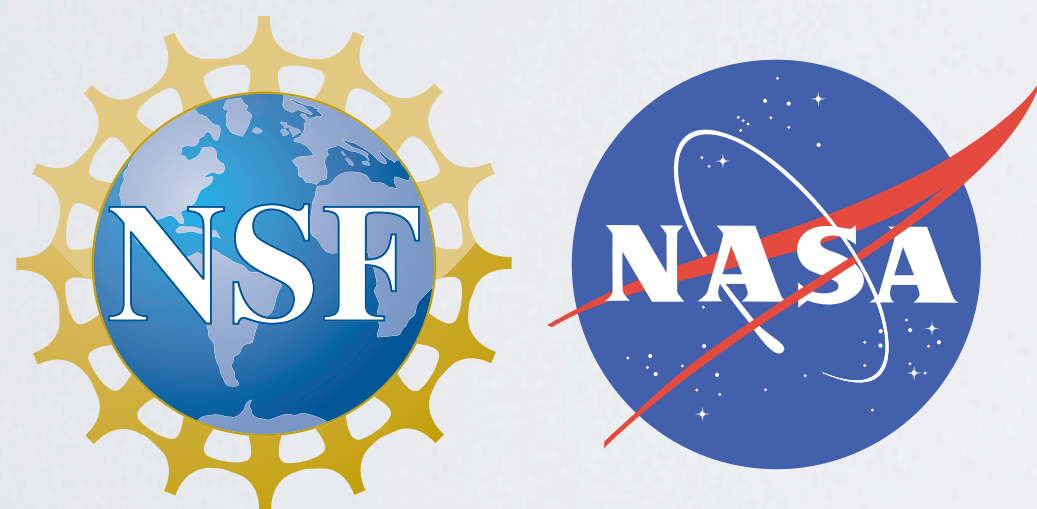


UNAVCO

PBO/SAFOD FACILITY REPORTS - TRANSITION TO GAGE FOR 2013-2018

Glen S. Mattioli, Ph.D.

Director of Geodetic Infrastructure and
PBO/SAFOD Director

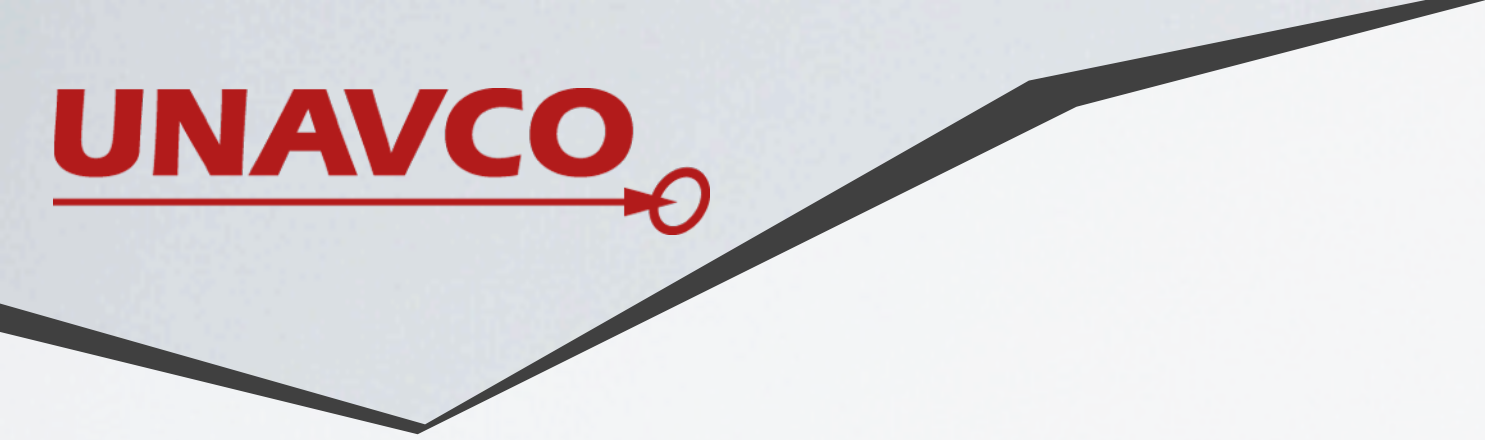


EarthScope Steering Committee Meeting, Oct. 8-9, 2013 - Boulder, CO



ESSC REPORT OUTLINE

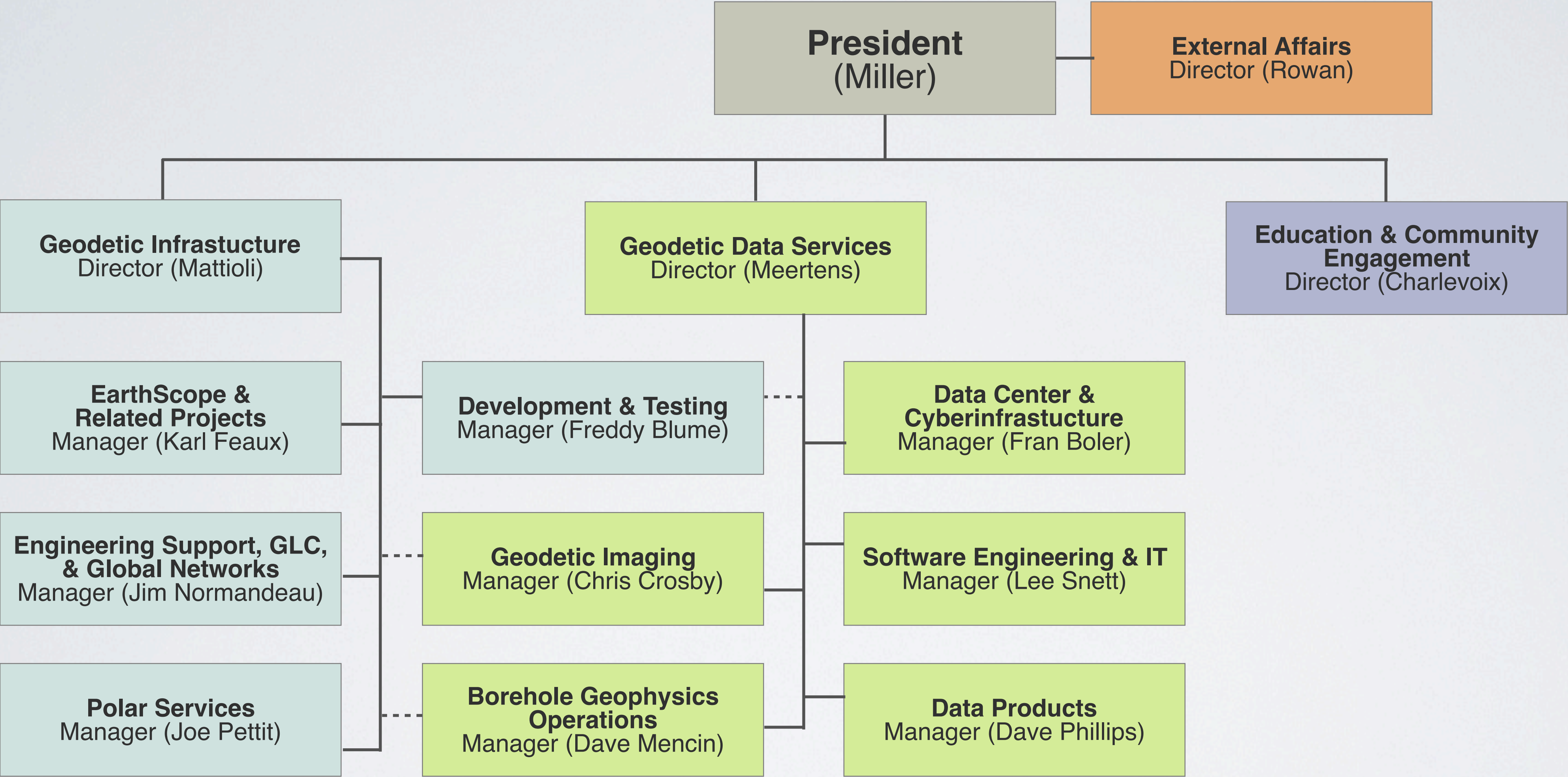
- Geodetic Infrastructure program organization and people
- Overview of GI program and PBO staff in GAGE: changes from last ESSC F2F
- EarthScope overview and highlights: PBO, SAFOD, and data products
- Special projects: GeoPentech (SONGS-II) and GeoGONAF
- Vision for the future: PBO basis for a multi-hazard network of networks across the Americas
- GAGE Budget and Scope: Plans versus reality in current environment
- Challenges going forward...



UNAVCO ORGANIZATIONAL STRUCTURE

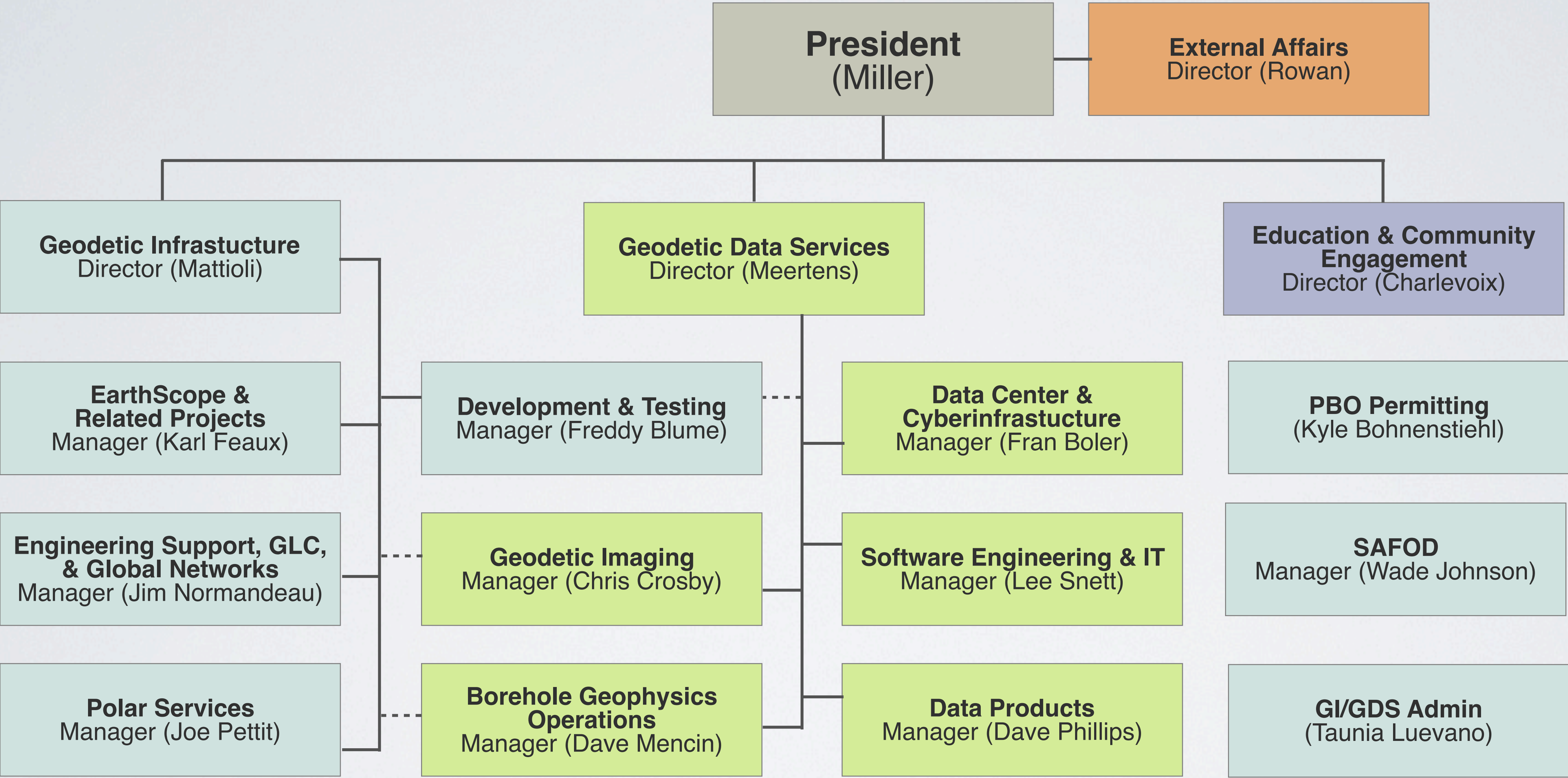


UNAVCO ORGANIZATIONAL STRUCTURE

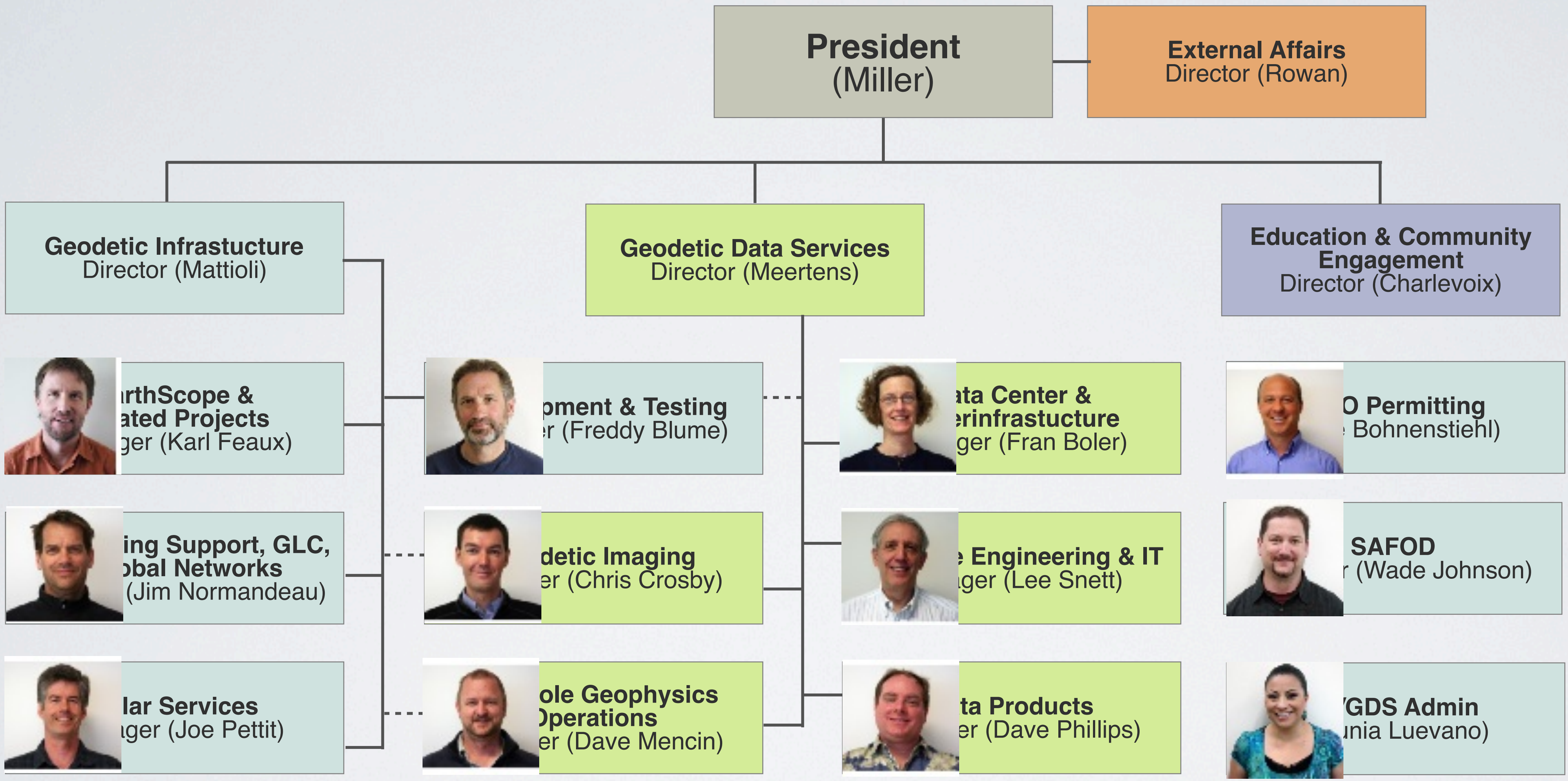




UNAVCO ORGANIZATIONAL STRUCTURE

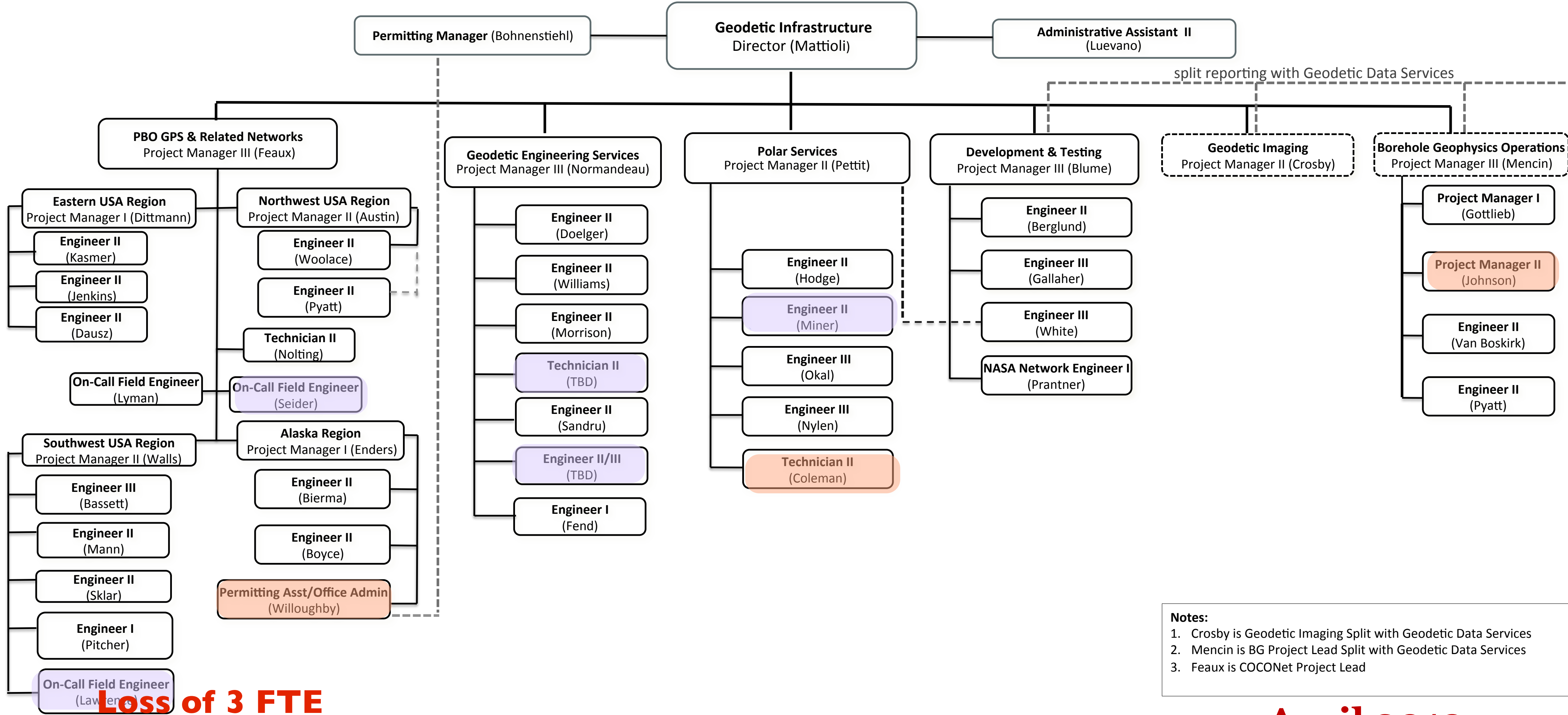


UNAVCO ORGANIZATIONAL STRUCTURE



GEODETTIC INFRASTRUCTURE ORG CHART

UNAVCO Geodetic Infrastructure



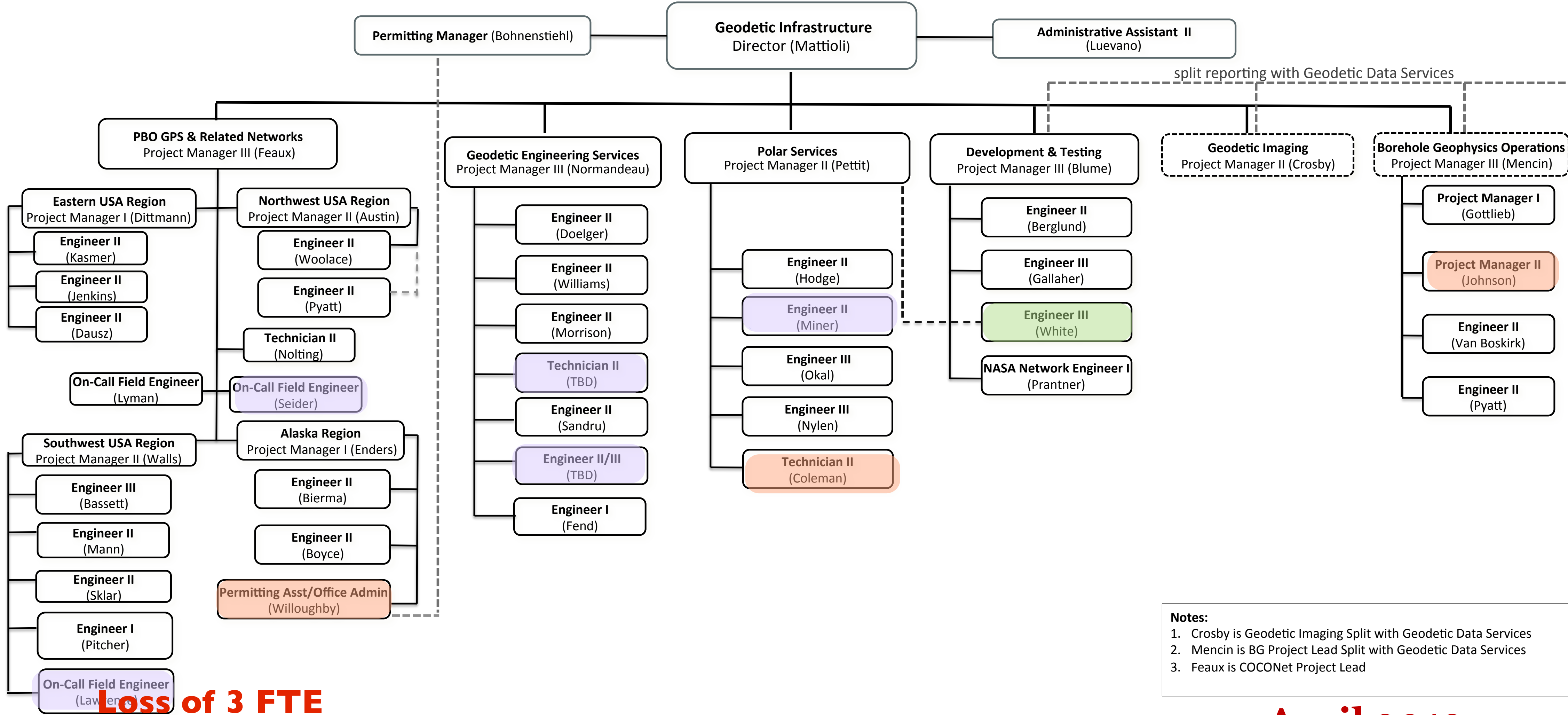
- Notes:**
- 1. Crosby is Geodetic Imaging Split with Geodetic Data Services
 - 2. Mencin is BG Project Lead Split with Geodetic Data Services
 - 3. Feaux is COCONet Project Lead

