UNAVCO

THE FUTURE OF PLATE BOUNDARY OBSERVATORY (PBO) GEODETIC RESOURCE FROM NOW TO 2028

Ken Austin
NW and Alaska Region Project Manager
UNAVCO, PBO

NSF NASA

56th meeting of the U.S. Civil GPS Service Interface Committee,
Sept 12, 2016 - Oregon Convention Center, Portland, OR

TALK OUTLINE

- Overview of UNAVCO GI program in NSF GAGE Facility
- EarthScope overview: PBO infrastructure buildout, current status, and data products
- Science Drivers: some examples from Cascadia, CA, and AK
- Codependencies: NASA READI earthquake early warning project; NOAA NWS-ZWD; NGS-CORS & OPUS services
- GAGE Budget and Scope: Plans versus reality in current environment
- Vision for the future: PBO as a basis for a multi-hazard network of networks across the Americas - possible refocusing, descoping, or upgrades and enhancements (*i.e.* new investments) to PBO? COCONet science snapshot
- Preliminary recommendations from the Breckenridge, CO, and Leesburg, VA NSF-funded Community Workshops - update on re-competition process post-GAGE Facility and EarthScope
- Summary and challenges going forward

GEODETIC INFRASTRUCTURE PROGRAM OVERVIEW

Geodetic Infrastructure Directorate

Community & Continuously Observing Networks

Plate Boundary Observatory

GPS and Metpack Operations

Borehole Geophysics Operations

NASA GGN

POLENET: GNET & ANET

COCONet, TLALOCNet, and Africa Array

Principal Investigator support

NSF - EAR, PLR funded

Campaign and longer term GPS deployments

Terrestrial Laser Scanning Projects

Emerging Imaging Geodesy Tools

HJOR cGPS GNET site - Photo credit: T. Nylen, 2014

EarthScope Background

- Funded by NSF
- Project started in 2003 - continues through 2018
- Three Components - Geodetic, Seismic, and Drilling
- Deploys thousands of seismic, GPS, and other geophysical instruments
- Purpose: To study the structure and evolution of the North American continent and the processes the cause earthquakes and volcanic eruptions.
- A collaboration between scientists, educators, policy makers, and the public to learn about and utilize exciting scientific discoveries as they are being made.
- Total EarthScope Budget: ~$500M over the lifetime of the project

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Big Science: The Universe's Ten Most Epic Projects

By Gregory Mone, Brooke Borel, Katherine Bagley and Jennifer Abbasi Posted 7.16.11 at 8:06 pm 12 Comments

IMAGE 10 OF 10

1: The Earthscope

EarthScope

1

Annual budget: $25,000,000
Construction cost: $197,000,000
Staff: 110
Physical size: 3.8 million square miles
Scientific utility: 10
WIIFY: 10
Wow factor: 10

A telescope to peer deep into the heart of our planet

Designed to track North America's geological evolution, EarthScope is the largest science project on the planet. This earth-sciences observatory records data over 3.8 million square miles. Since 2003, its more than 4,000 instruments have amassed 67 terabytes of data—that's equivalent to more than a quarter of the data in the Library of Congress—and add another terabyte every six to eight weeks

