up Red: down



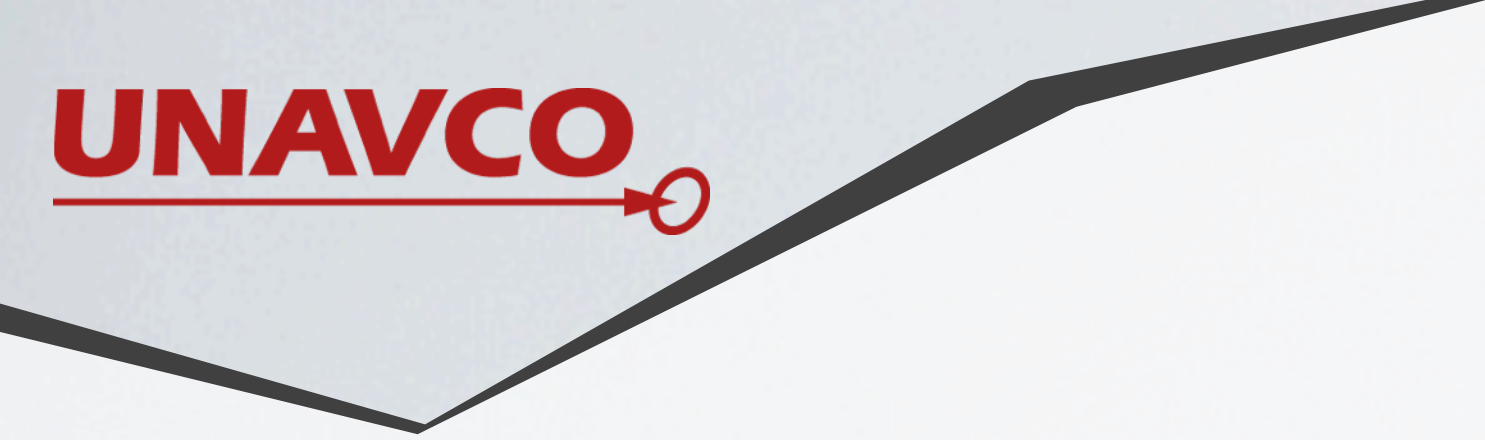
Map Tools

Layers

- Base Layers
- ☐ Basic
 - ☐ Satellite
 - ☒ Terrain
 - ☐ USGS Topo Quads
- Overlays
- ☐ Tectonic Plates
 - ☒ Fault Lines
 - ☐ US Interstates

NOAA and NASA are building systems that depend on PBO, but NSF is not committed to O&M beyond 2018 or upgrades to RT-GPS or GNSS...

SCEC and USGS are operating like PBO is a utility, it will always be on...



QUESTIONS?