Loss of 3 FTE

April 2013

GEODETTIC INFRASTRUCTURE ORG CHART

UNAVCO Geodetic Infrastructure



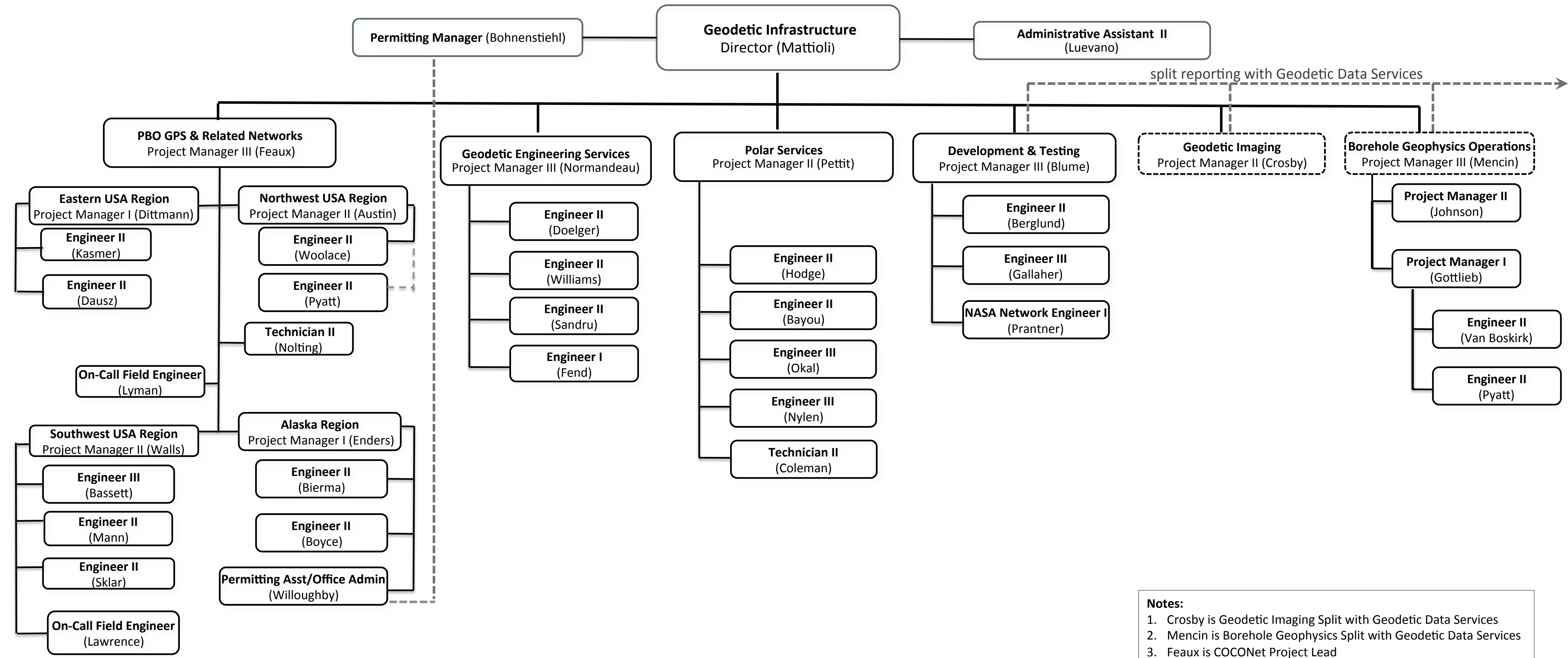
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Loss of 3 FTE

April 2013

GEODETTIC INFRASTRUCTURE ORG CHART

UNAVCO Geodetic Infrastructure



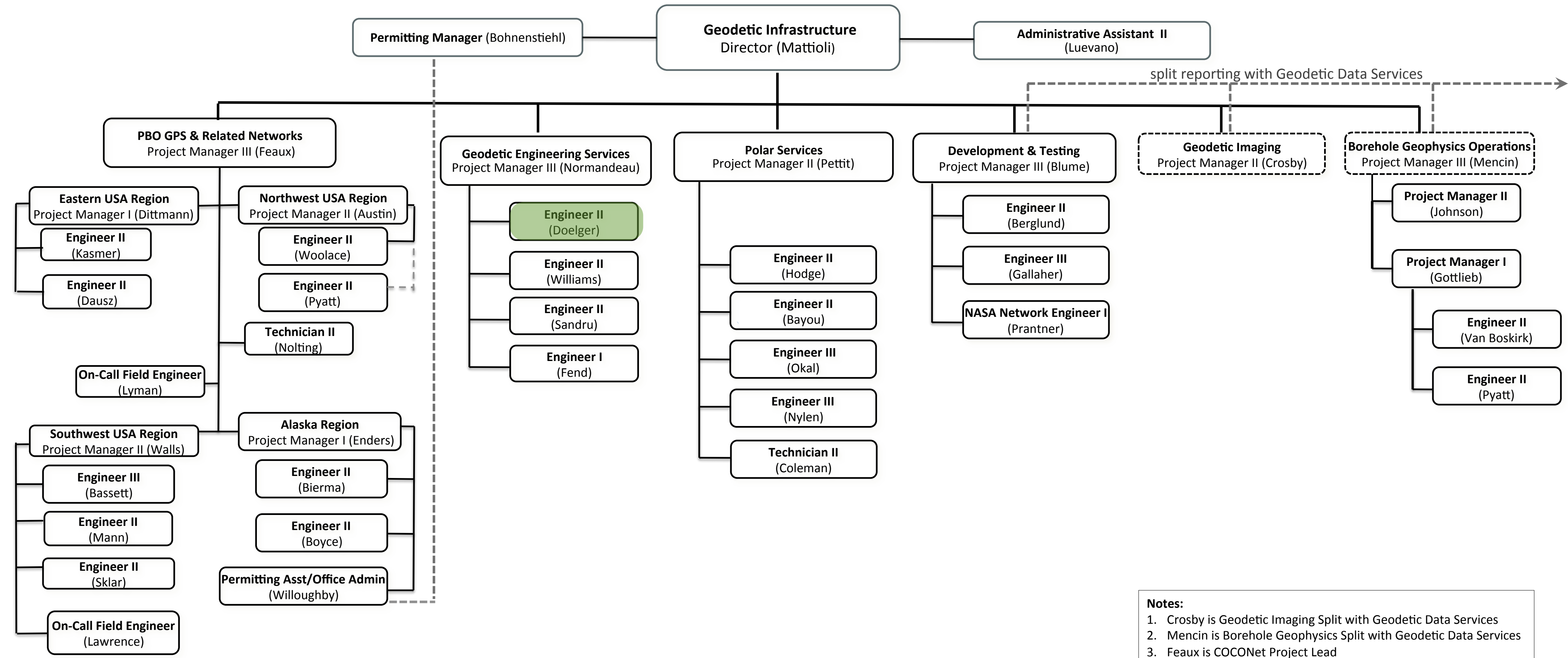
Loss of 3 FTE

- Notes:
- 1. Crosby is Geodetic Imaging Split with Geodetic Data Services
 - 2. Mencin is Borehole Geophysics Split with Geodetic Data Services
 - 3. Feaux is COCONet Project Lead

August 2013

GEODETTIC INFRASTRUCTURE ORG CHART

UNAVCO Geodetic Infrastructure



Loss of 3 FTE

- Notes:
- 1. Crosby is Geodetic Imaging Split with Geodetic Data Services
 - 2. Mencin is Borehole Geophysics Split with Geodetic Data Services
 - 3. Feaux is COCONet Project Lead

August 2013



A FOUNDATION FOR INNOVATION: GRAND CHALLENGES IN GEODESY

Where is the Water?

Where does the Earth Store fresh water?

How will the Earth System respond as mean sea level rises?

How do Earth's glaciers and ice sheets change over time?

Earth the Machine

How do tectonic plates deform?

What physical processes govern earthquakes?

How does Earth's surface evolve?

What are the mechanics of magmatic and eruptive systems?



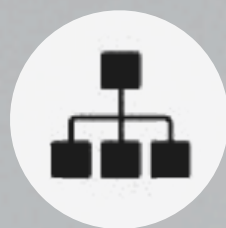


GAGE Facility

NSF Guidance:
Single Cooperative Agreement 2013



Geodetic Infrastructure



Geodetic Data Services



Education & Community
Engagement

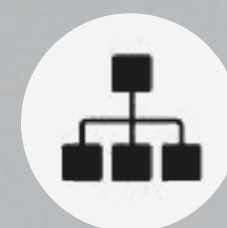


GAGE Facility

NSF Guidance:
Single Cooperative Agreement 2013



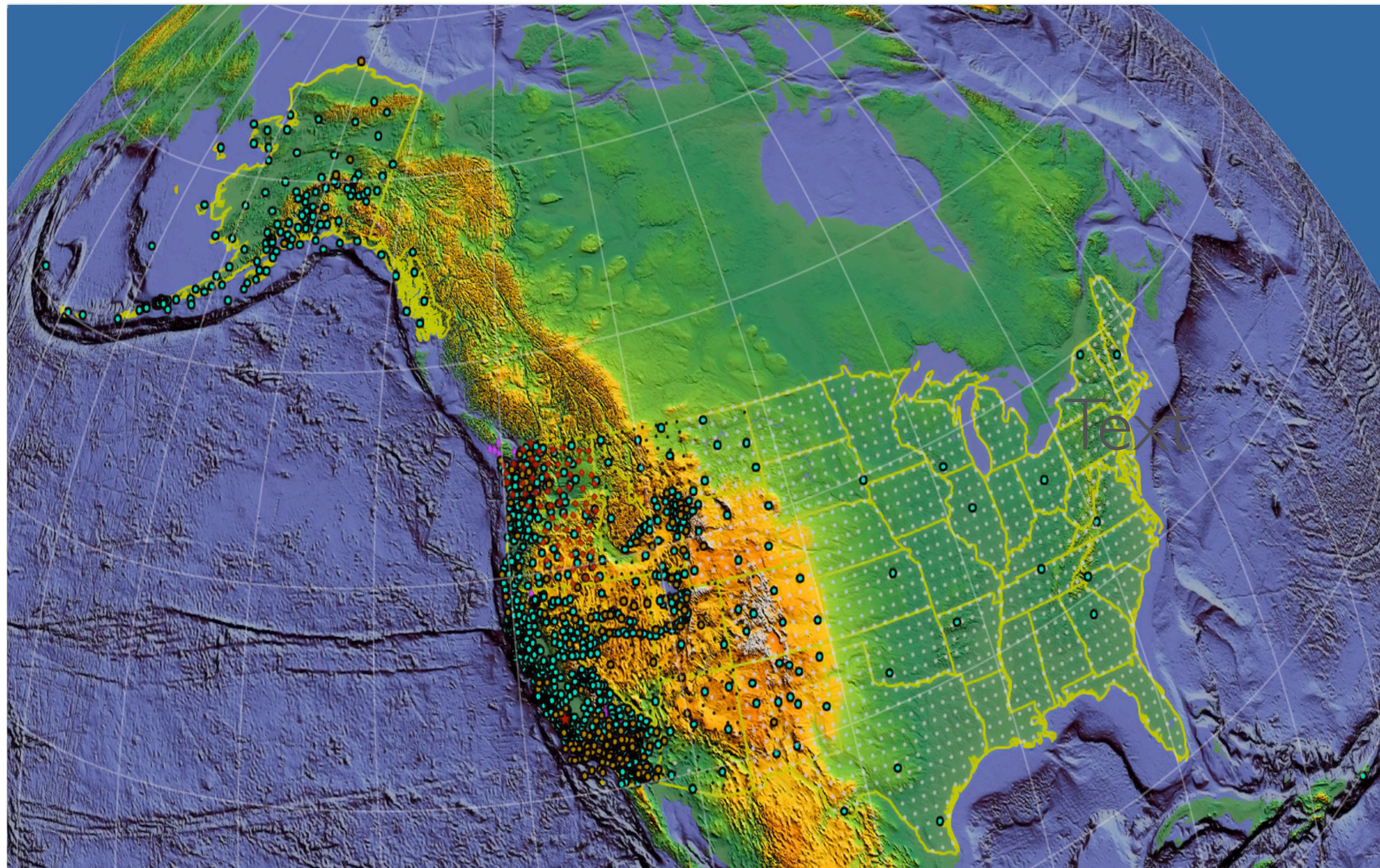
Geodetic Infrastructure



Geodetic Data Services



Education & Community
Engagement



Technical advancements:

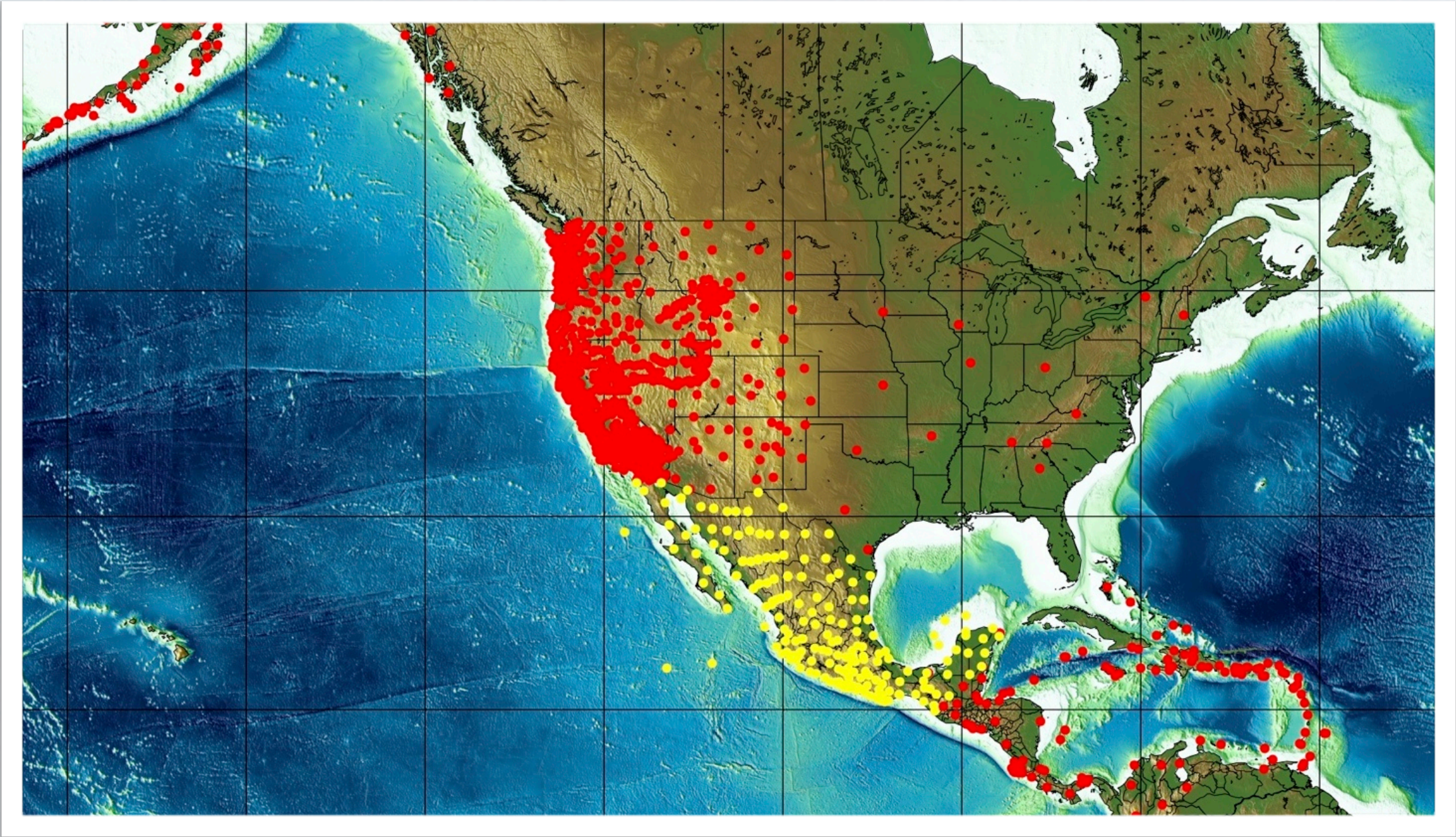
- community data formats for real-time GPS
- collocation of accelerometers & high-rate GPS
- Cascadia & planned GAGE upgrades
- changes in the landscape with vendors

Integrative science:

- tomography & kinematics for geodynamics
- episodic tremor and slip
- GPS seismology
- early GPS centroid determination

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

GPS



Governance and
Community

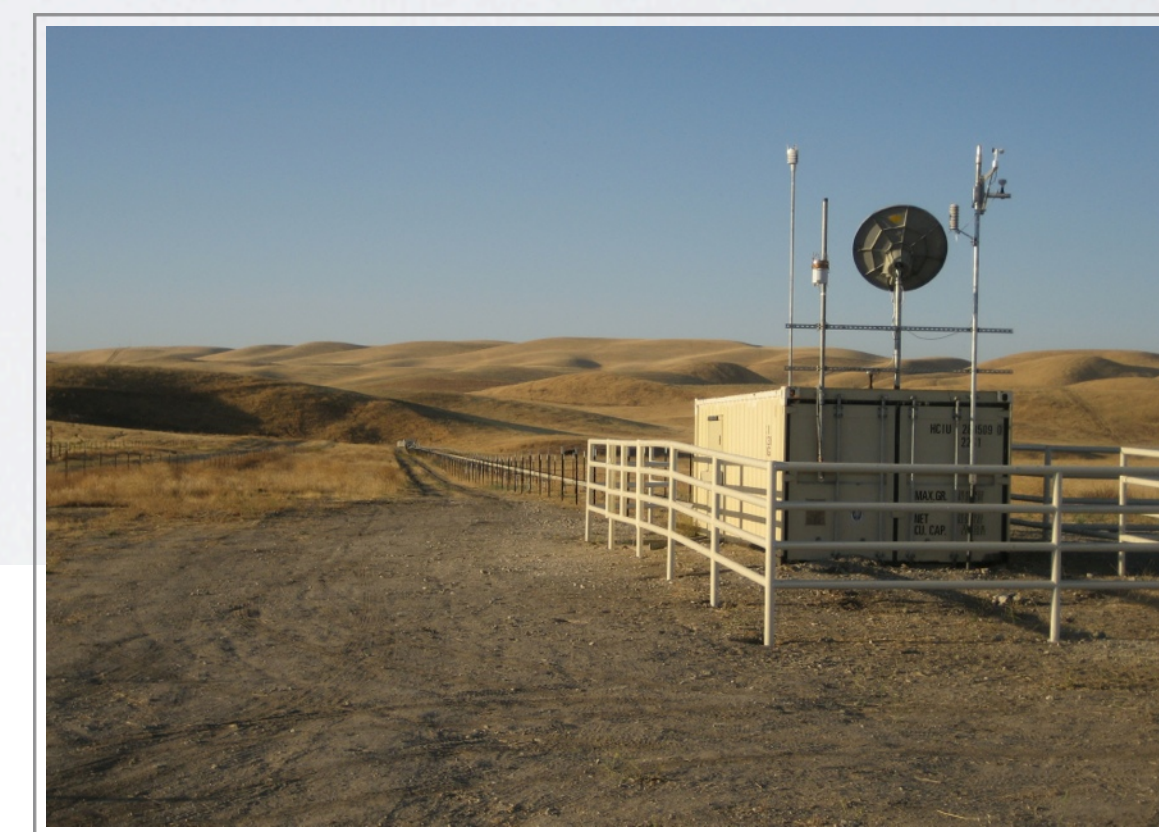
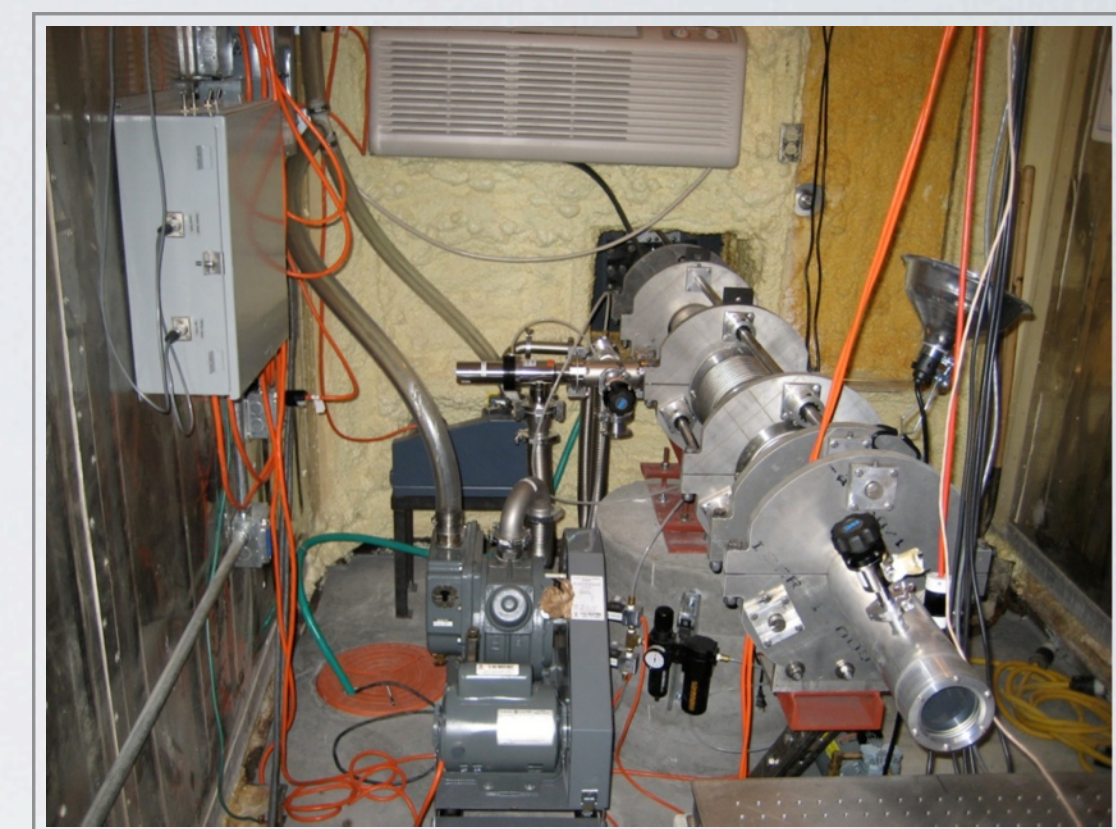
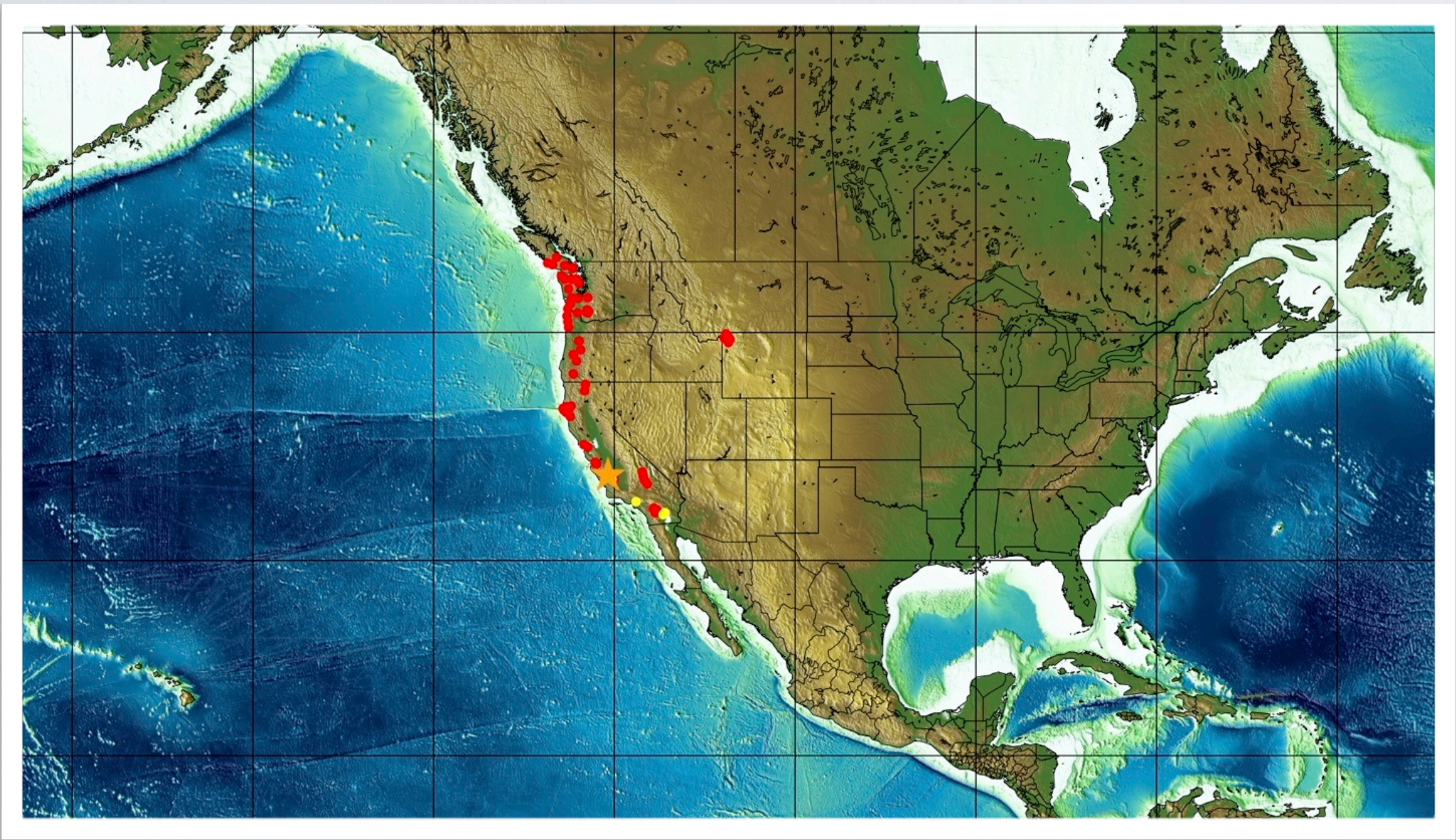
GAGE
Impact