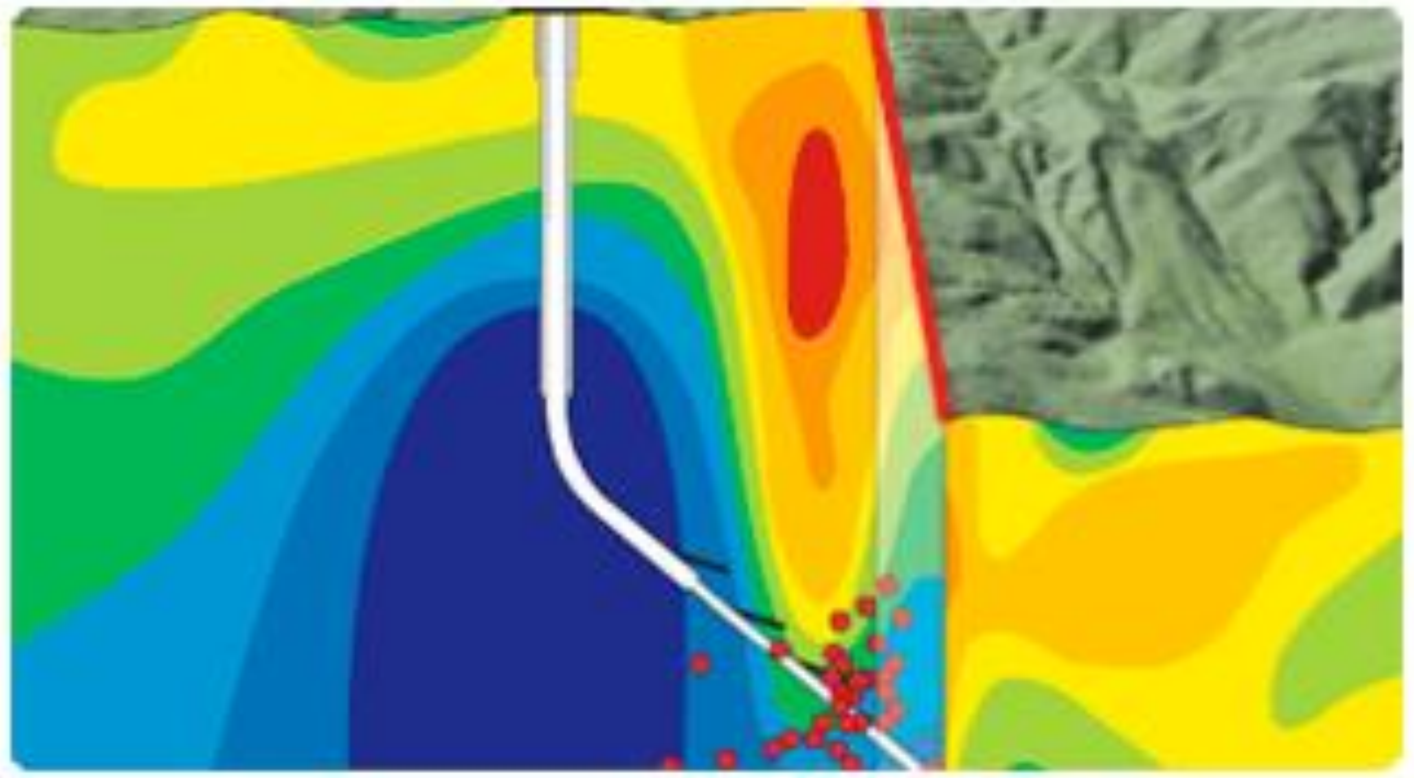
Scientific Utility

Researchers are using EarthScope, which consists of many kinds of experiments, to examine all facets of North America's geological composition. Across the continental U.S. and Puerto Rico, 1,100 permanent GPS units track deformations in the land's surface caused by tectonic shifts below. Seismic sensors next to the active San Andreas Fault in California record its tiniest slips, while rock samples pulled from a drill site that extends two miles into the fault reveal the grinding and strain on the rocks that occur when the two sides of the fault slide past each other during an earthquake. And over the course of 10 years, small crews have hauled a moveable array of 400 seismographs across the country using backhoes and sweat. By the time the stations reach the East Coast next year, they will have collected data from almost 2,000 locations.