Geodetic
Infrastructure

Geodetic Data
Services

Education &
Community
Engagement

Beyond 2018



Governance and
Community

GAGE
Impact

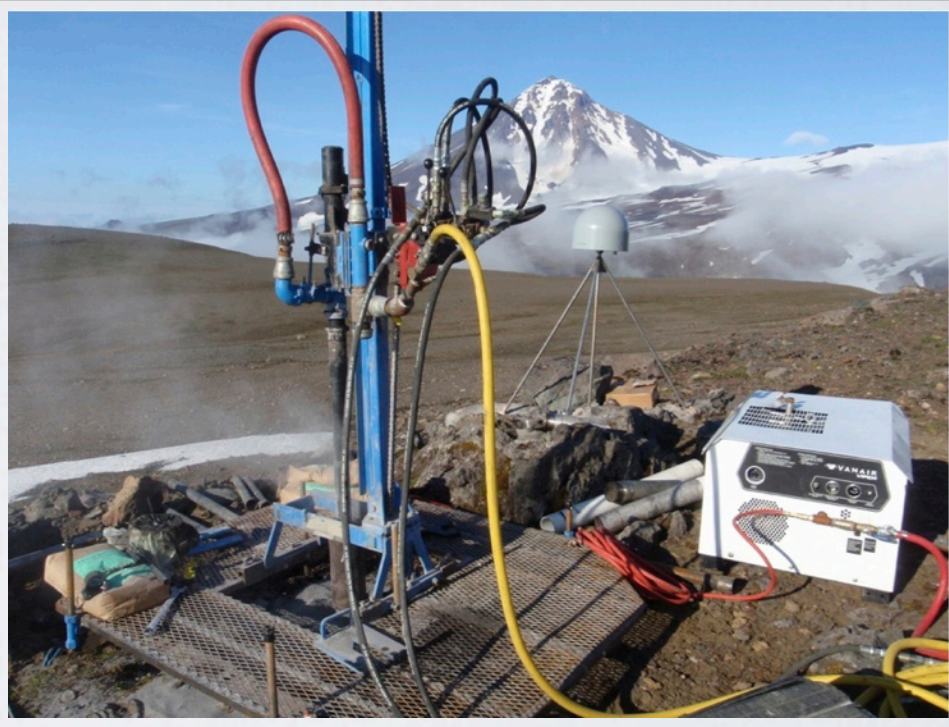
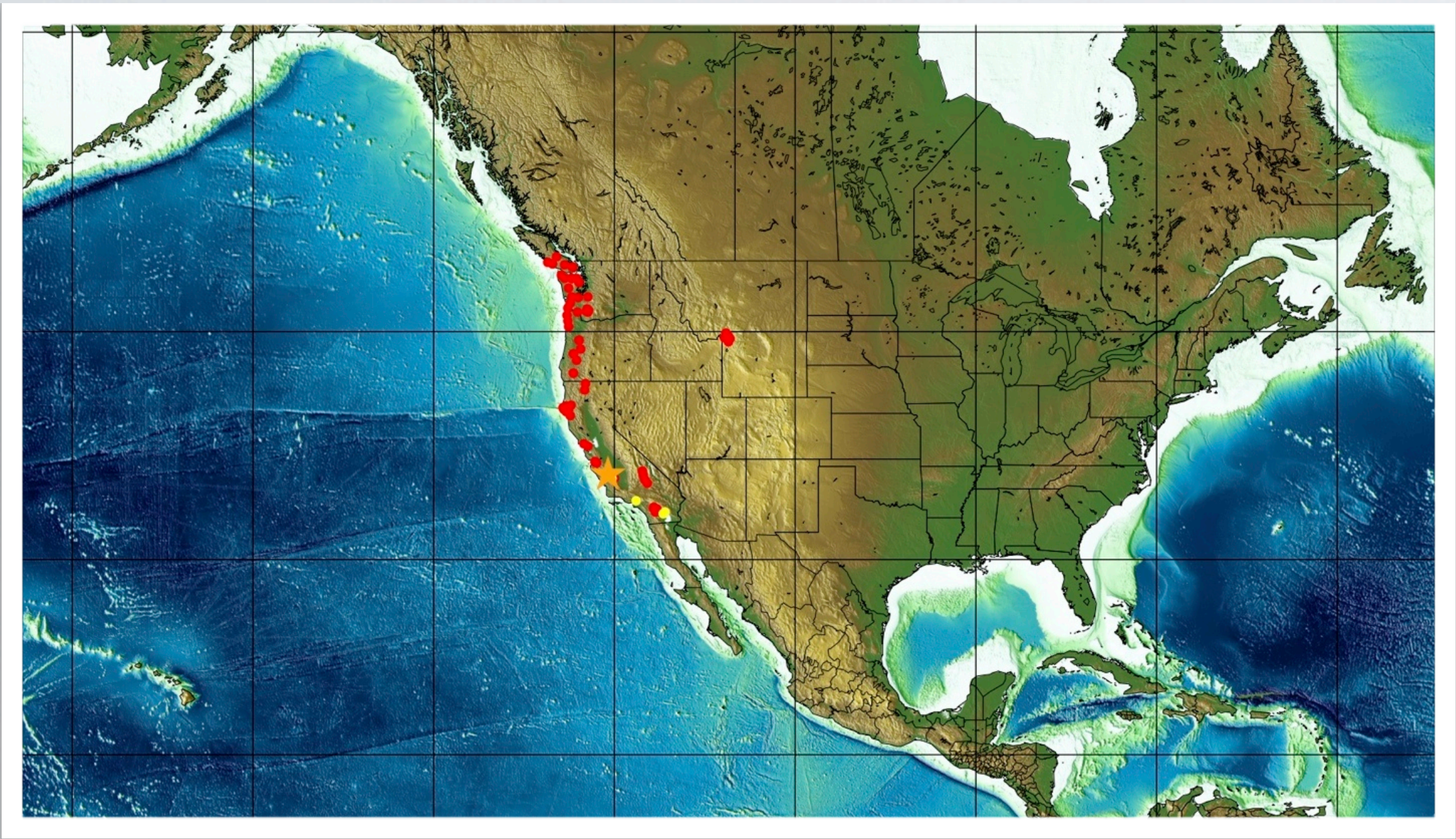
Geodetic
Infrastructure

Geodetic Data
Services

Education &
Community
Engagement

Beyond 2018

TILTMETERS



GPS



LONG BASELINE STRAINMETERS



TILTMETERS



Governance and
Community

GAGE
Impact

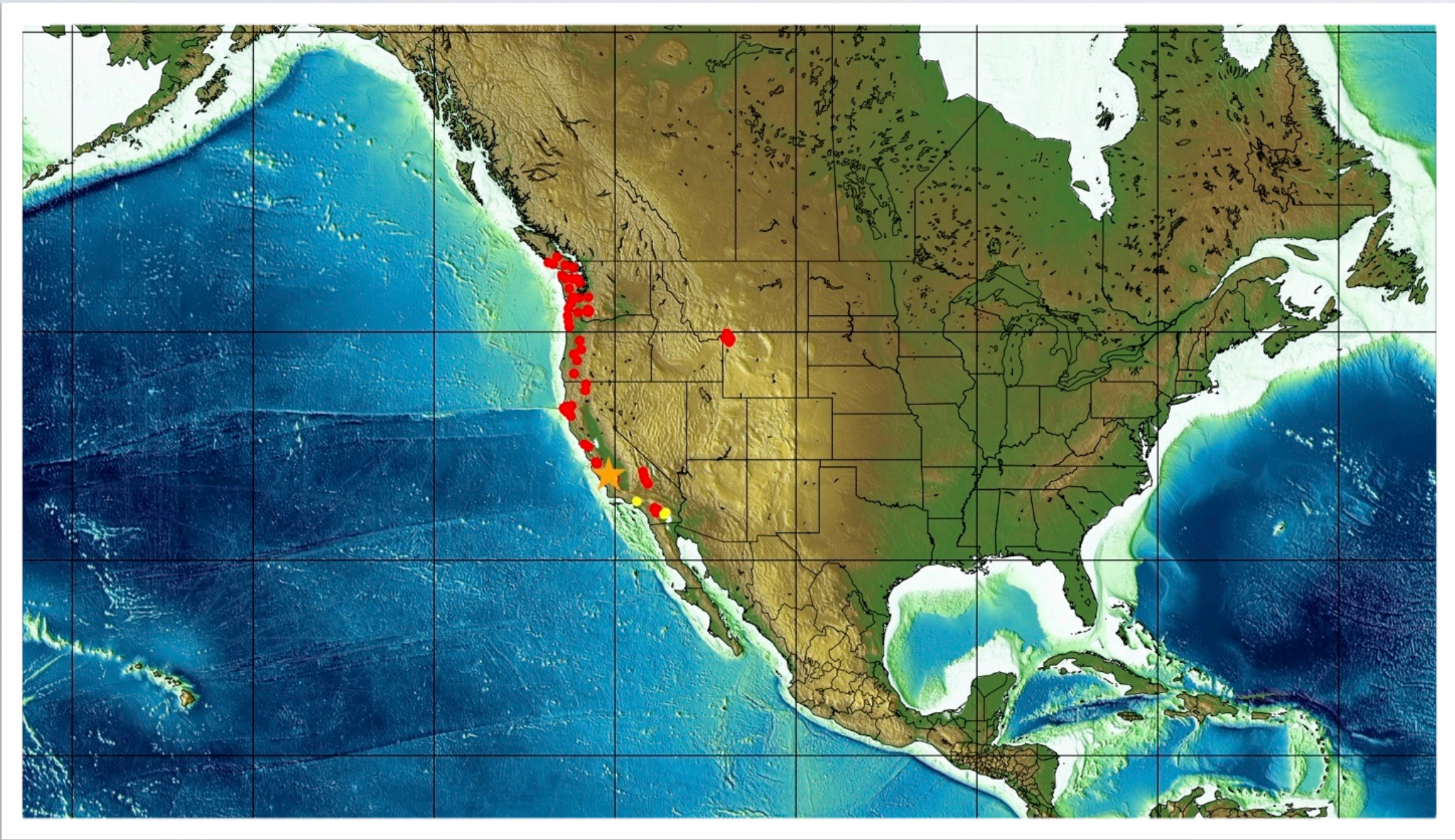
Geodetic
Infrastructure

Geodetic Data
Services

Education &
Community
Engagement

Beyond 2018

BOREHOLE STRAINMETERS



GPS

LONG BASELINE STRAINMETERS

TILTMETERS

BOREHOLE STRAINMETERS

Governance and
Community

GAGE
Impact

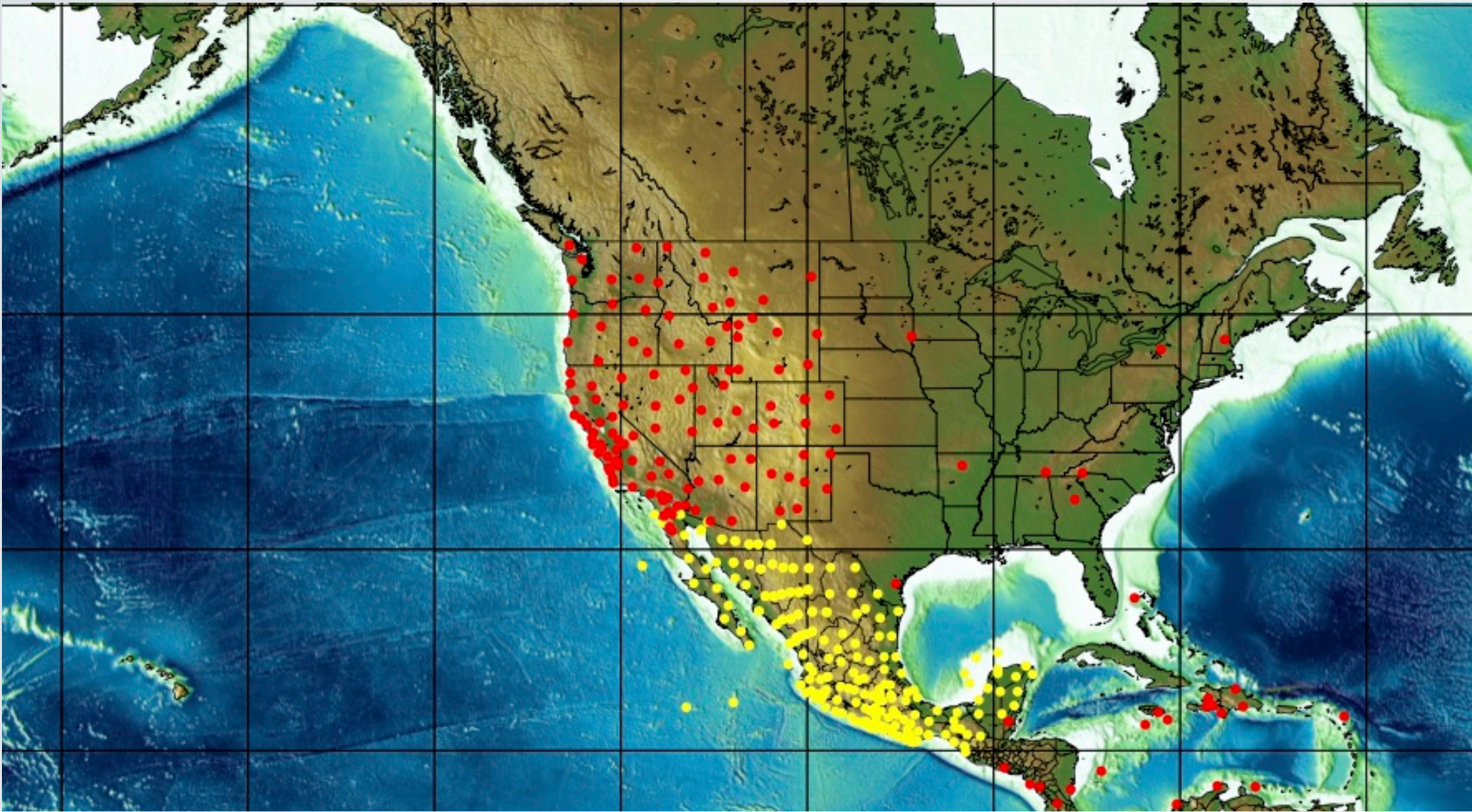
Geodetic
Infrastructure

Geodetic Data
Services

Education &
Community
Engagement

Beyond 2018

MET PACKS



GPS

Four small images showing GPS equipment and personnel. The first shows two people in orange shirts working with a tripod-mounted antenna. The second shows a GPS antenna on a pole in a field. The third shows a GPS antenna on a pole next to a building. The fourth shows a GPS antenna on a pole next to a building.

LONG BASELINE STRAINMETERS

Three small images showing long baseline strainmeter equipment. The first shows a large antenna on a tripod. The second shows a close-up of a strainmeter sensor. The third shows a strainmeter sensor in a field.

TILTMETERS

Four small images showing tiltmeter equipment. The first shows a tiltmeter sensor in a borehole. The second shows a tiltmeter sensor in a field. The third shows a tiltmeter sensor in a field. The fourth shows a tiltmeter sensor in a field.

BOREHOLE STRAINMETERS

Three small images showing borehole strainmeter equipment. The first shows a borehole strainmeter in a field. The second shows a borehole strainmeter in a field. The third shows a borehole strainmeter in a field.

MET

One small image showing a MET Pack antenna.

Governance and
Community

GAGE
Impact

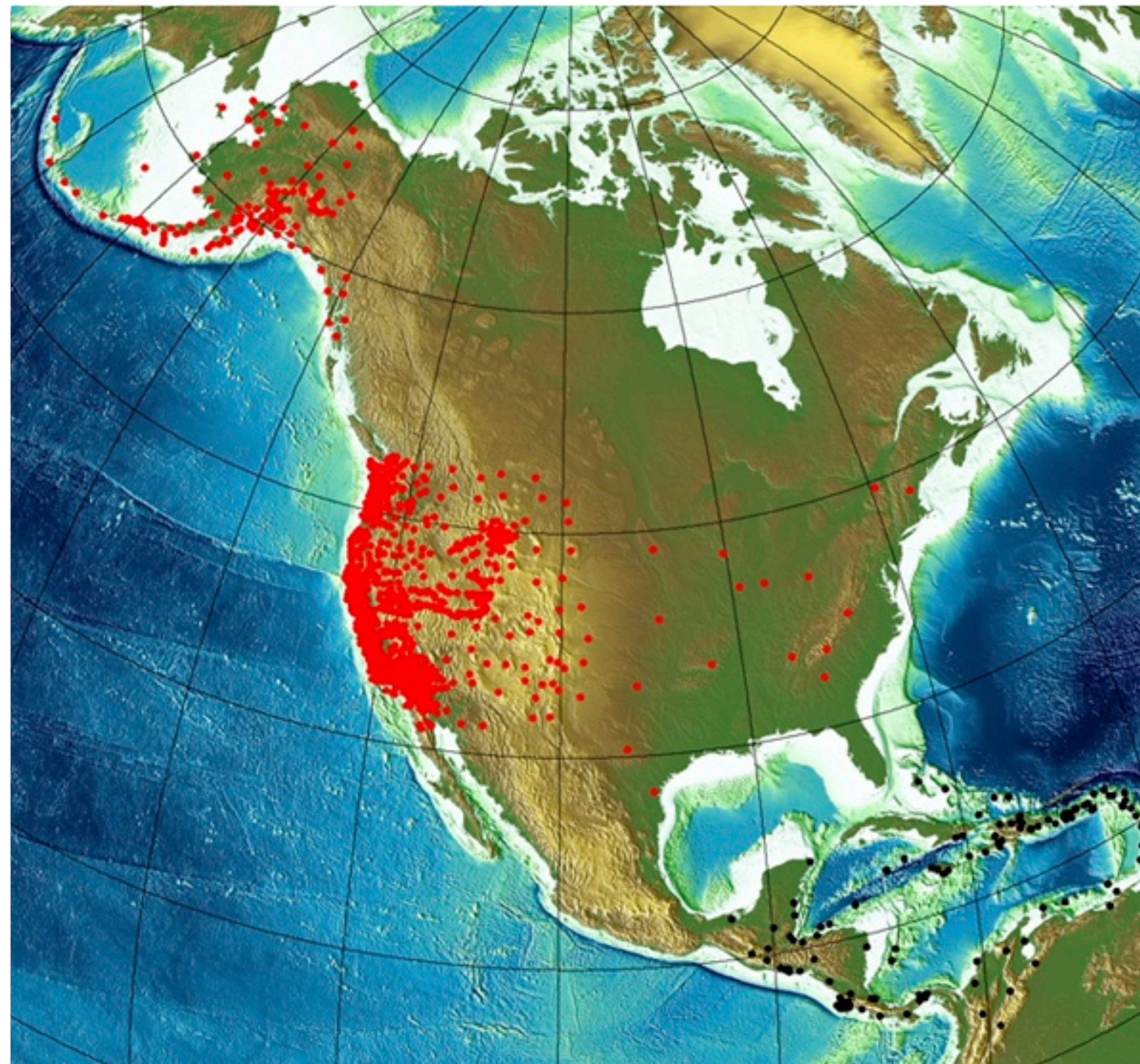
Geodetic
Infrastructure

Geodetic Data
Services

Education &
Community
Engagement

Beyond 2018

GAGE: REAL-TIME GPS/GNSS UPGRADE PLAN



●
Real-Time
Stations

Governance and
Community

GAGE
Impact

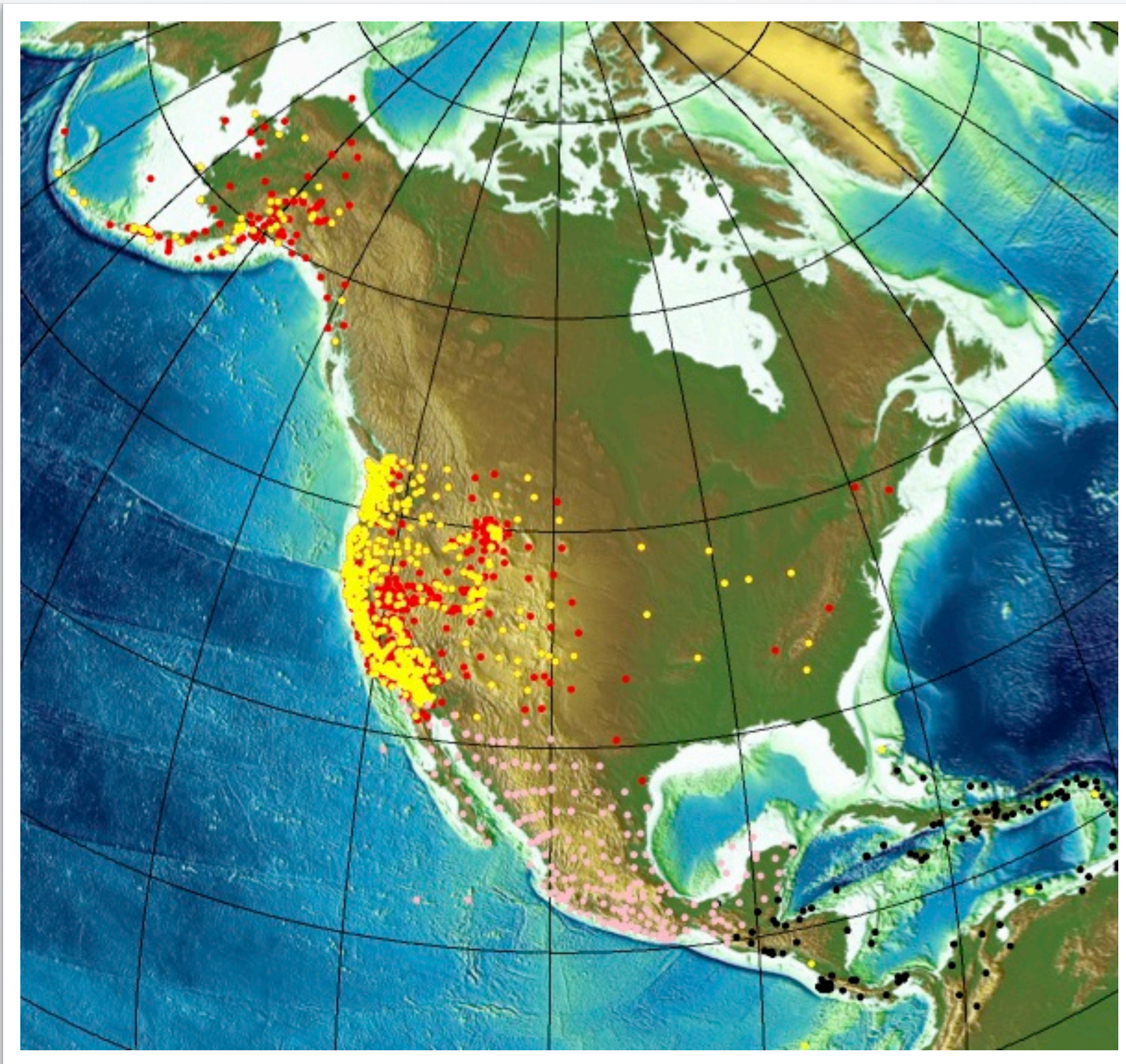
Geodetic
Infrastructure

Geodetic Data
Services

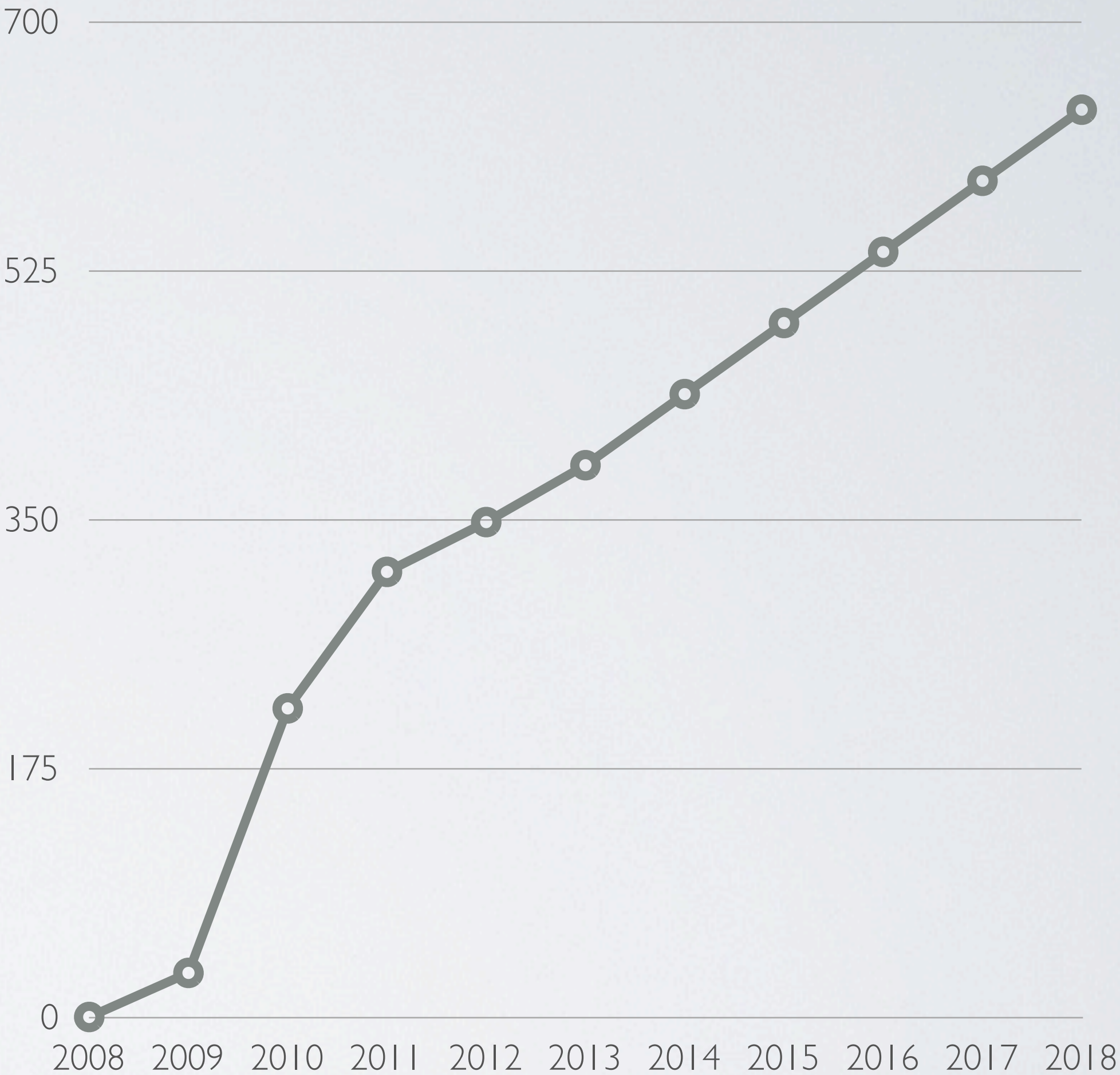
Education &
Community
Engagement

Beyond 2018

GAGE: REAL-TIME GPS/GNSS UPGRADE PLAN



Real-Time Stations



Governance and
Community

GAGE
Impact

Geodetic
Infrastructure

Geodetic Data
Services

Education &
Community
Engagement

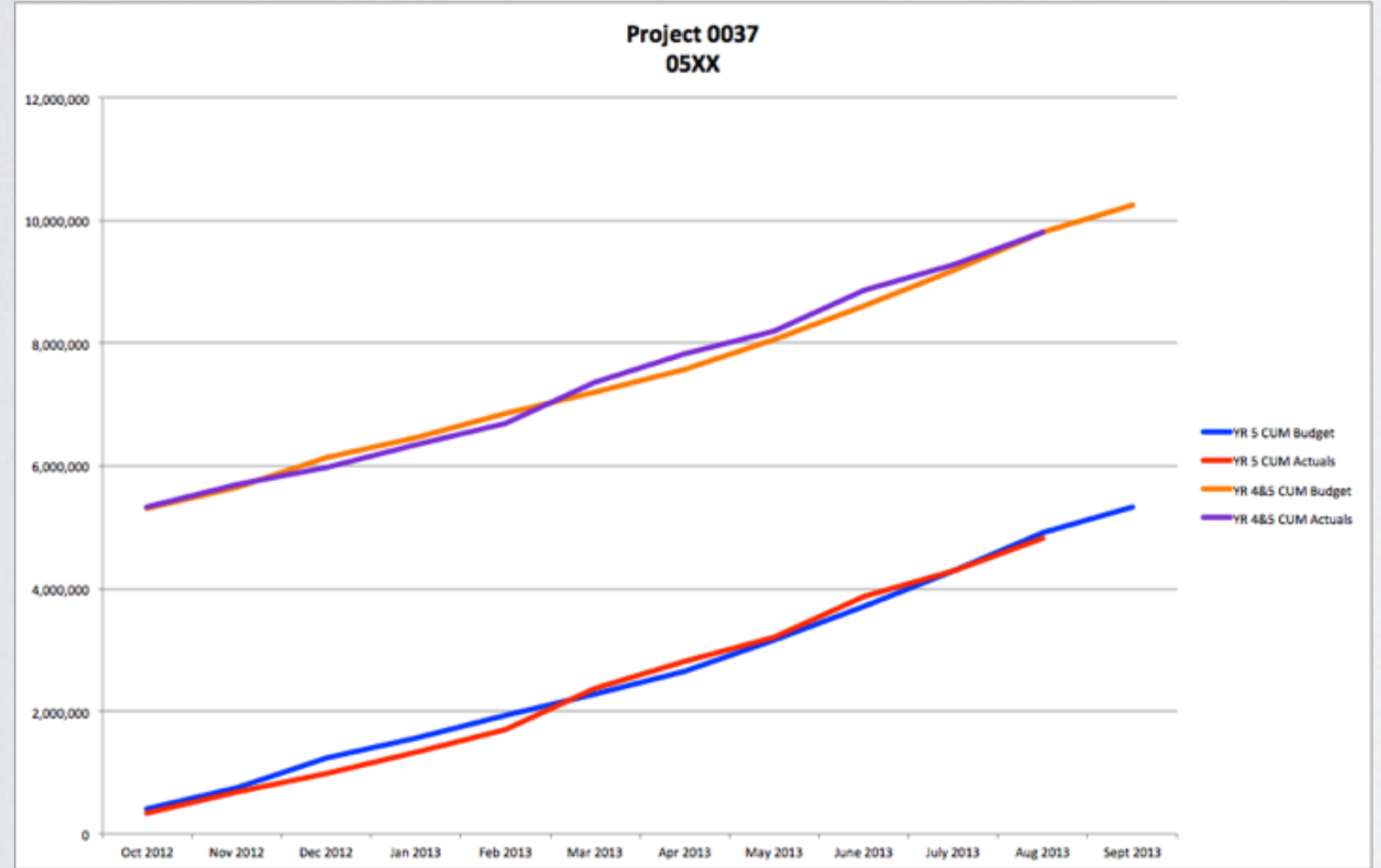
Beyond 2018



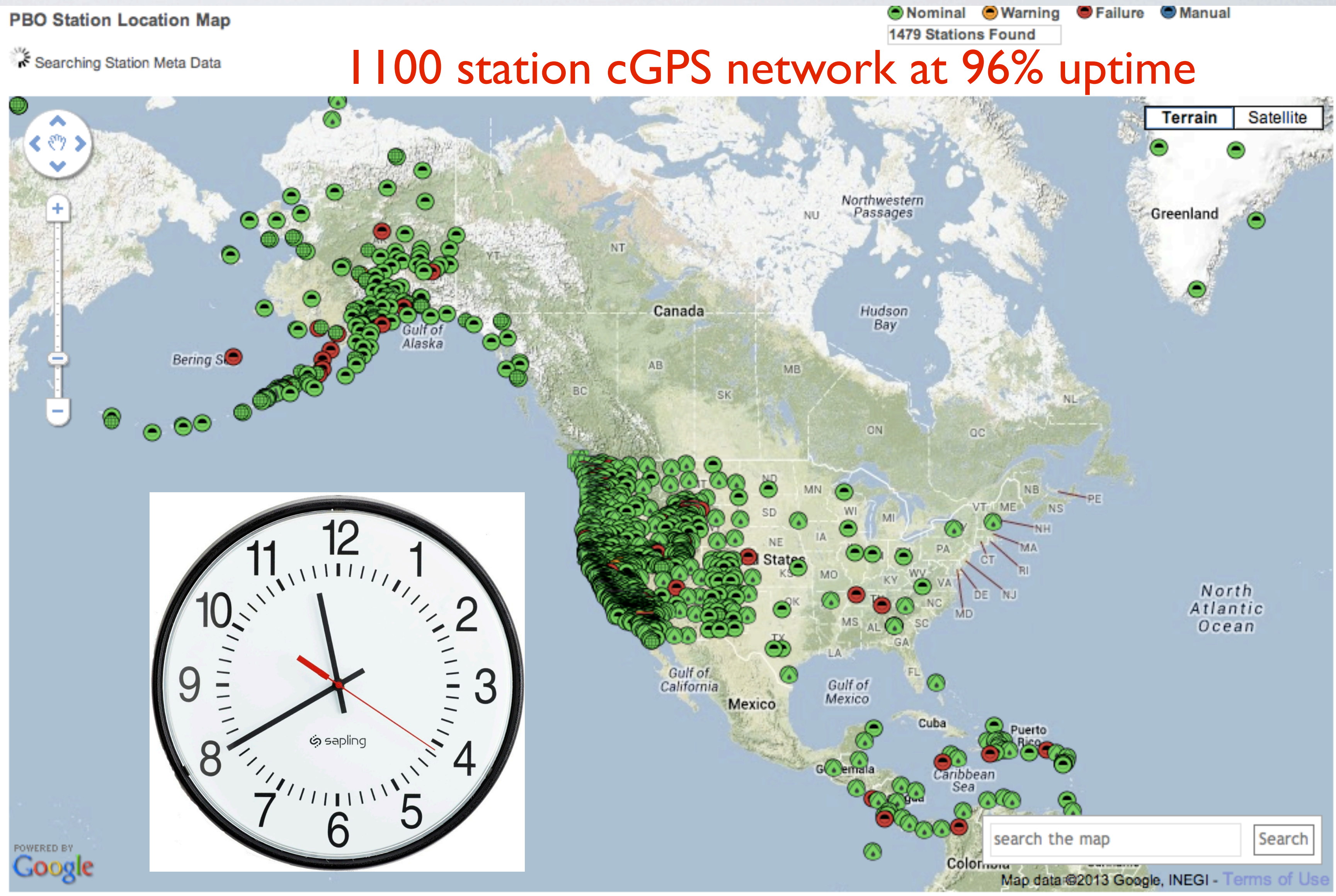
earth
scope

PLATE BOUNDARY OBSERVATORY

PBO FACILITY HIGHLIGHTS



PBO GPS Ops <0.07% variance



1100 station cGPS network at 96% uptime



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