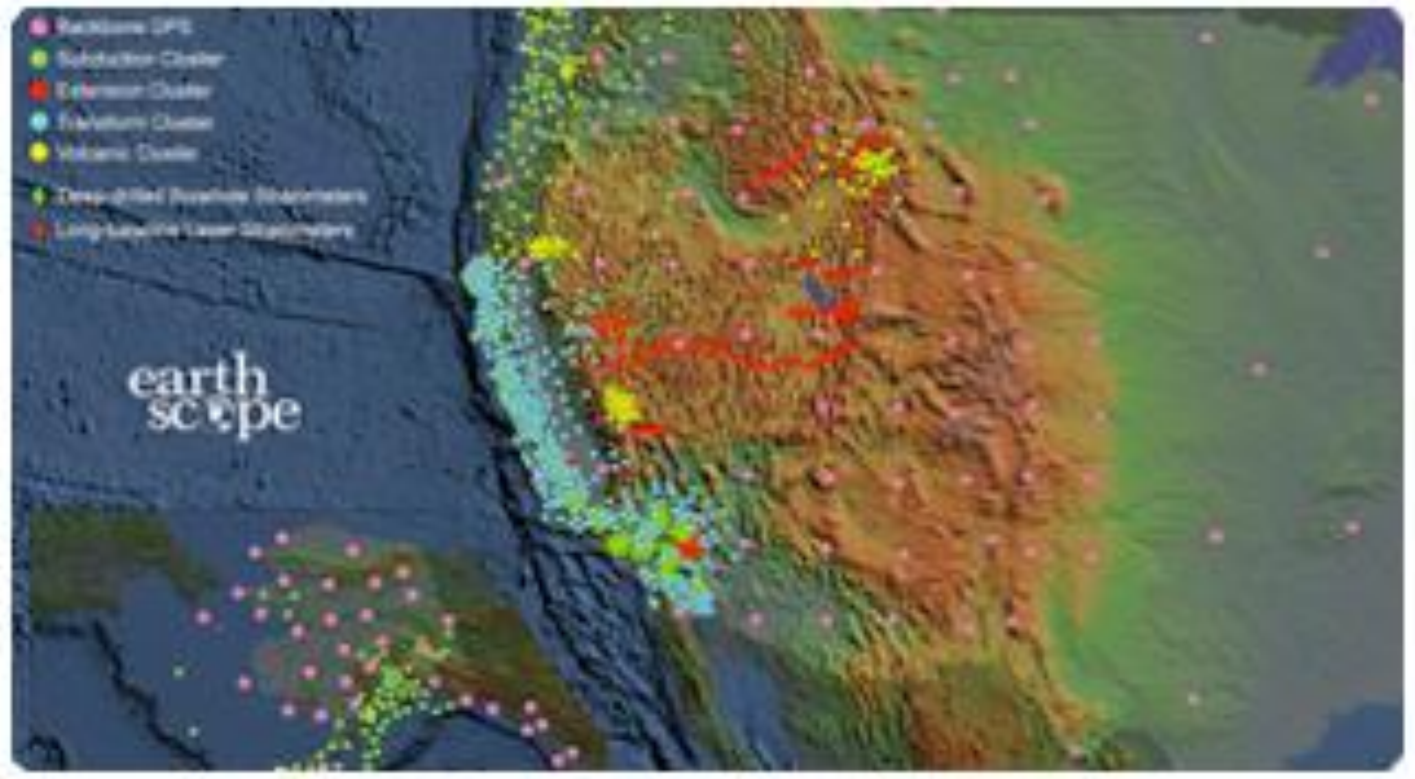
What's In It For You

Collectively, EarthScope's measurements could help explain the forces behind geological events such as earthquakes and volcanic eruptions, leading to better detection. So far, data from the project has shown that rocks in the San Andreas Fault are weaker than those outside it and that the plume of magma under Yellowstone's supervolcano is even bigger than previously suspected.