- **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

P804
DDBM



P806
MAST



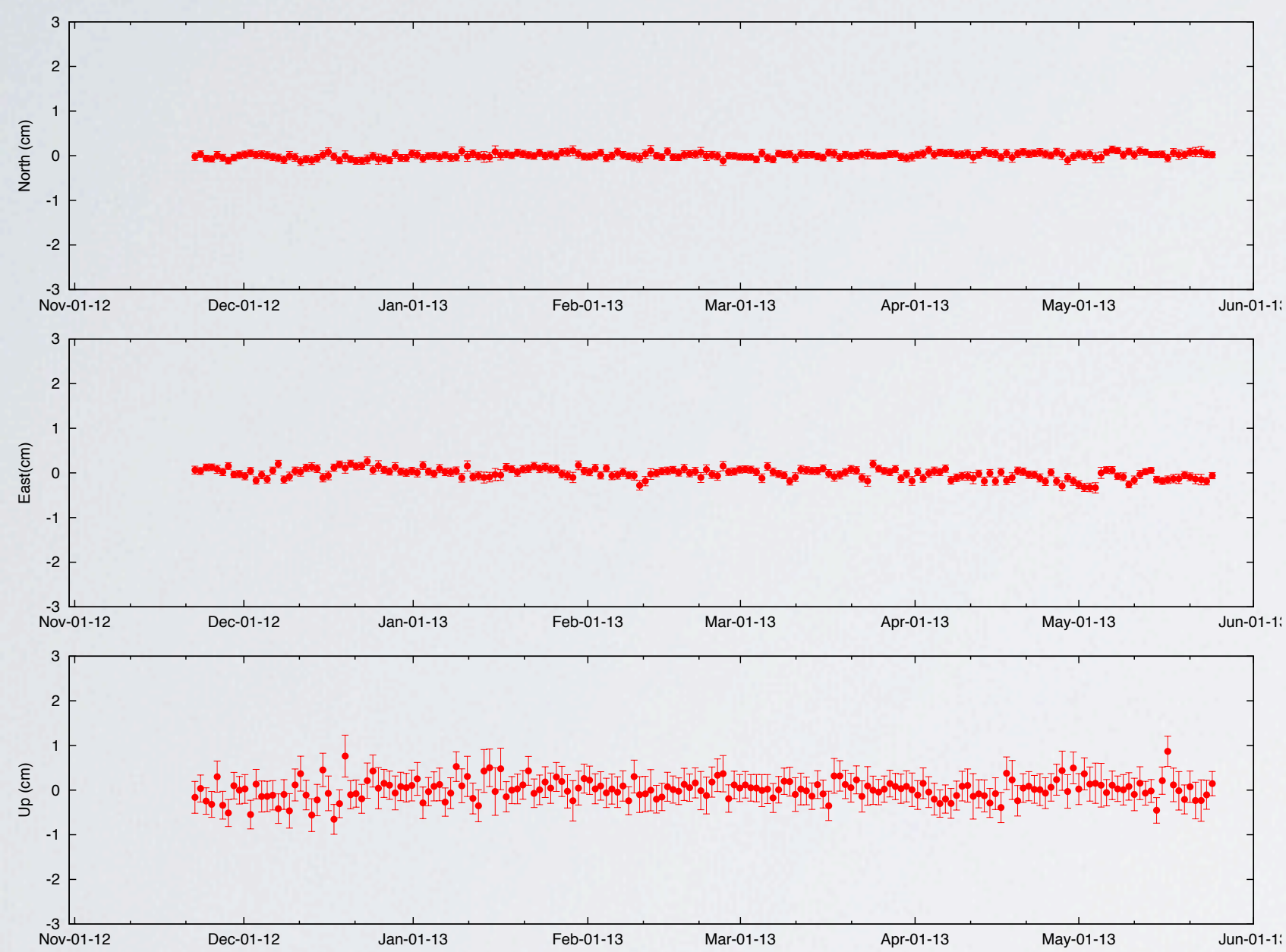
P805
SDBM



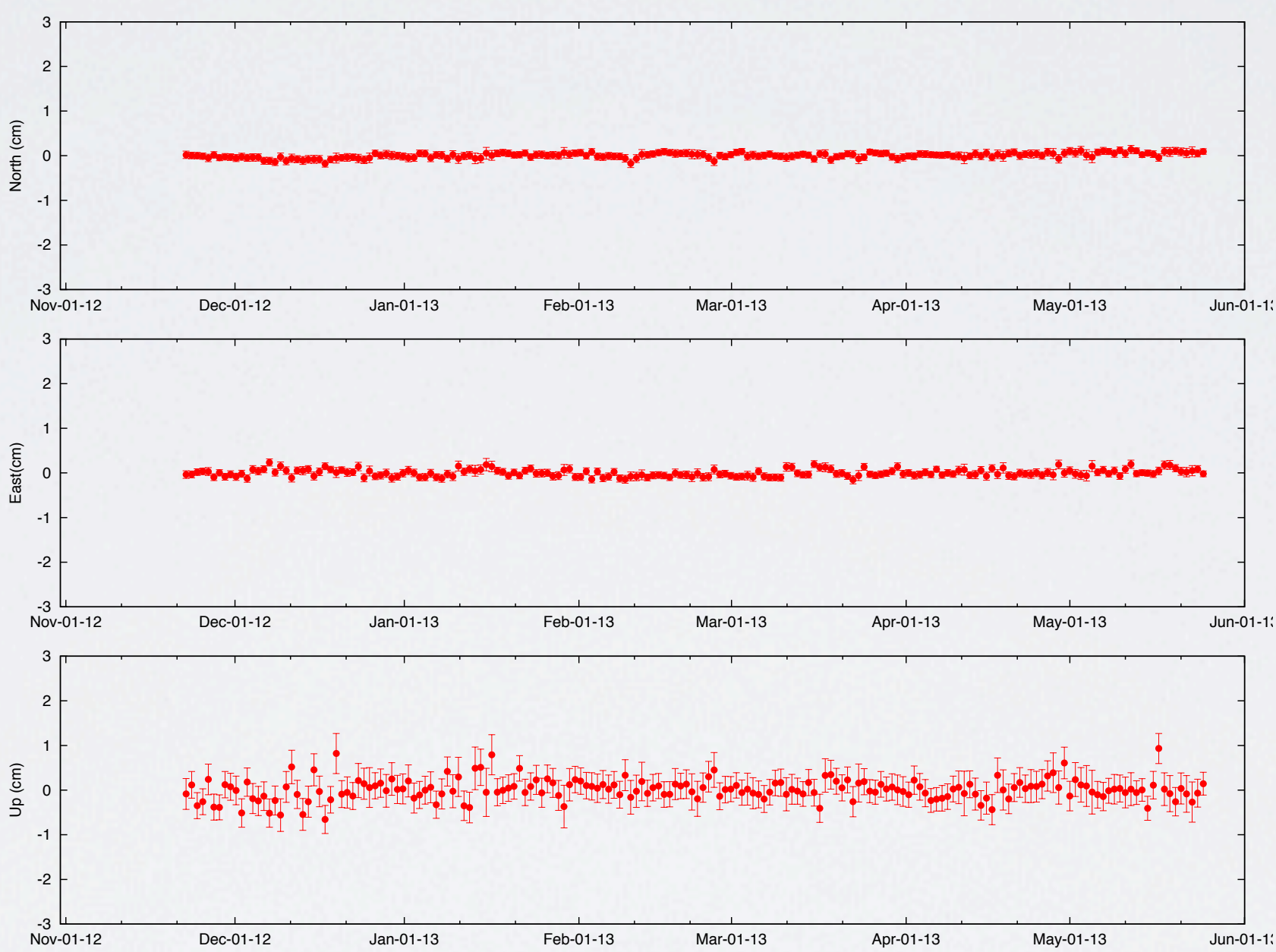


GAMIT TIME-SERIES

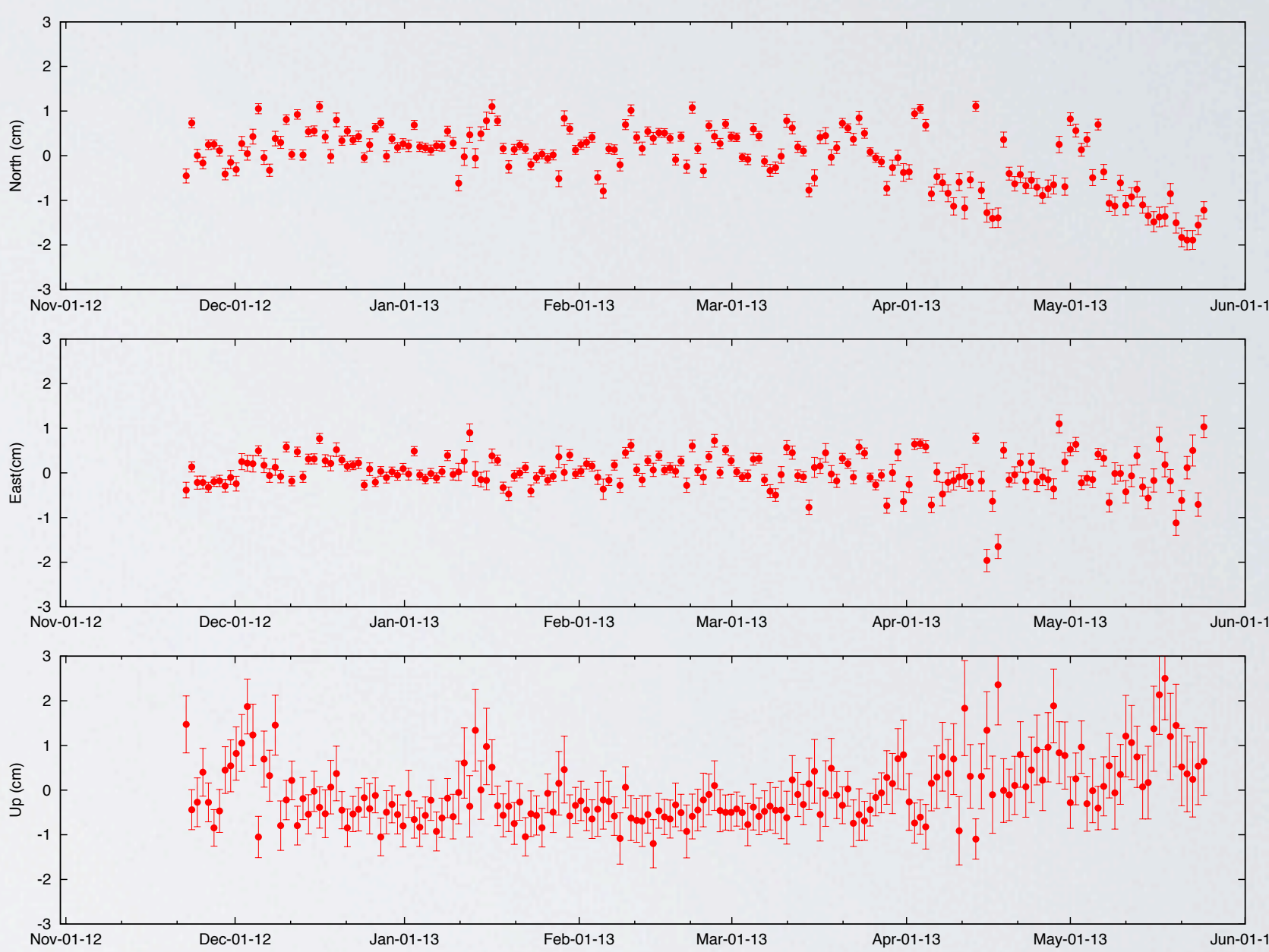
P804-DDBM



P805-SDBM

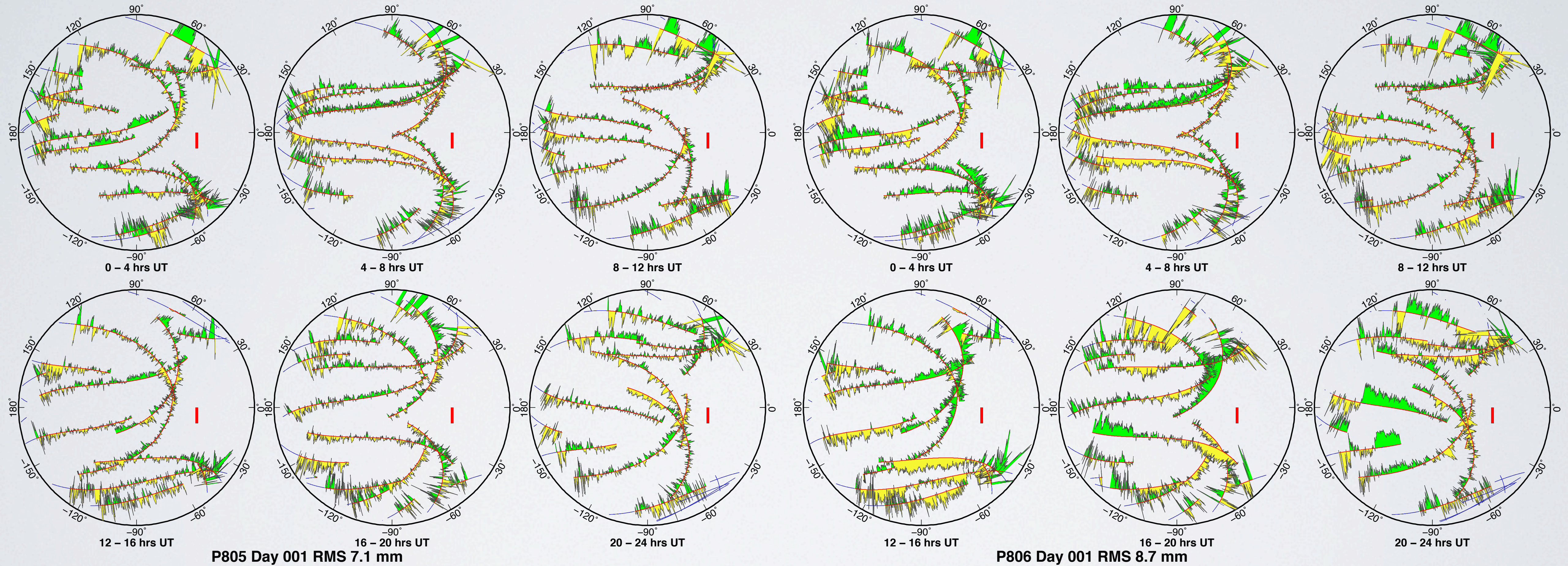


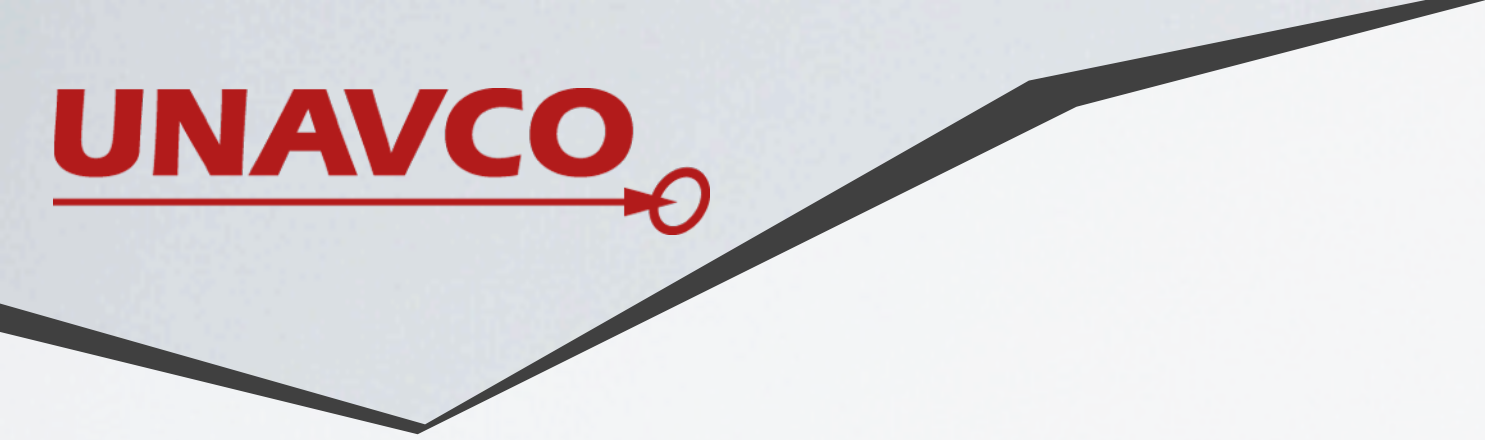
P806-MAST



P805

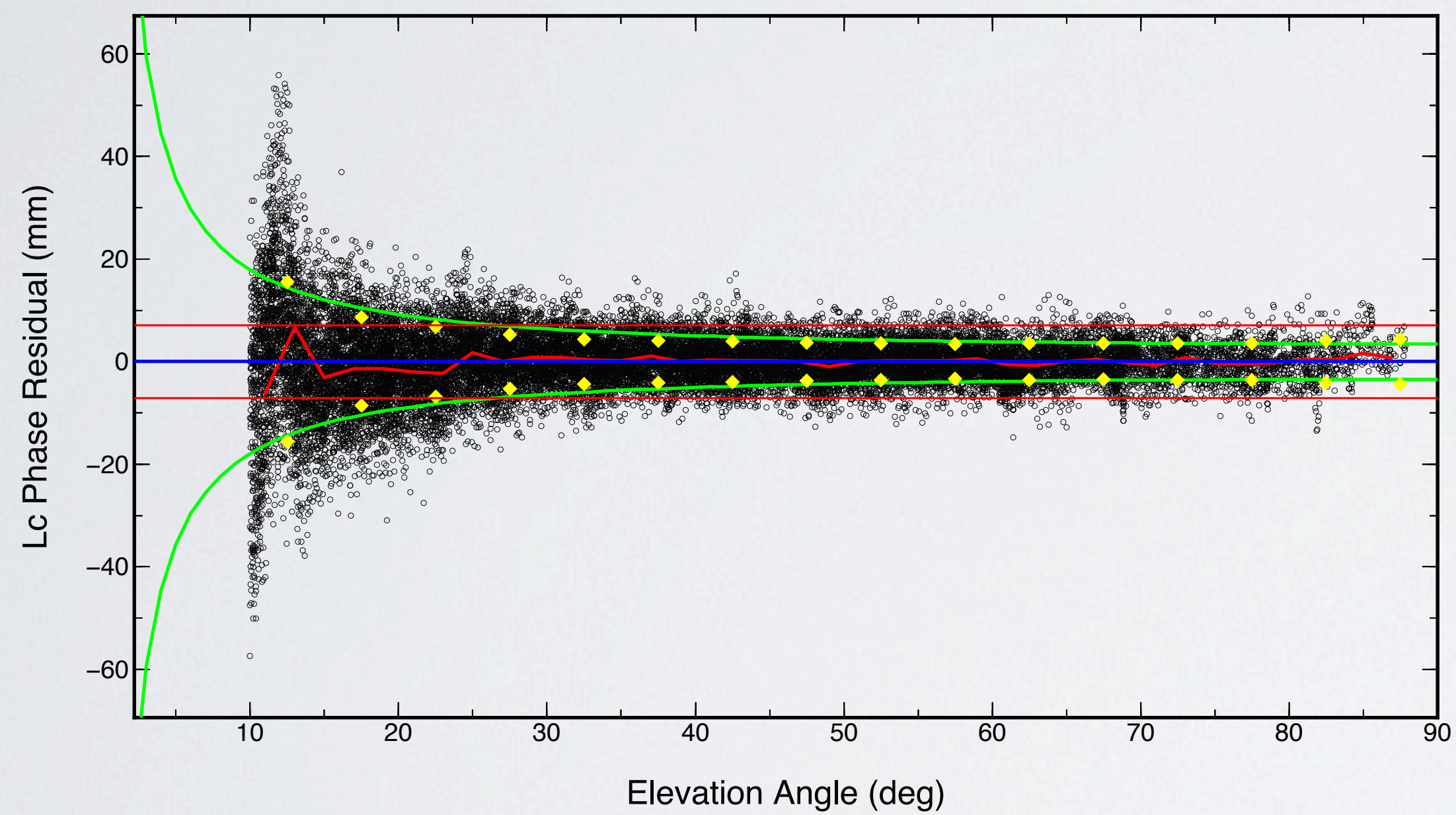
P806



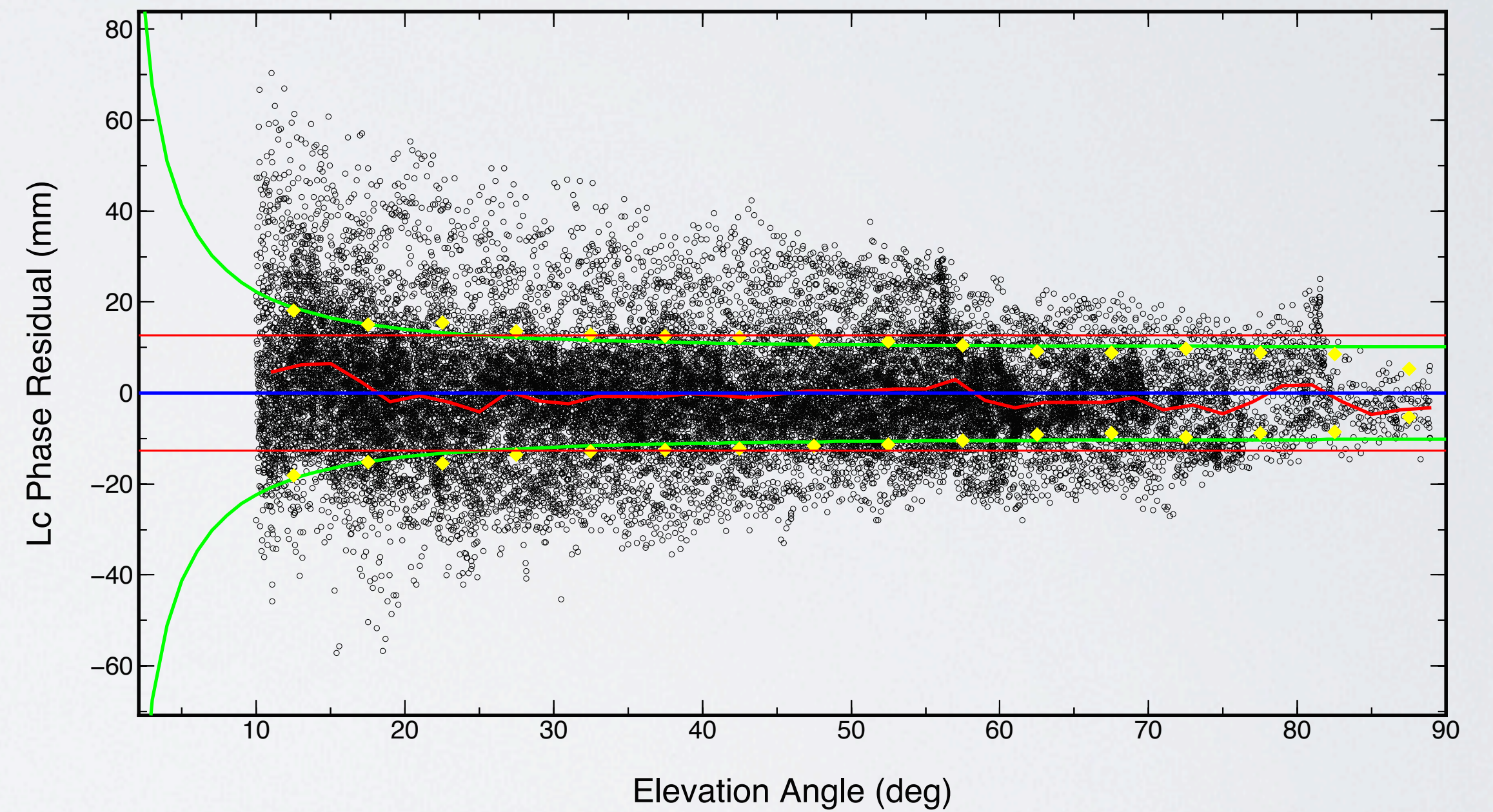


LC PHASE RESIDUALS

P805



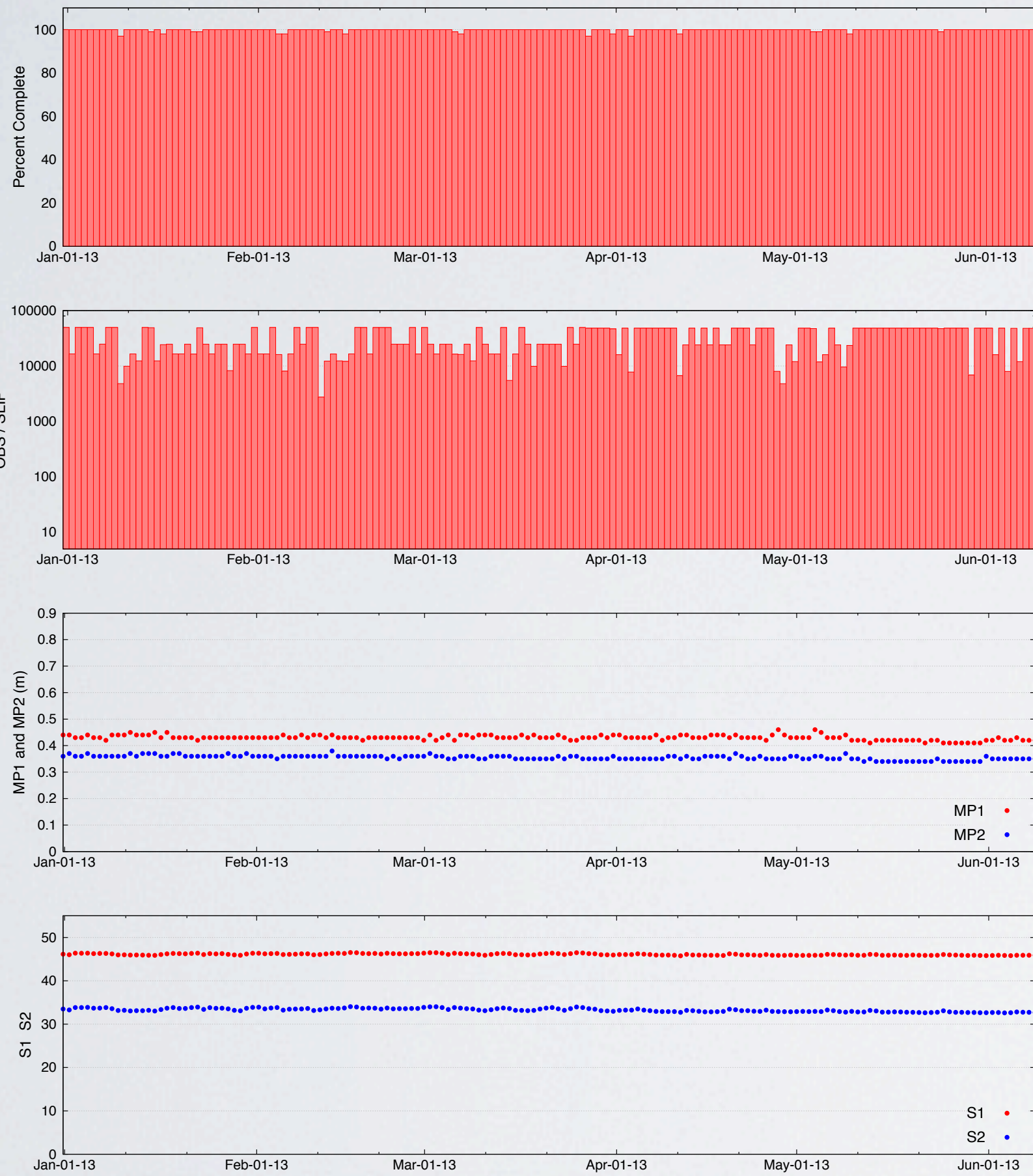
P806





QC RESULTS

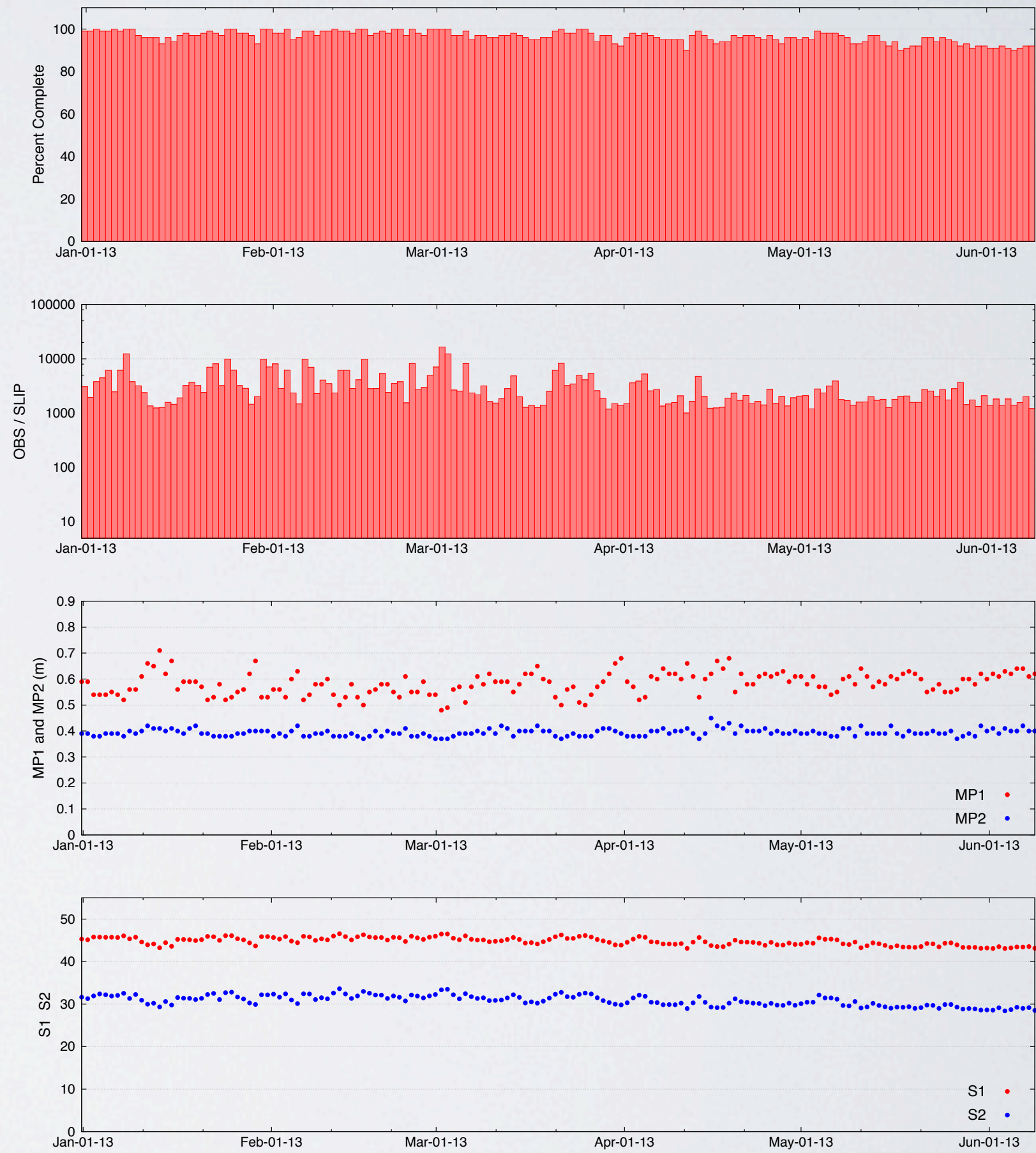
P804-DDBM



P805-SDBM



P806-MAST

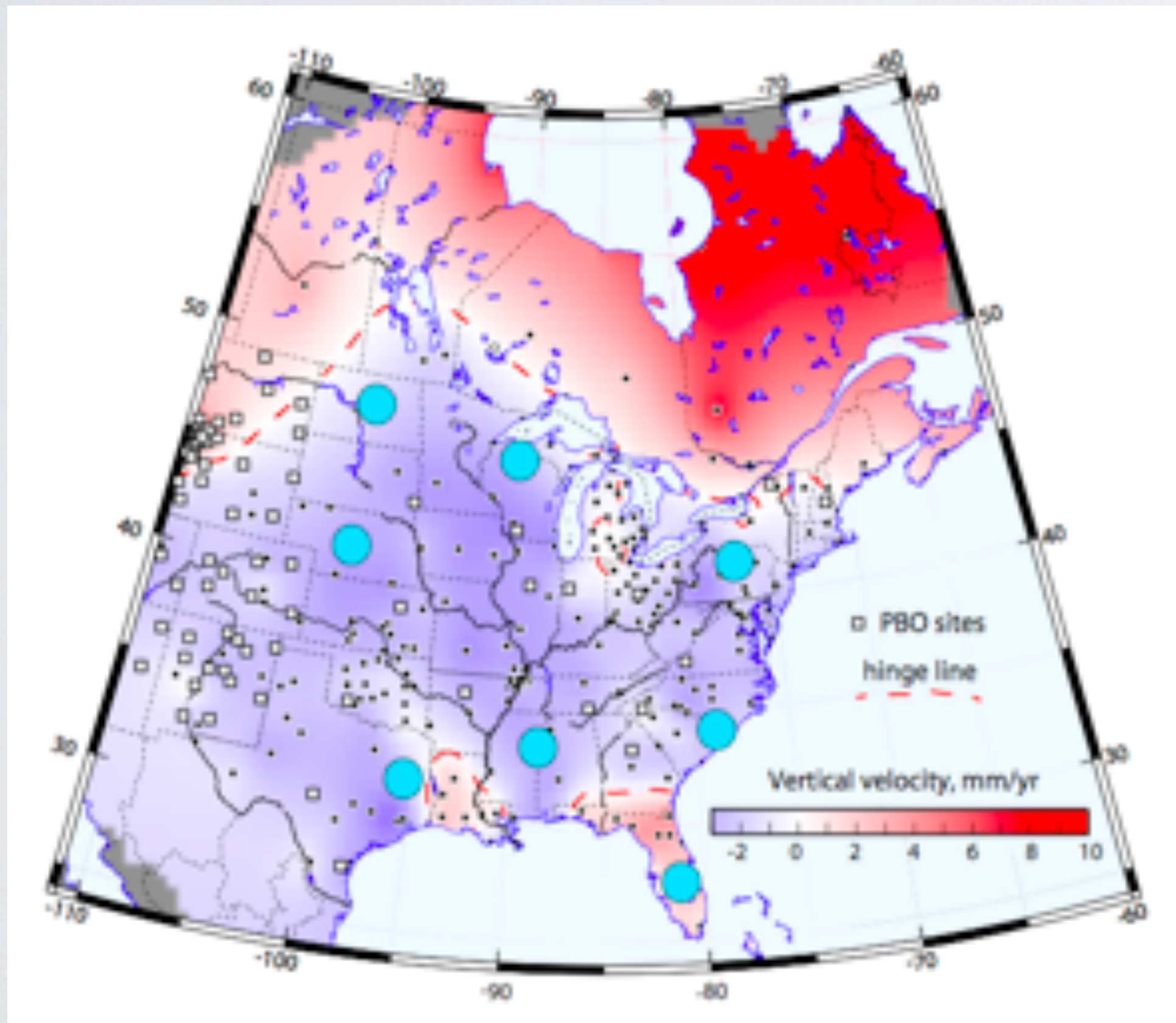


PBO FACILITY HIGHLIGHTS

- **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

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

- Upgraded 8 sites with new SIO MEMS accelerometer units
- **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

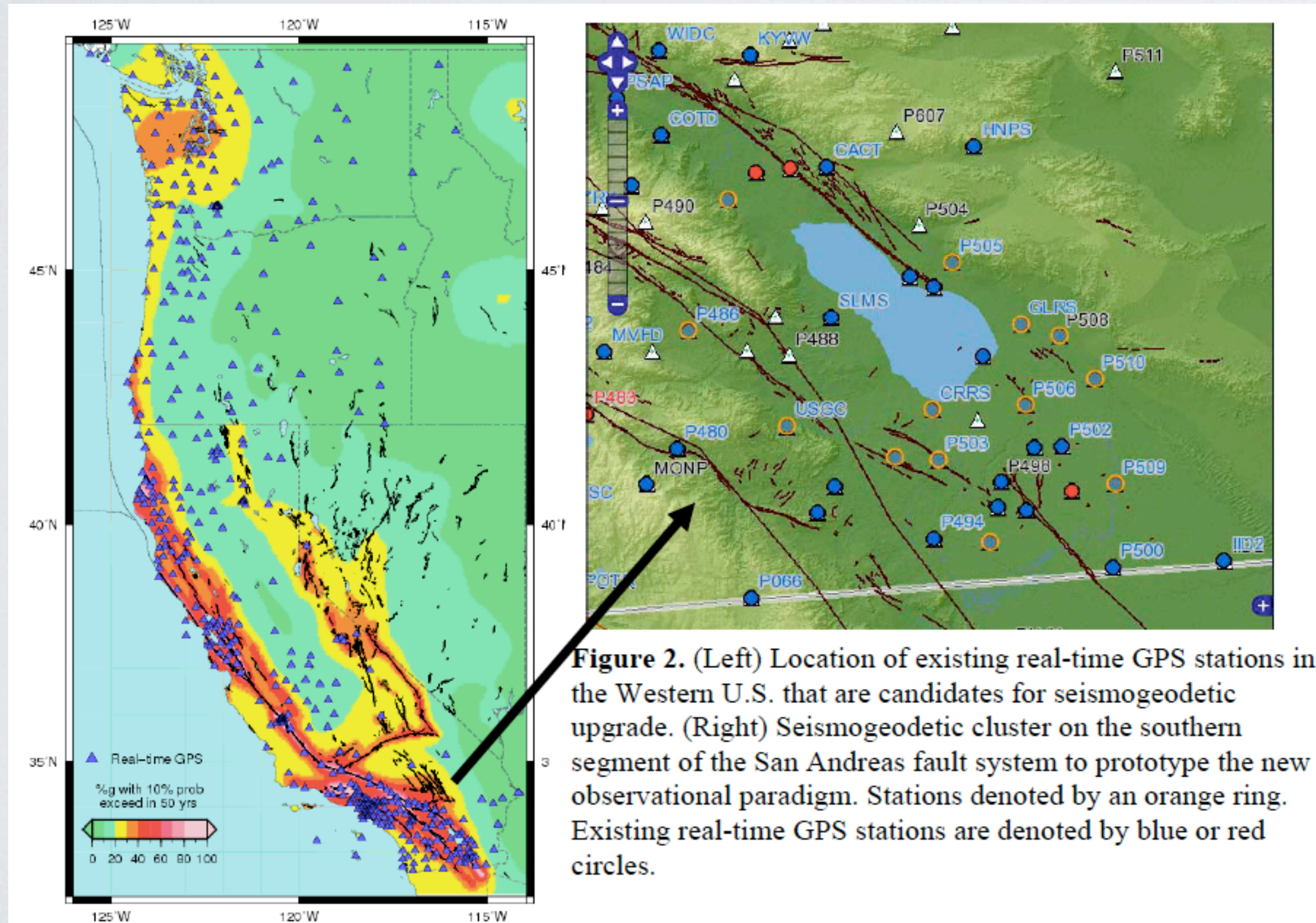
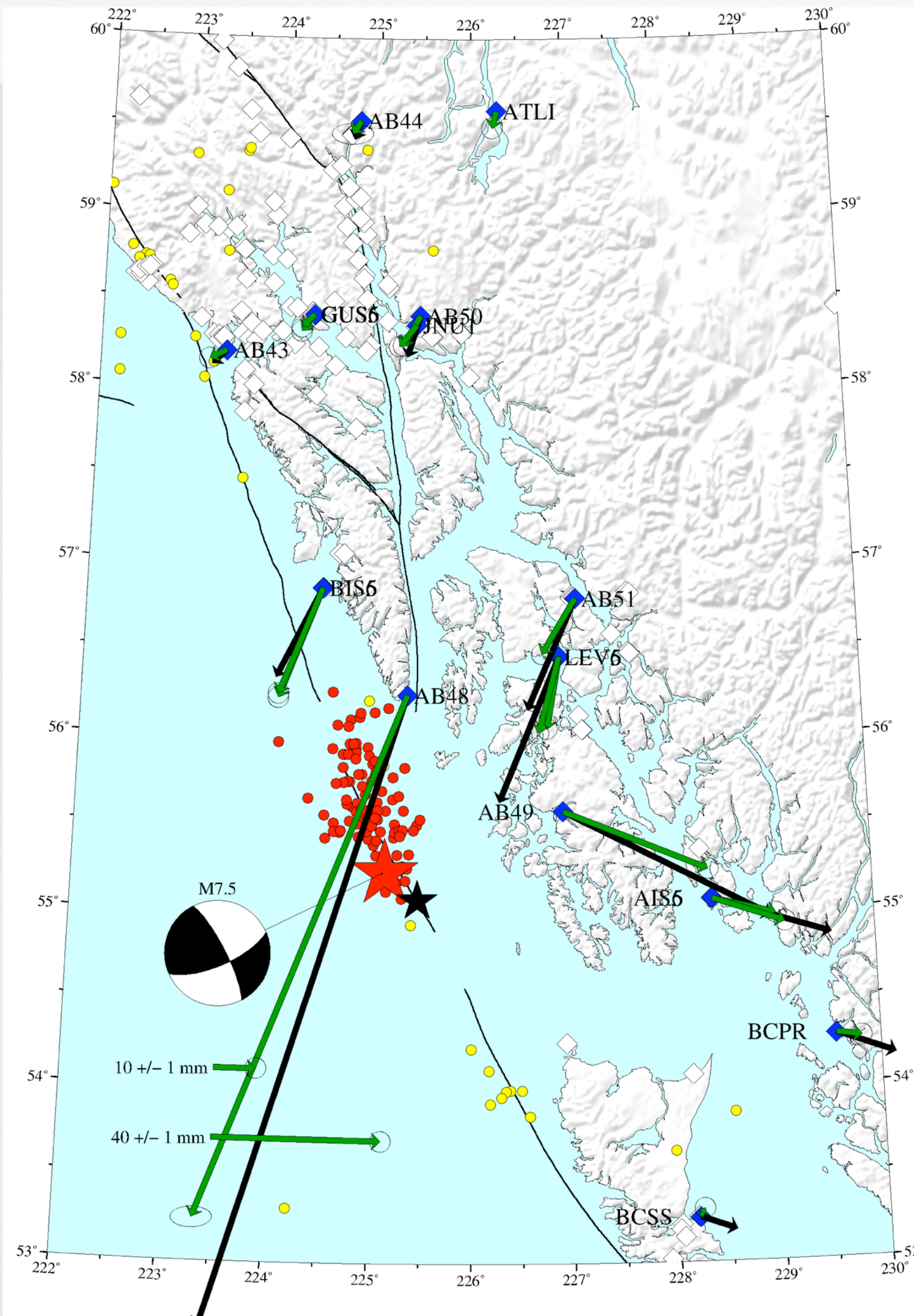


Figure 2. (Left) Location of existing real-time GPS stations in the Western U.S. that are candidates for seismogeodetic upgrade. (Right) Seismogeodetic cluster on the southern segment of the San Andreas fault system to prototype the new observational paradigm. Stations denoted by an orange ring. Existing real-time GPS stations are denoted by blue or red circles.



PBO EVENT RESPONSE

PBO cGPS processing and figure from J. Freymueller, UAF compared with finite fault model based on teleseismic waveform data by G. Hayes, USGS



• **M7.5 Craig, Alaska, 2013-01-05**

- Event response forum and web page
- Coordination between UNAVCO and ACC/AC's
- Issue: ~3-day data outage at nearby site AB48 after EQ; will affect offset calculations by ACC
- 1 Hz, 5 Hz data from PBO sites
 - 76 stations @ 5Hz on DOY 005 (24GB)
 - 107 stations @ 1Hz on DOY's 001-008 (25GB)

• **M7.8 Masset (Haida Gwaii), Canada, 2012-10-08**

- 1 Hz, 5 Hz data from PBO sites

• **Notes on 5 Hz data**

- 5Hz data for "entire PBO network" Initially requested by PI's; subsequently reduced to ~1000 km radius in both events
- Large scale 5Hz data downloads depend upon, and have impacts on, comms, data curation, etc.
- UNAVCO anticipates that 5Hz data requests will become increasingly common. We are therefore re-evaluating our current event response procedures to meet evolving community expectations. We are developing a formal 5Hz data support and management plan.

Loss of staff in GAGE will impact Event Response

GEOPENTECH - EDISON PROJECT

Project Goals:

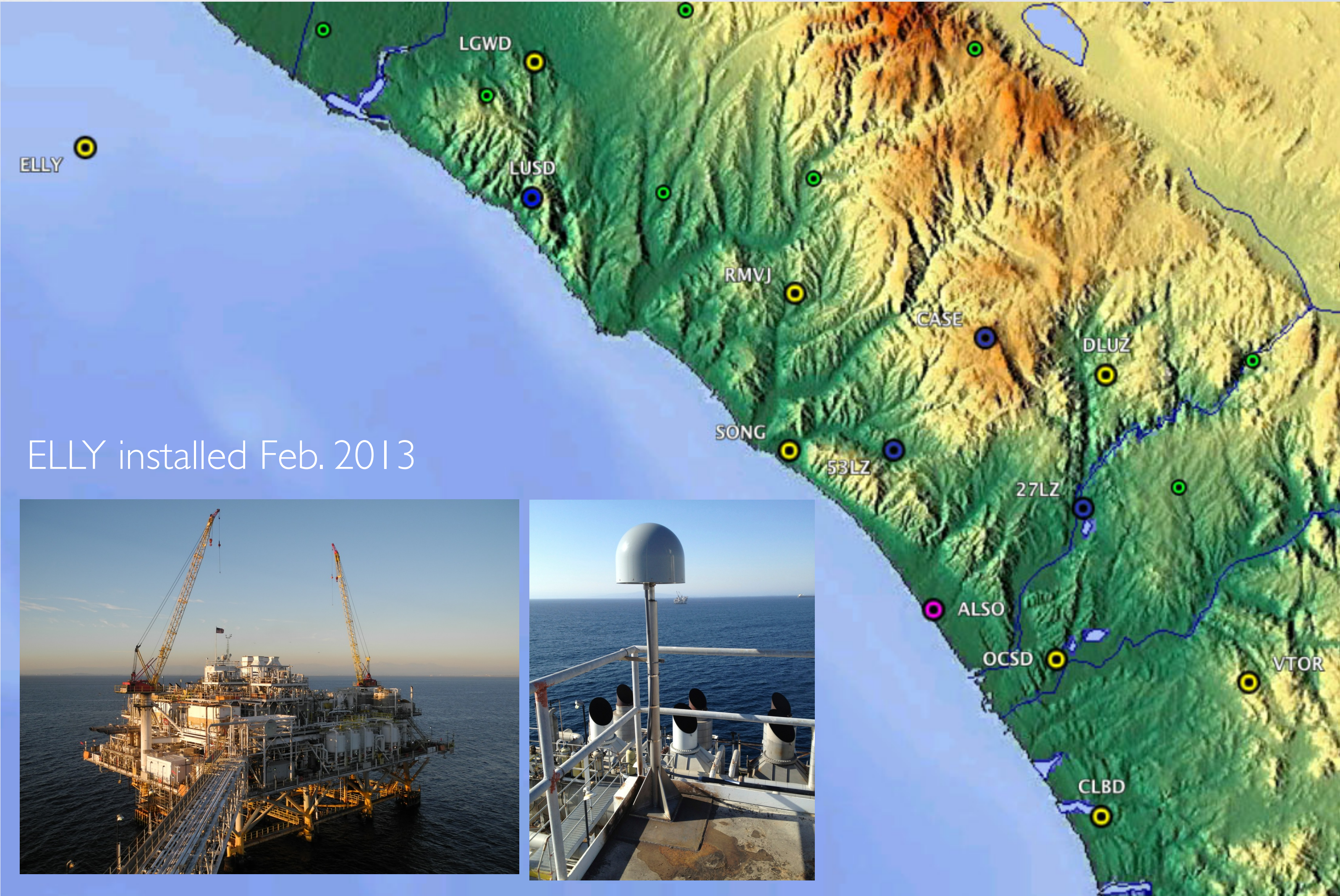
- SONGS Seismic Source Characterization and Seismic Hazards Analysis
- Densify PBO network in Southern California
- UNAVCO to build 12-13 new stations in the region
- Construction: 2 Phases, 5 years of O&M - \$1.5M project

Progress to Date:

- Reconnaissance, permitting, and installation of 8 GPS stations completed (yellow dots) and streaming low-latency, high-rate GPS
- 4 permits in-process (blue dots)

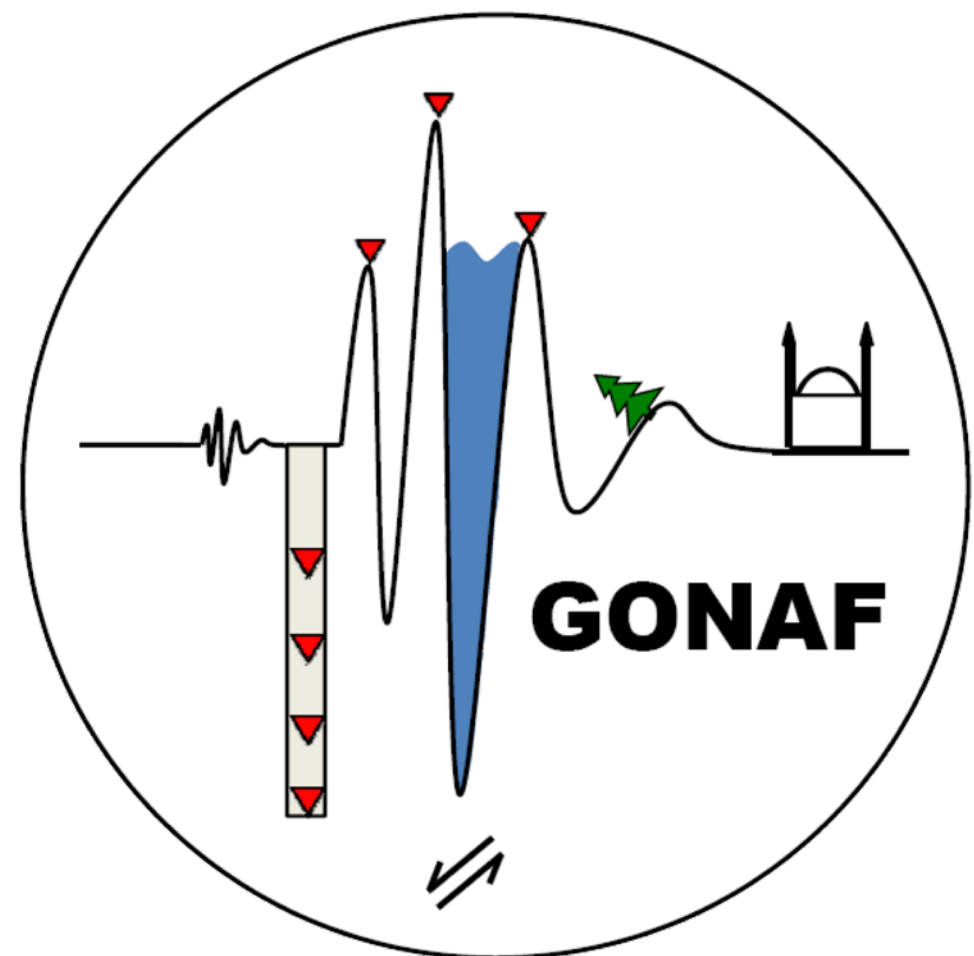
Project Status Change:

- SONGS Facility scheduled for shutdown; project will continue as planned



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

GeoGONAF



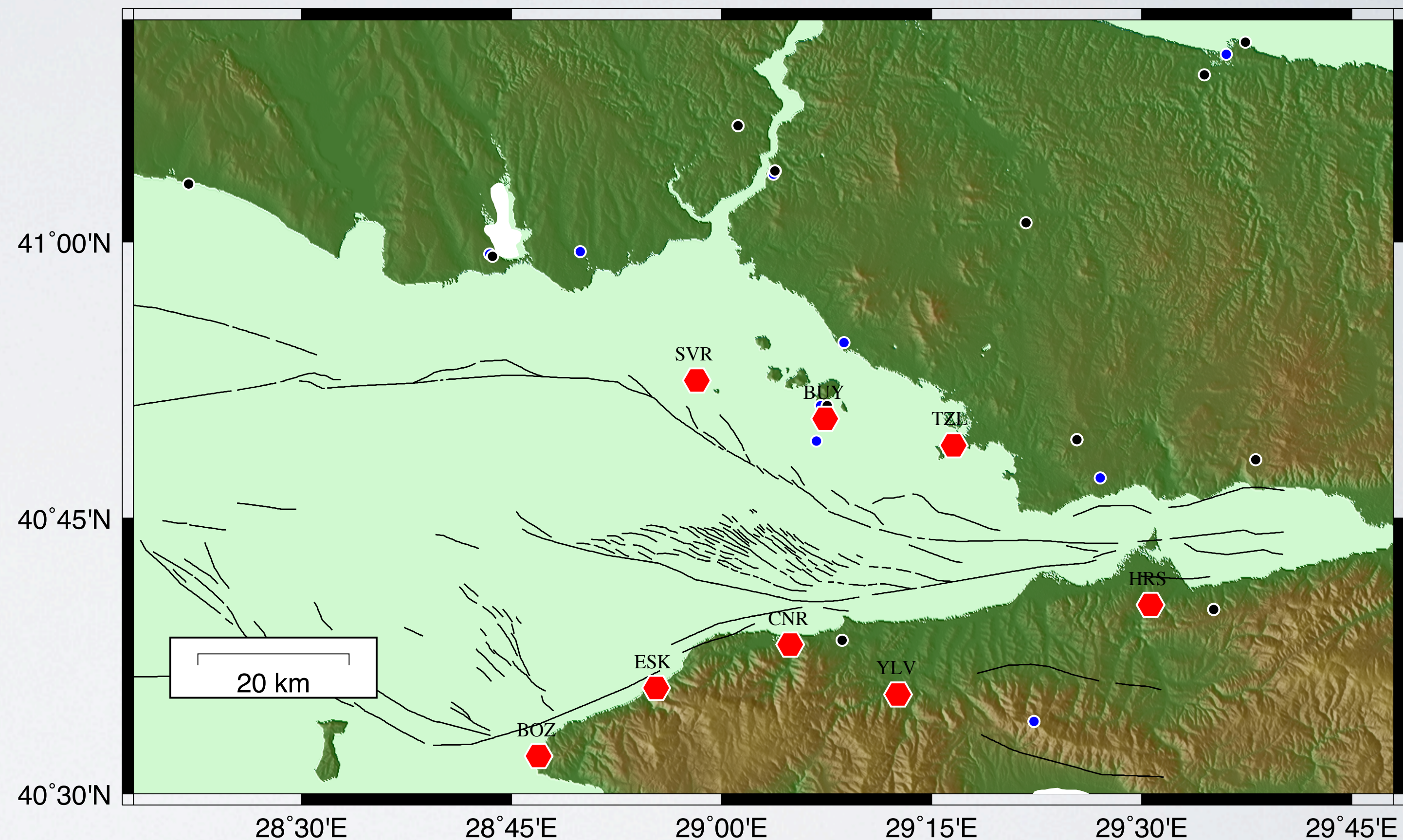
GFZ
Helmholtz Centre
POTSDAM

AFAD



MIT

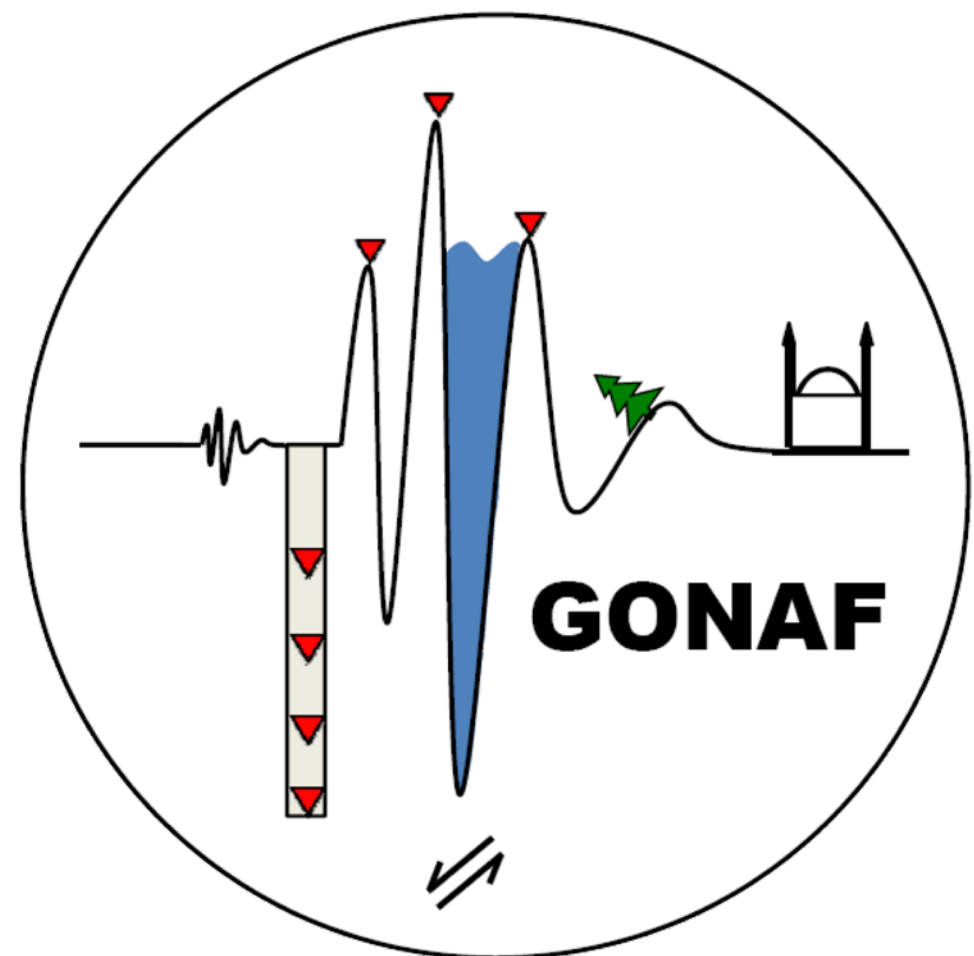
- GFZ (German)
- AFAD (Turkey)
- Kandili University (Turkey)
- Bosphorus University (Turkey)
- University of Colorado (USA)
- MIT (USA)
- UNAVCO (USA)



As part of GeoGONAF, **UNAVCO** will install **three BSM instruments** (from ES pool) at the red dots (both primary and alternate sites shown)

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

GeoGONAF



GFZ
Helmholtz Centre
POTSDAM

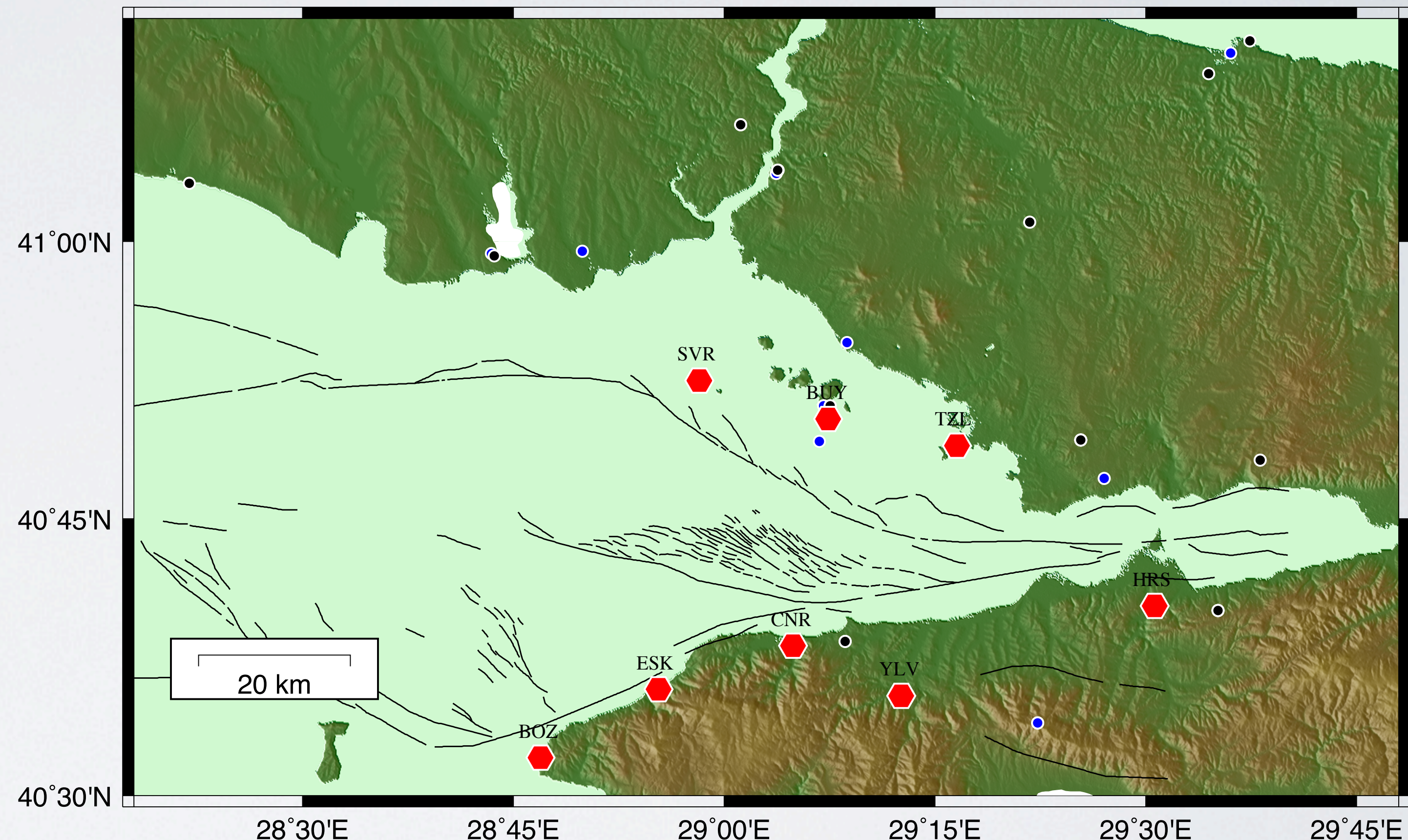
AFAD



MIT

- GFZ (German)
- AFAD (Turkey)
- Kandili University (Turkey)
- Bosphorus University (Turkey)
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- MIT (USA)
- UNAVCO (USA)