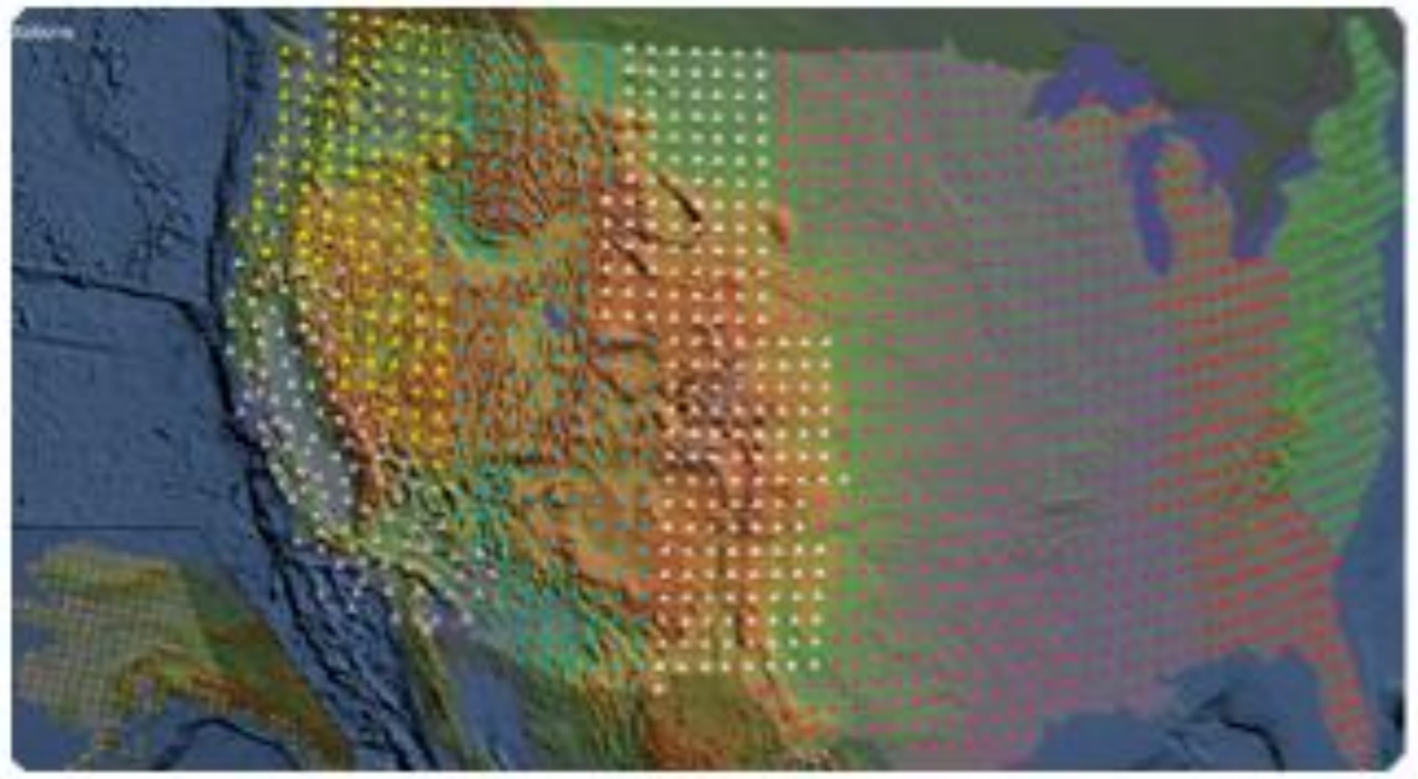
Drilling Component - SAFOD



Geodetic Component - PBO



Seismic Component - USArray



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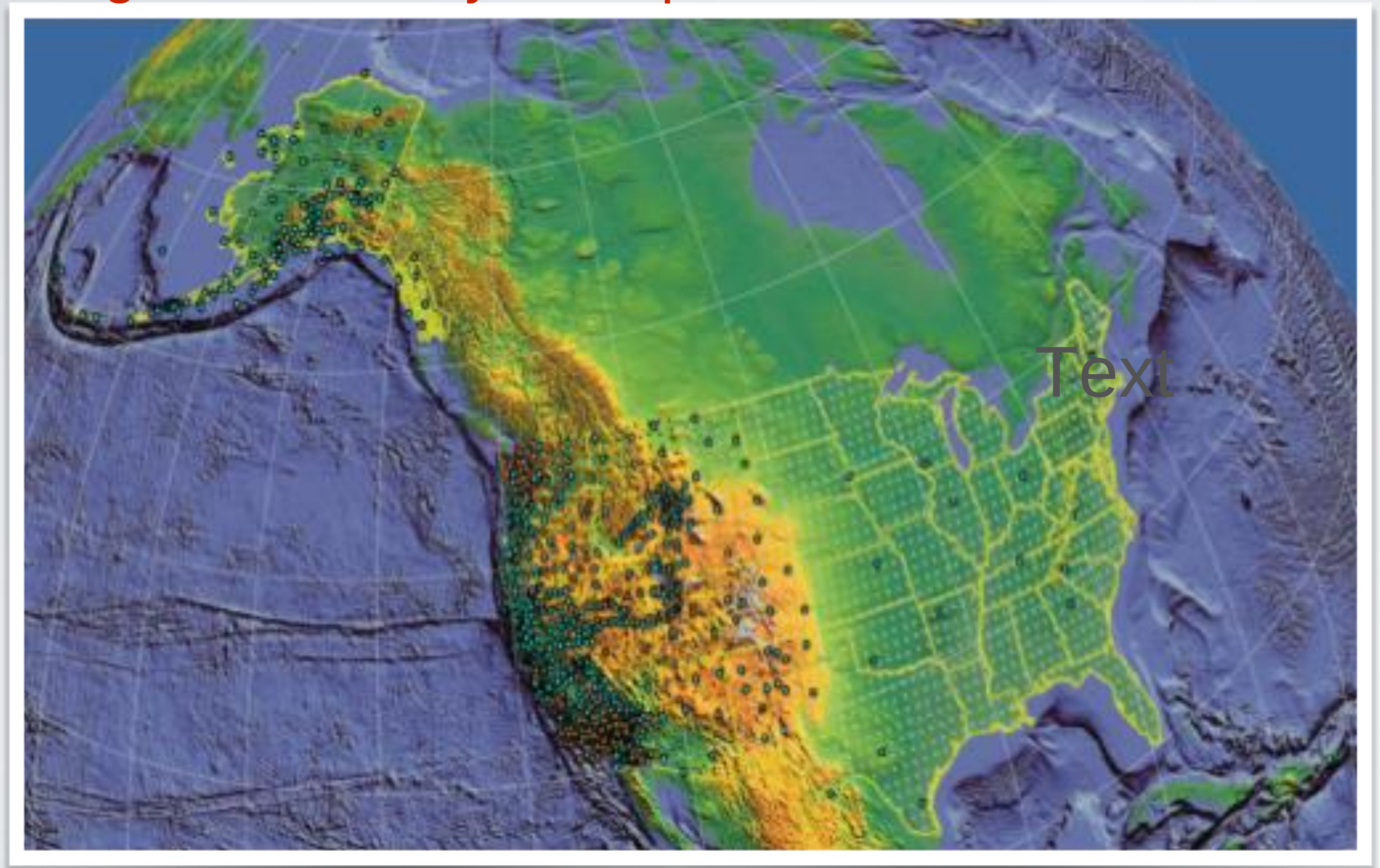
EARTHSCOPE: INTEGRATION OF GEODESY AND SEISMOLOGY

Designed as a 15 year experiment will sunset in 2018



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*

- Total EarthScope Budget: ~$500M

NSF

earthscope

PBO is the geodetic component of EarthScope (~$200M): 1100 cGPS, 78 BSM, 6 LSM, 26 tiltmeters

The Plate Boundary Observatory

Focused, dense deployments of cGPS and strainmeter arrays

- 1100 continuous Global Positioning Systems around tectonic clusters
- 78 borehole strainmeters
- 5 long baseline strainmeters
- 26 tiltmeters
- 100 meteorological instruments