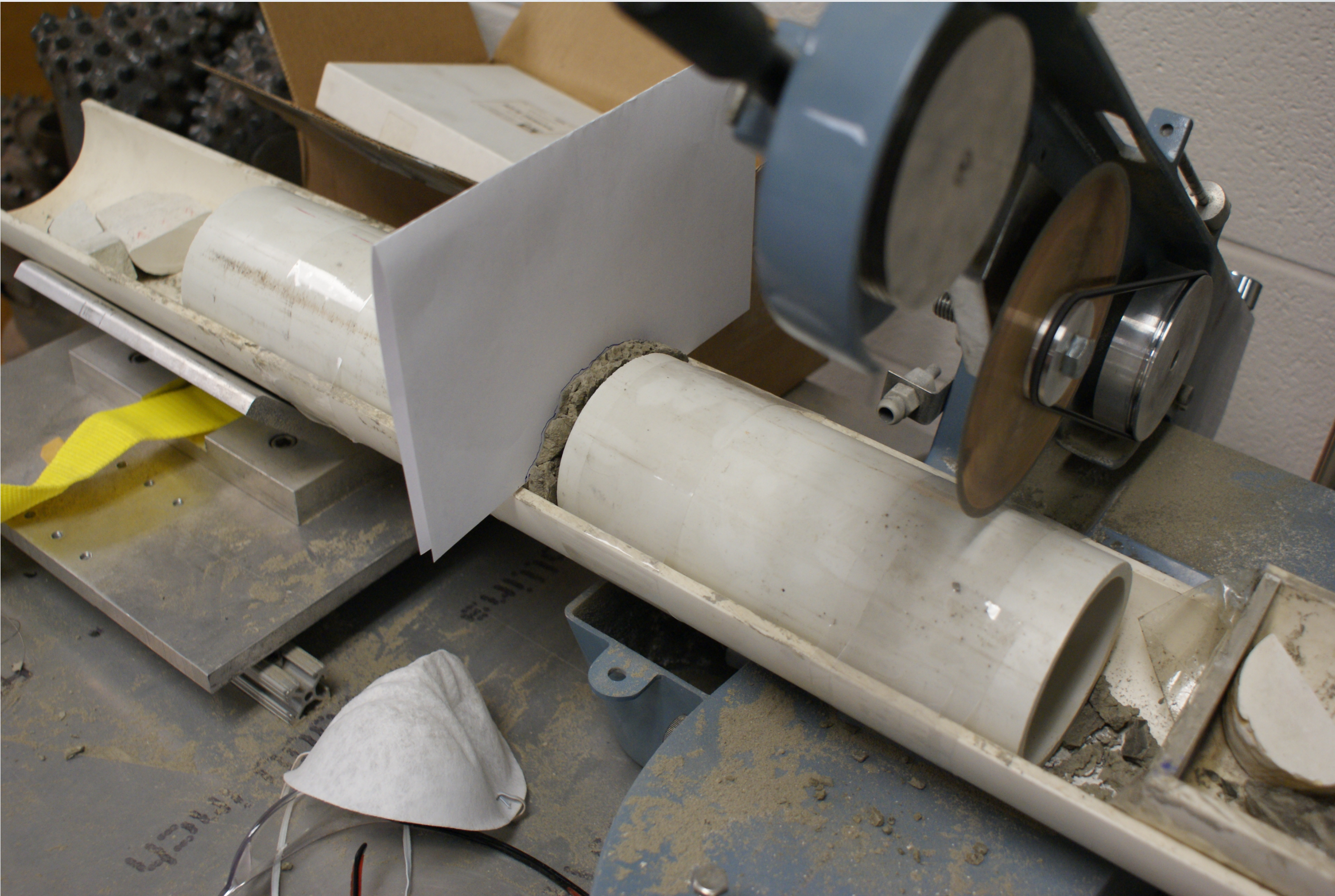
Project on hold due to partial government shutdown



As part of GeoGONAF, **UNAVCO** will install **three BSM instruments** (from ES pool) at the red dots (both primary and alternate sites shown)

SAFOD UPDATE

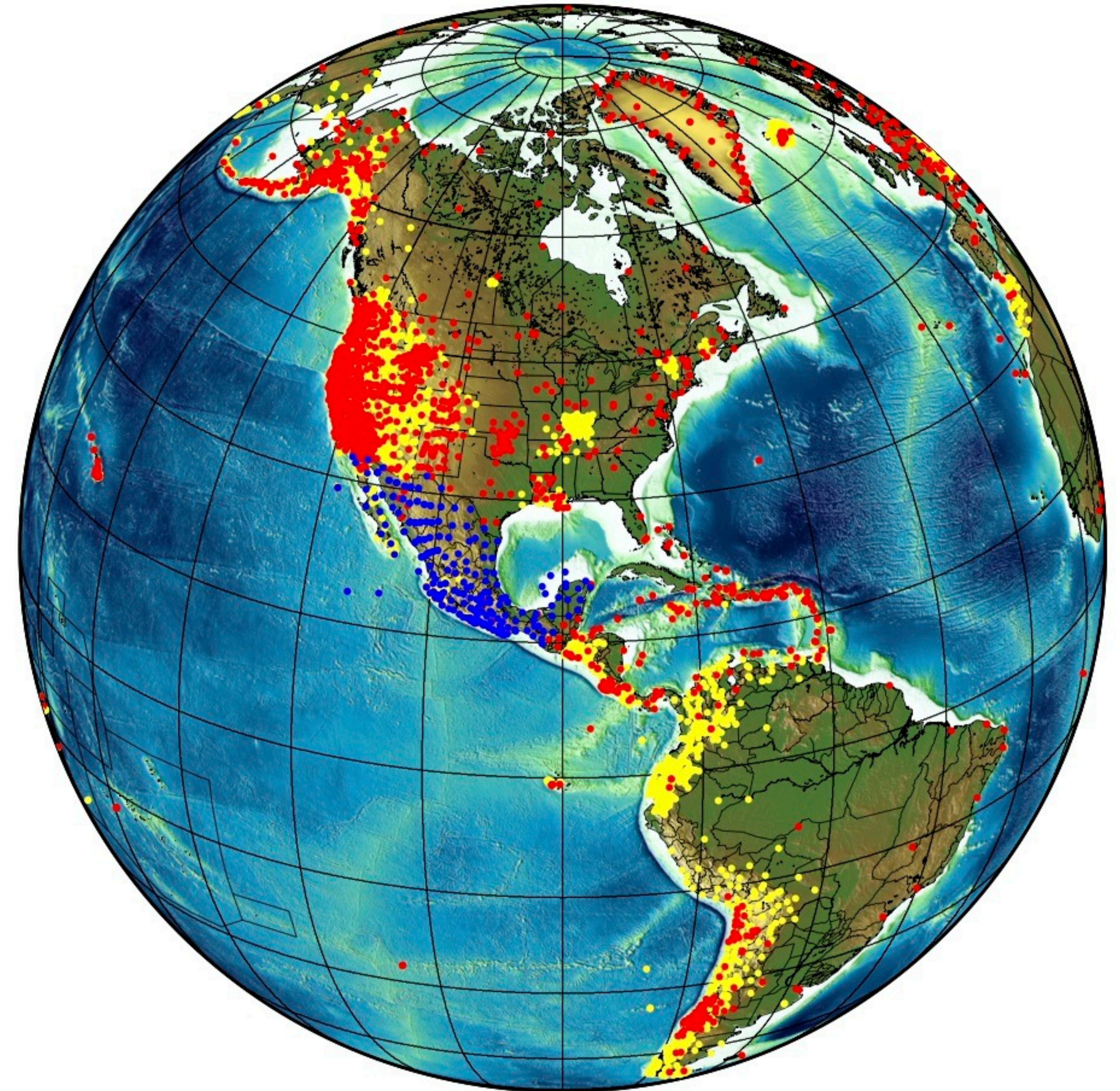
- Current status of SAFOD main hole: Data continues to be collected from vertical laser strainmeter. The USGS has been recording data from a three component passive seismometer. Current status unknown due to government shutdown
- UNAVCO will continue to manage the SAFOD main hole until the end of the no-cost extension or a new management office is designated.
- Fourth round of core solicitation: UNAVCO had anticipated completing the Fourth round solicitation process by September 30th 2013. Due to problems with the core viewer the Sample Selection Committee work has been delayed. We anticipate this work will be completed by Nov 15th, 2013.
- SAFOD core management: Texas A&M has been designated the new management office for SAFOD core operations starting Oct 1, 2013. The core viewer software has been transferred to Texas A&M University as of Oct 1st, 2013. UNAVCO has extended the TAMU subaward until Dec 31st, 2013 to allow a smooth transition from the sub-award to TAMU fully managing SAFOD core operations.



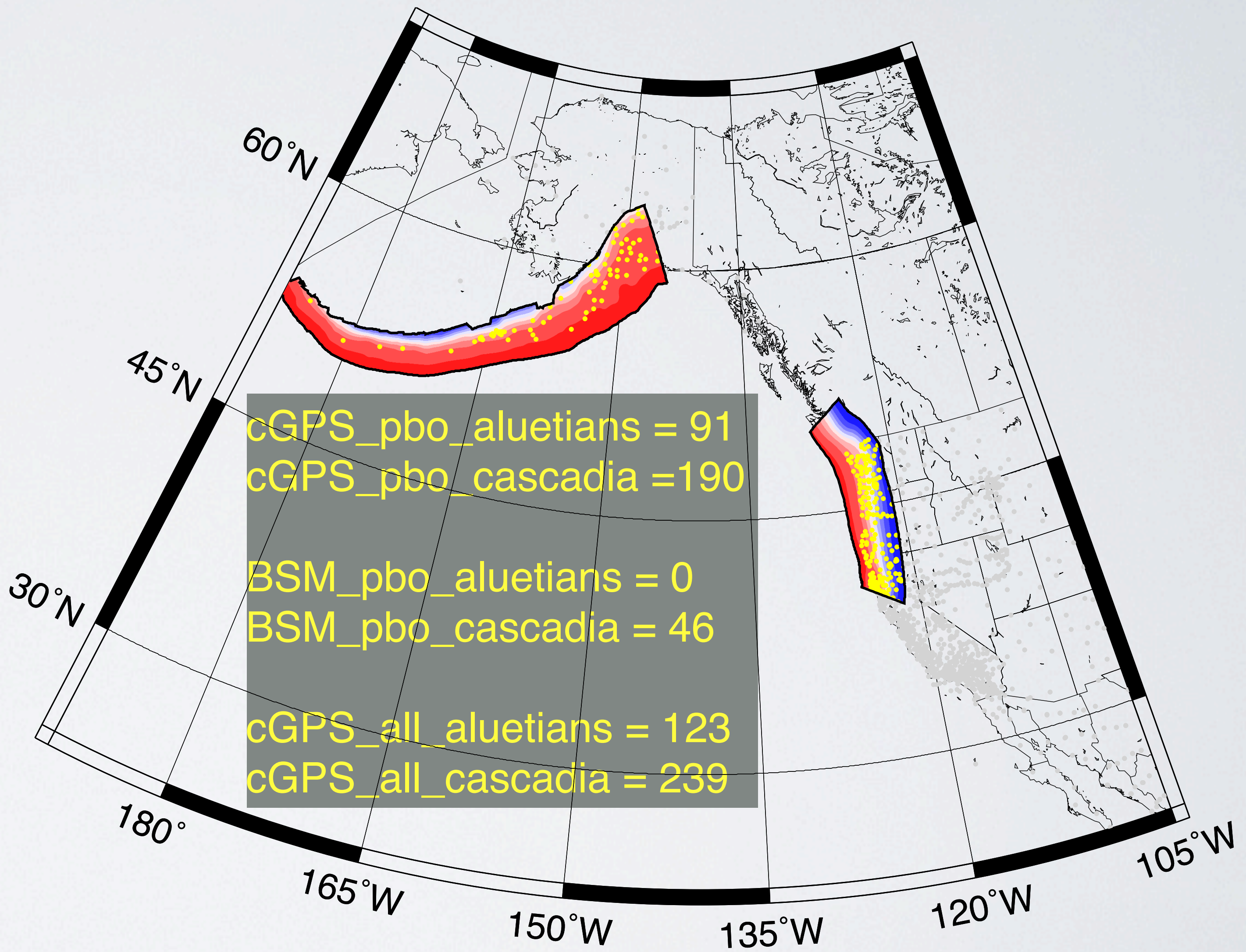
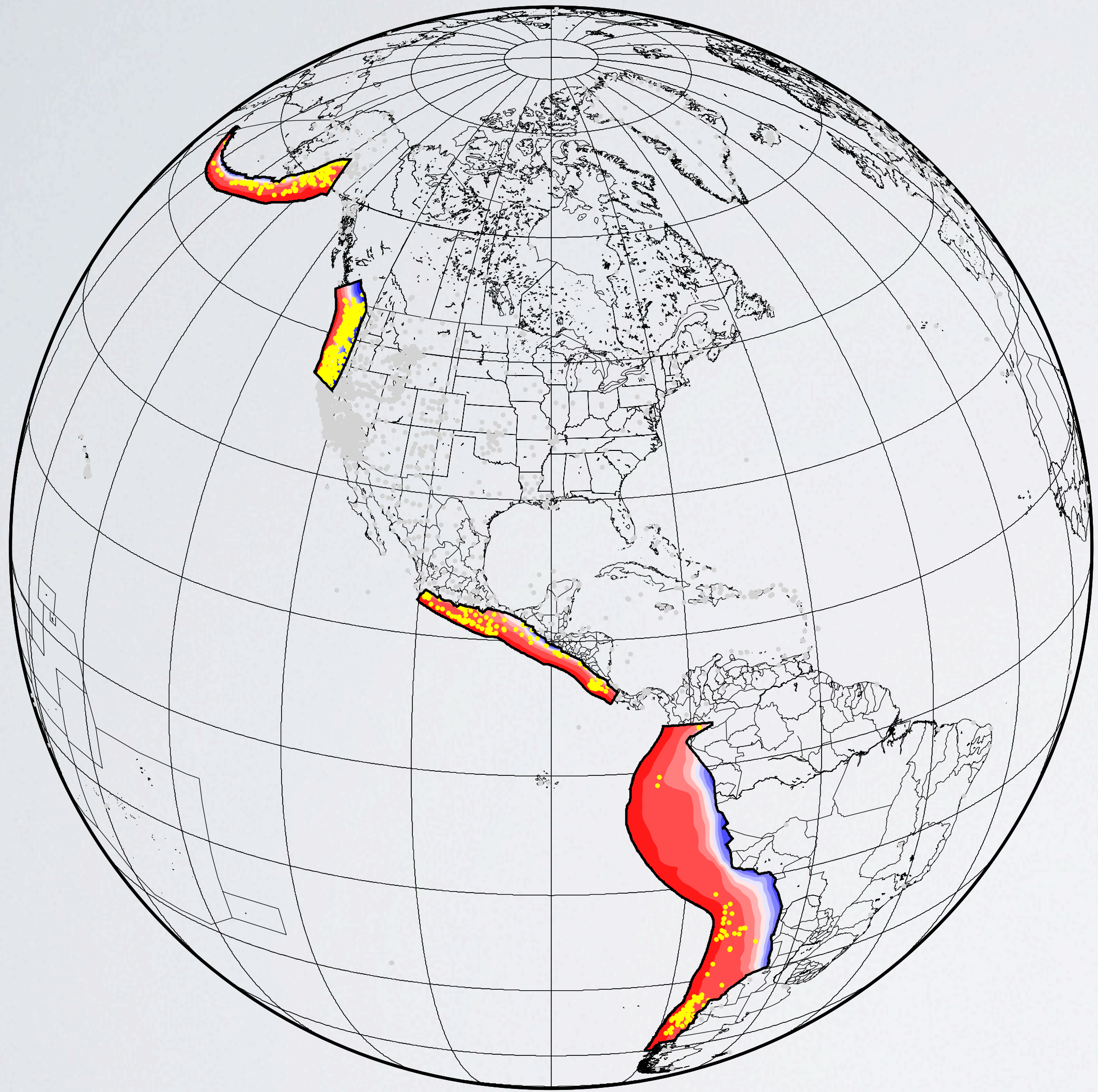
Simulated SAFOD Core cuts

A Global Network of Geodetic Networks

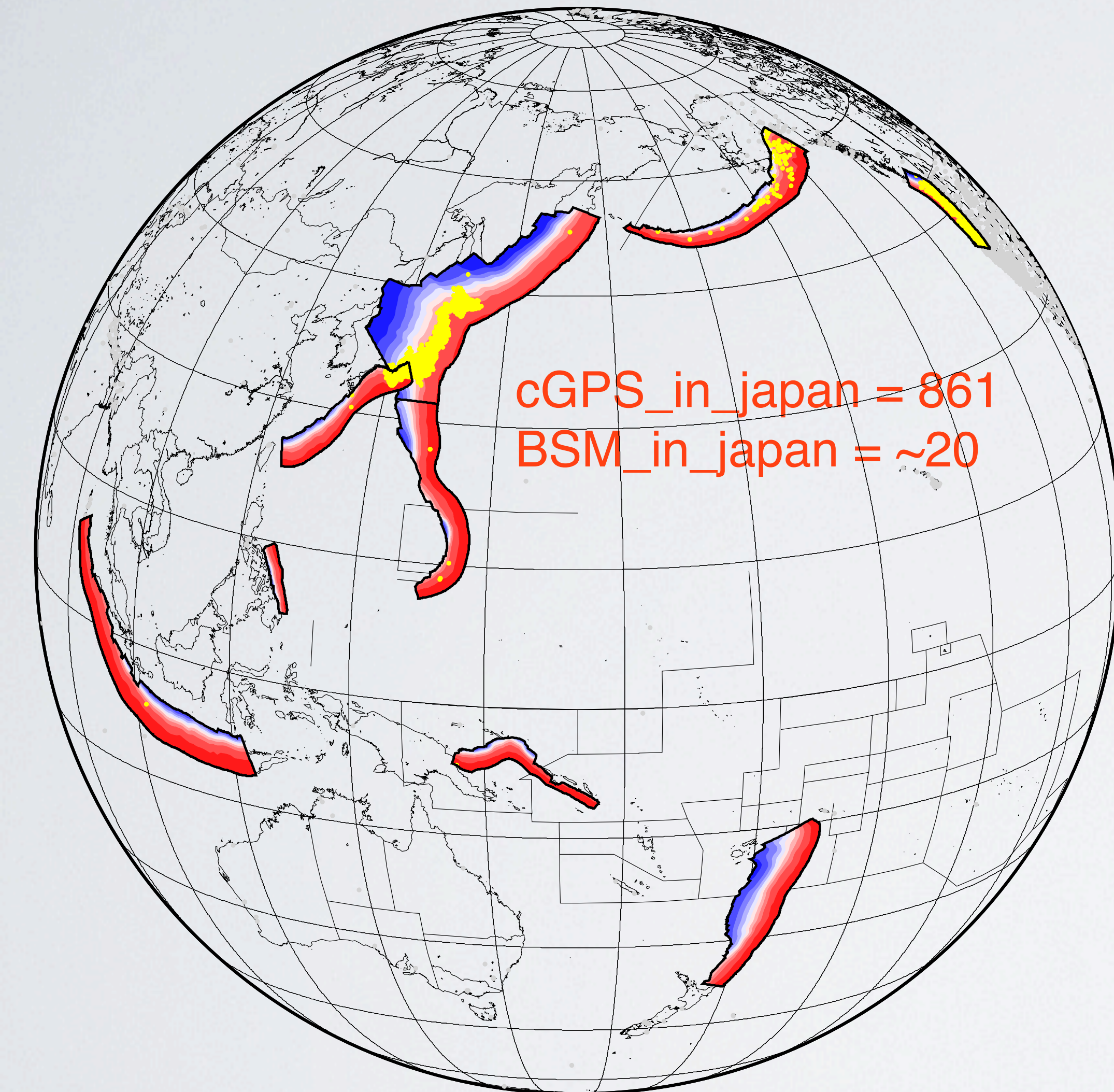
- Interdisciplinary & international leverage for multi-hazards observatories
- Proliferation of geodetic monumentation in multi-purpose networks
- International federations linking networks across borders
- Disseminated archives for shared capacity
- Provide leadership for the “Next Big Thing”



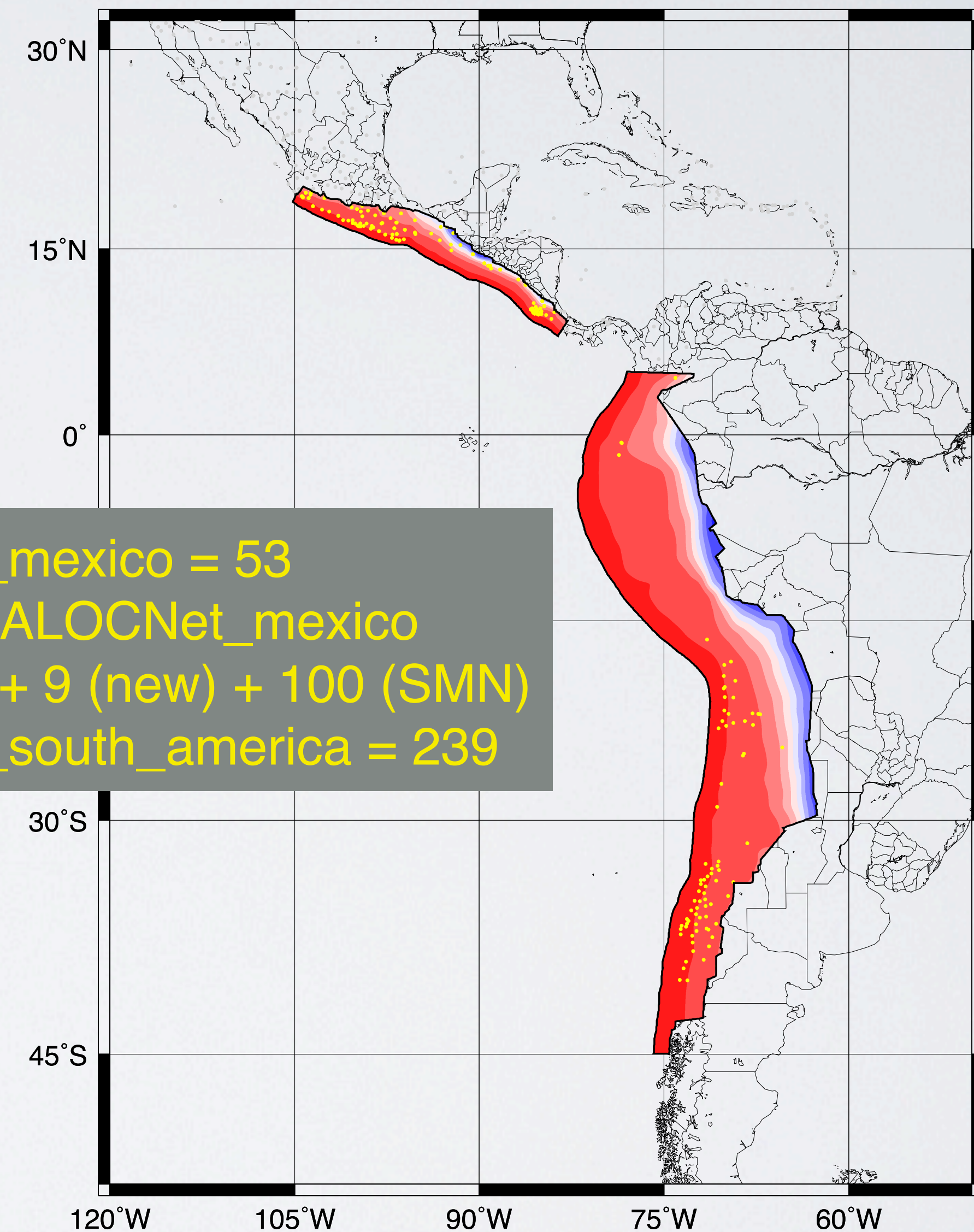
PBO+COCONET+TLALOCNET: A NUCLEUS FOR A NETWORK OF GEODETIC NETWORKS ALONG WESTERN NAM - SUBDUCTION ZONE OBSERVATORY



PBO+COCONET+TLALOCNET: A NUCLEUS FOR A NETWORK OF GEODETIC NETWORKS ALONG WESTERN NAM - SUBDUCTION ZONE OBSERVATORY



cGPS_in_mexico = 53
cGPS_TLALOCNet_mexico
= 29 (up) + 9 (new) + 100 (SMN)
cGPS_in_south_america = 239



GEODESY LANDSCAPE - THE NEXT BIG THING? LOOKING FORWARD ACROSS THE AMERICAS

Interdisciplinary leverage for multi-hazards observatories

Collaborative multi-national efforts

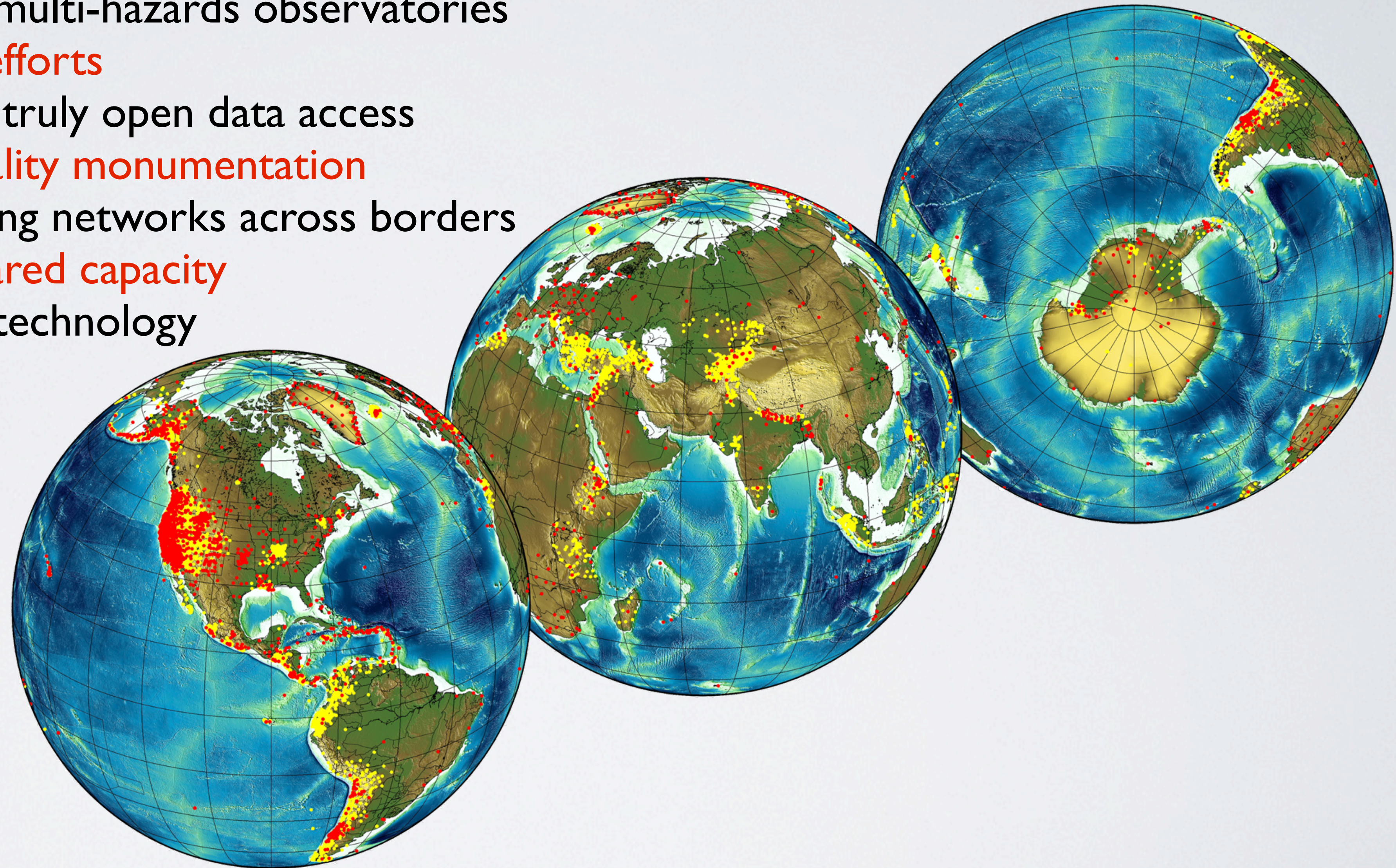
Growing the commitment to truly open data access

Commitment to geodetic quality monumentation

International federations linking networks across borders

Disseminated archives for shared capacity

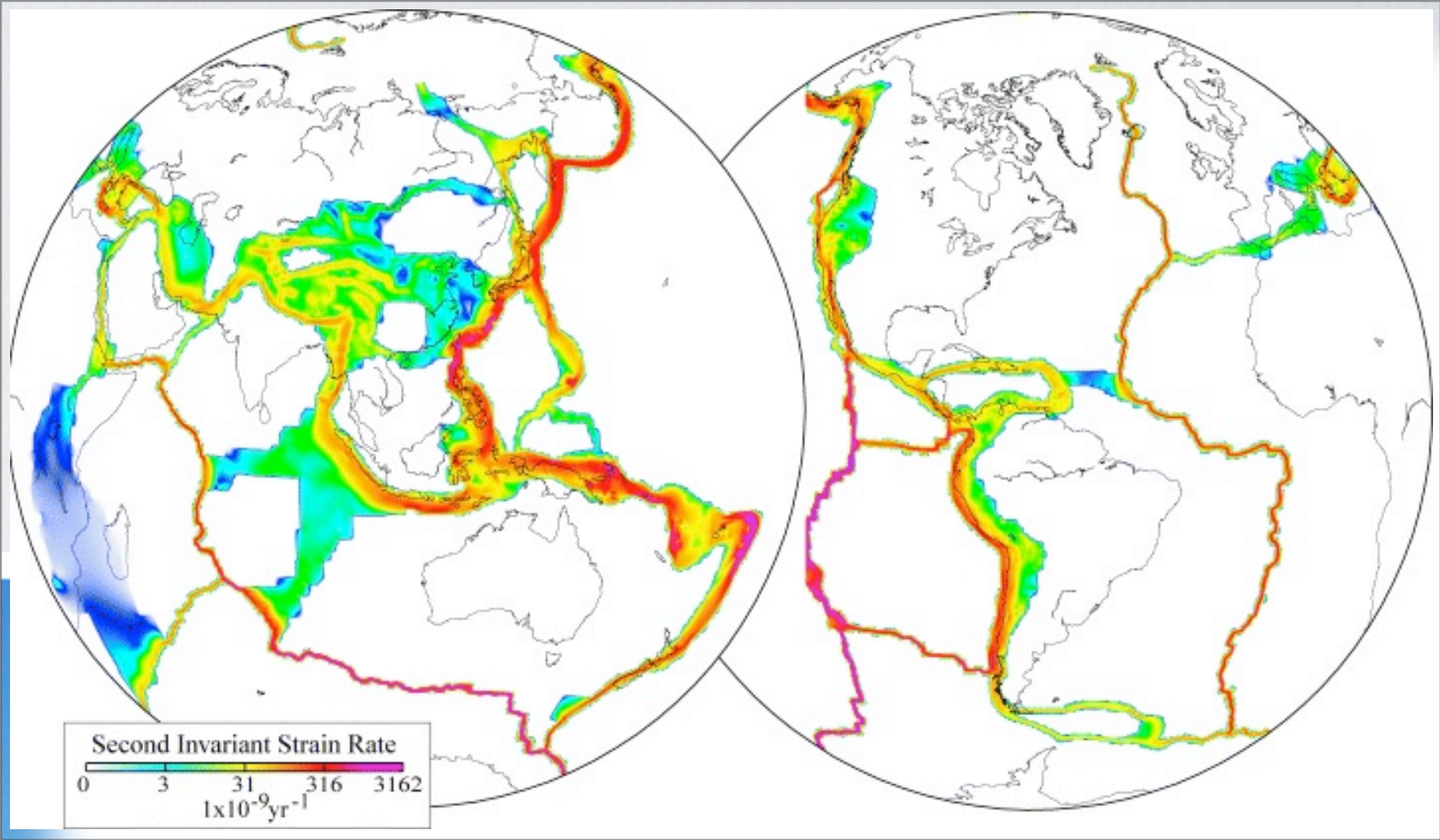
Driving development of new technology
for sea-floor geodesy



GEODESY FOR BROAD IMPACT

In the Public Interest: Societal Benefits

- Building capacity and infrastructure for research*
- Earthquake, tsunami, volcano, weather hazard assessment*
- Rapid deformation detection for hazard warning*
- Space weather and the ionosphere*
- Collateral benefits for science and society*



Governance and
Community

GAGE
Impact

Geodetic
Infrastructure

Geodetic Data
Services

Education &
Community
Engagement

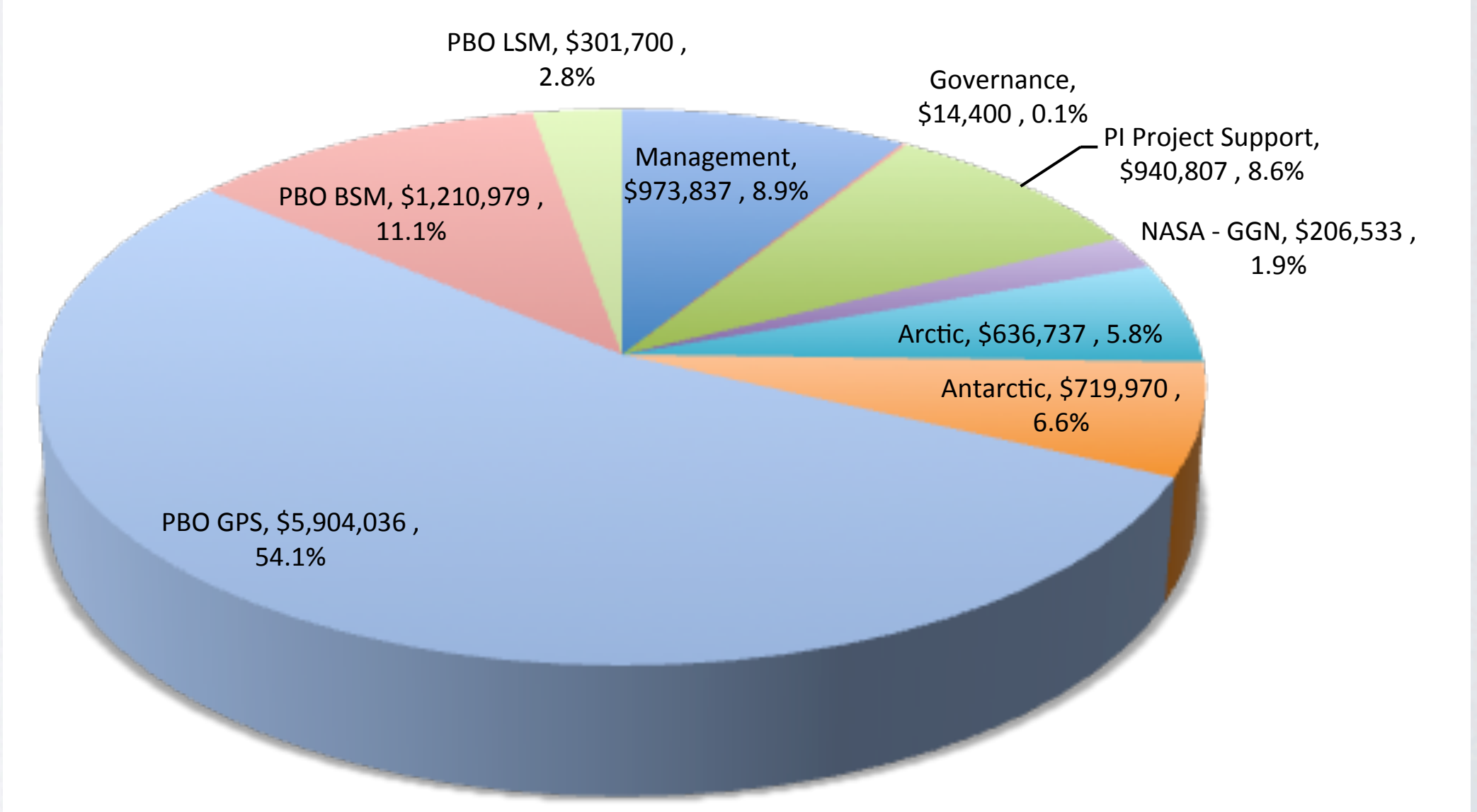
Beyond 2018



GAGE BUDGET - IMPLICATIONS FOR GI AND PBO

- NSF has informed UNAVCO that significant budget cuts should be expected in FY2014; These cuts could continue into FY2015.
- GI is \$10.9M of \$17.4M (63%) of GAGE.
- PBO comprises \$7.4M of \$10.9M (68%) of GI budget proposed in GAGE for FY2014.
- How should cuts proceed?
- Decrease PBO scope: delete observations systems: LSM, BSM, Tilt, 10-20% GPS, RT-GPS?
- Descope by region: SAF, AK, Eastern US, Basin & Range, Yellowstone?
- Forestall all possible scheduled or routine O&M for 1 year?
- Reallocate PBO funds and use to support other components of GI: e.g. TLS, TSAR, data products, PI science...?

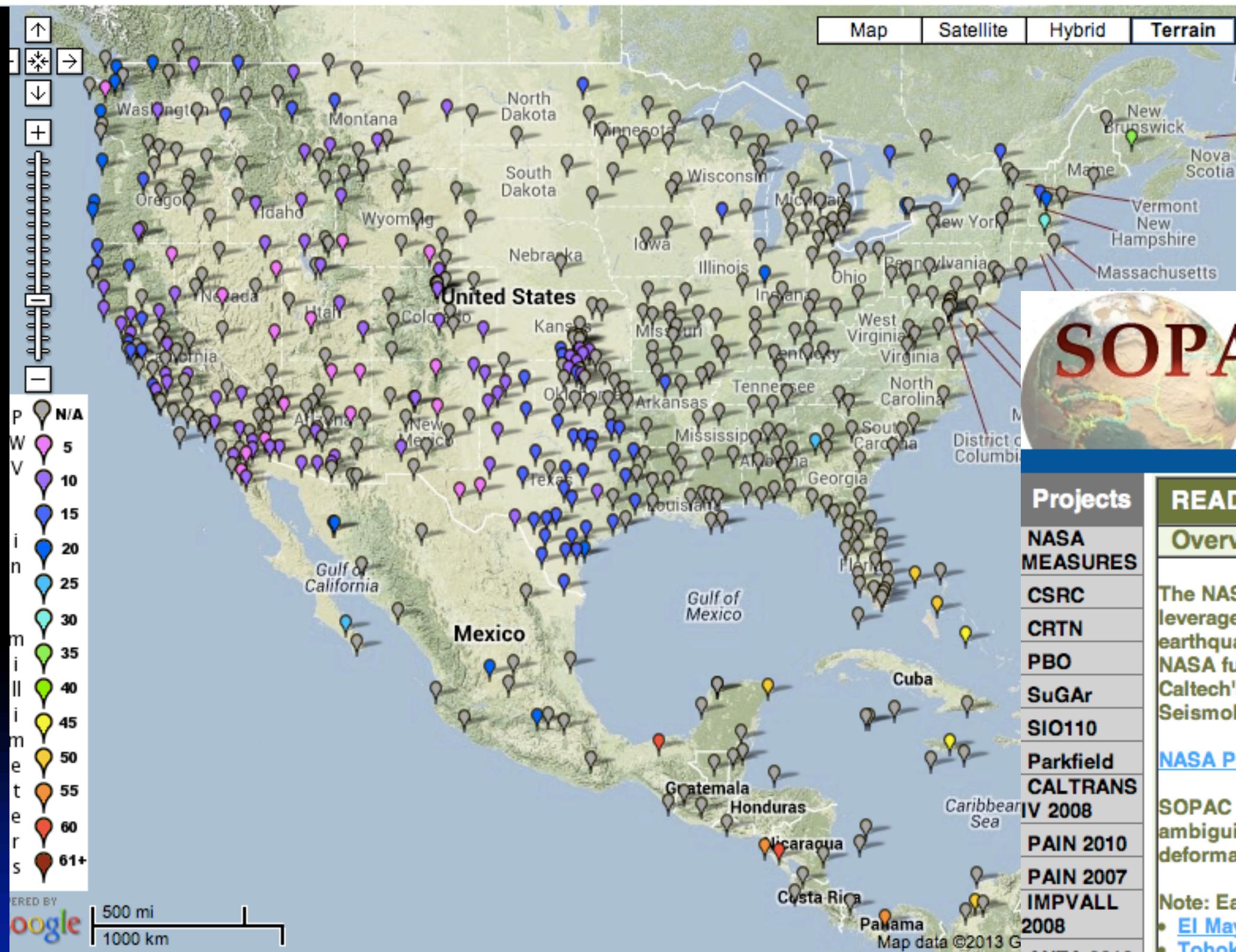
Infrastructure GI - WBS U1.1				
	NSF	NASA	Polar	GI U1.1
FTEs	33.8	1.9	8.3	44.0
Labor	\$2,022,246	\$98,681	\$501,189	\$2,622,116
Fringe	\$1,161,911	\$57,729	\$293,196	\$1,512,835
Equipment	\$546,003	\$8,058	\$96,000	\$650,060
Travel Domestic	\$692,725	\$5,008	\$12,000	\$709,734
Travel Foreign	\$15,022	\$1,196	\$20,000	\$36,218
Participant Support	\$14,400	\$0	\$12,000	\$26,400
Materials and Supplies	\$1,069,669	\$10,332	\$176,996	\$1,256,997
Subawards	\$289,000	\$0	\$0	\$289,000
Other	\$2,528,514	\$2,092	\$97,869	\$2,628,474
UNAVCO Indirect Costs	\$1,006,270	\$23,438	\$147,457	\$1,177,165
Total Costs	\$9,345,760	\$206,533	\$1,356,707	\$10,909,000
	85.7%	1.9%	12.4%	



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](#) search Quick links: [scripps orbit and permanent array cent](#)

[Data Archive](#) | [Processing](#) | [Projects](#) | [Sites](#) | [Maps](#) | [Other](#)
NASA MEASURES | CSRC | PBO

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](#)

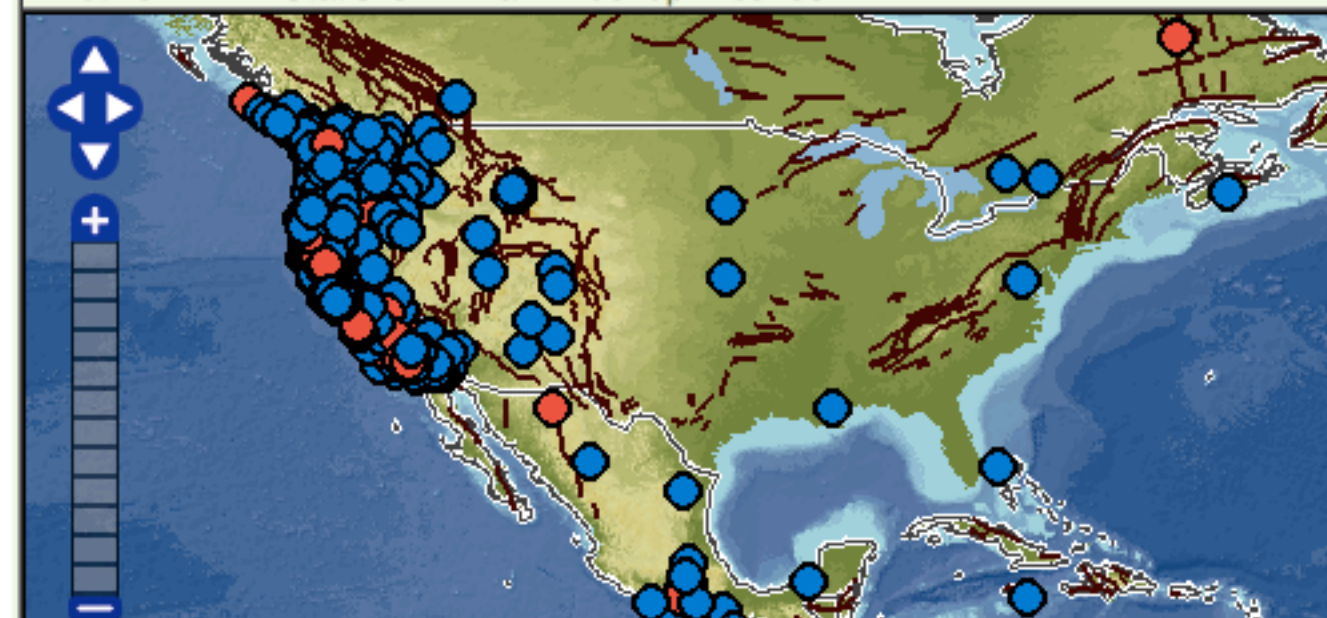
SOPAC computes real-time GPS satellite clocks and fractional-cycle biases for use in precise point positioning with ambiguity resolution using real-time data from GPS stations in North America (outside the zone of active tectonic deformation in the Western U.S. and British Columbia). See interactive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

Note: Earthquake information available in GPS Explorer:

- [El Mayor-Cuicapah \(2010-04-04\)](#)
- [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

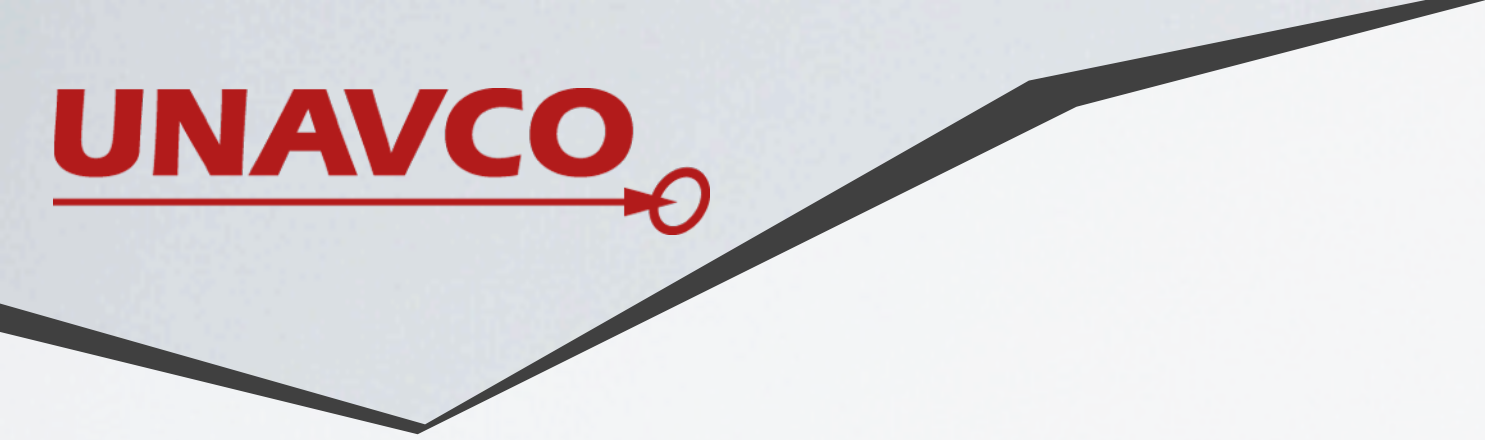
- ☐ Basic
- ☐ Satellite
- ☒ Terrain
- ☐ USGS Topo Quads

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?