Portable GPS receivers

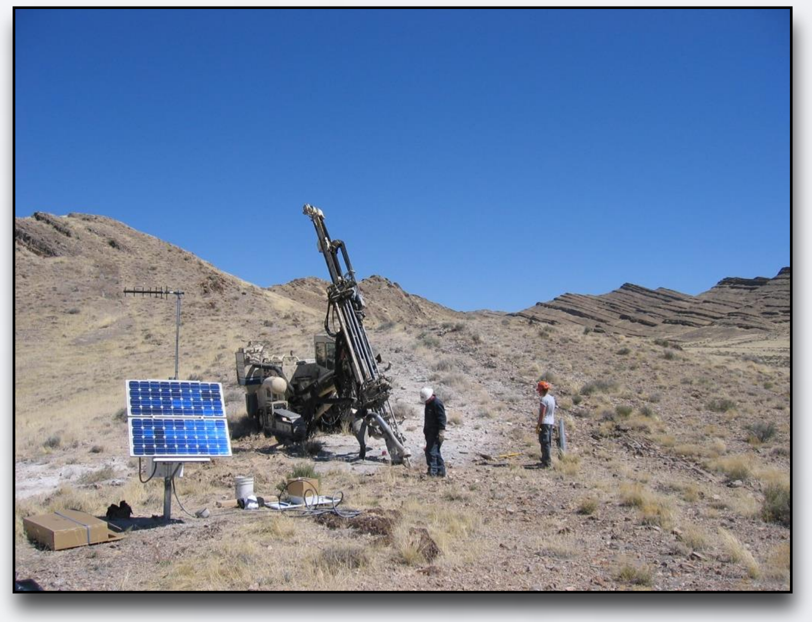
- Pool of 100 portable GPS receivers for temporary deployments to areas not sufficiently covered by continuous GPS

Geo-EarthScope

- InSAR imagery covering the western US
- LIDAR imagery covering the northern and southern San Andreas Fault, Yellowstone Caldera, and faults in Cascadia and Alaska

Network Costs

- $100M - Construction Phase (2003-2008)
- $54M - Operations and Maintenance Phase 1 (2009-2013)
- $46M - Operations and Maintenance Phase 2 (2014-2018)



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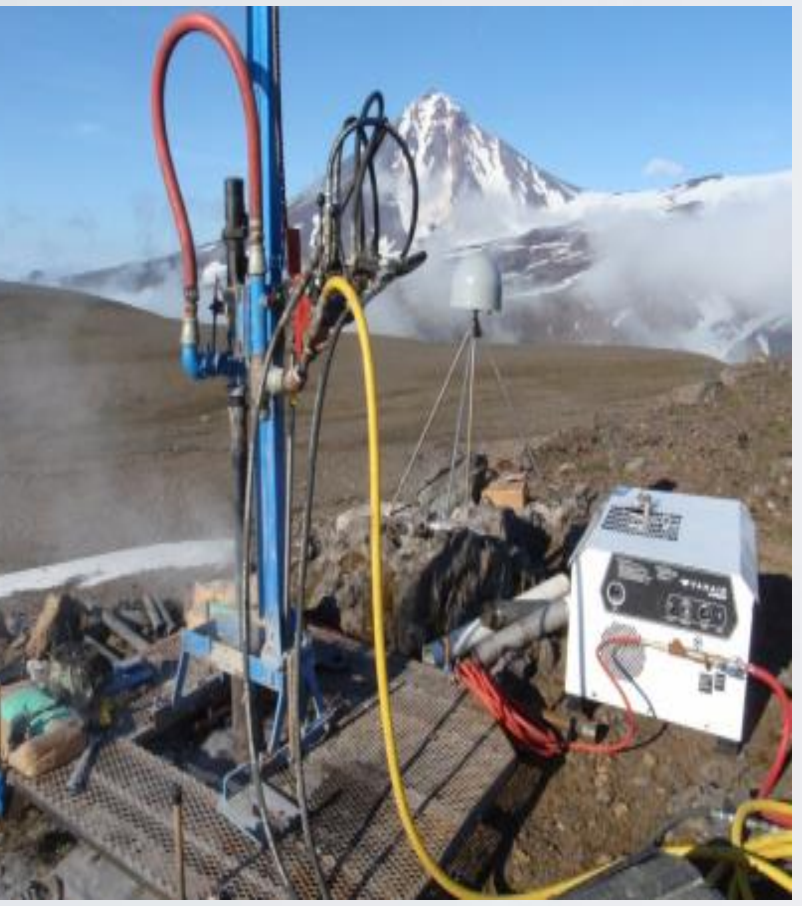
PBO: A NUCLEUS FOR A NETWORK OF GEODETIC NETWORKS



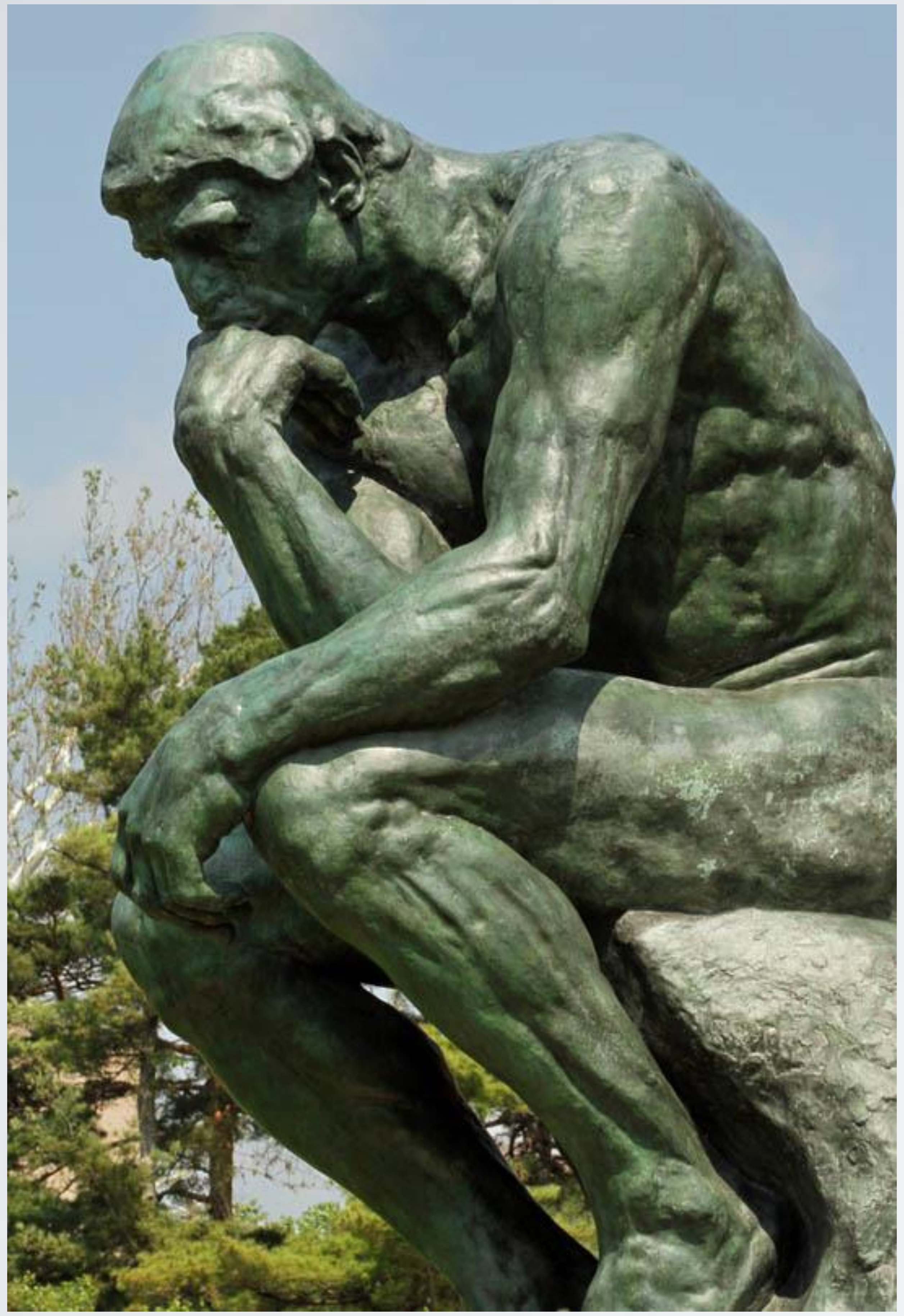


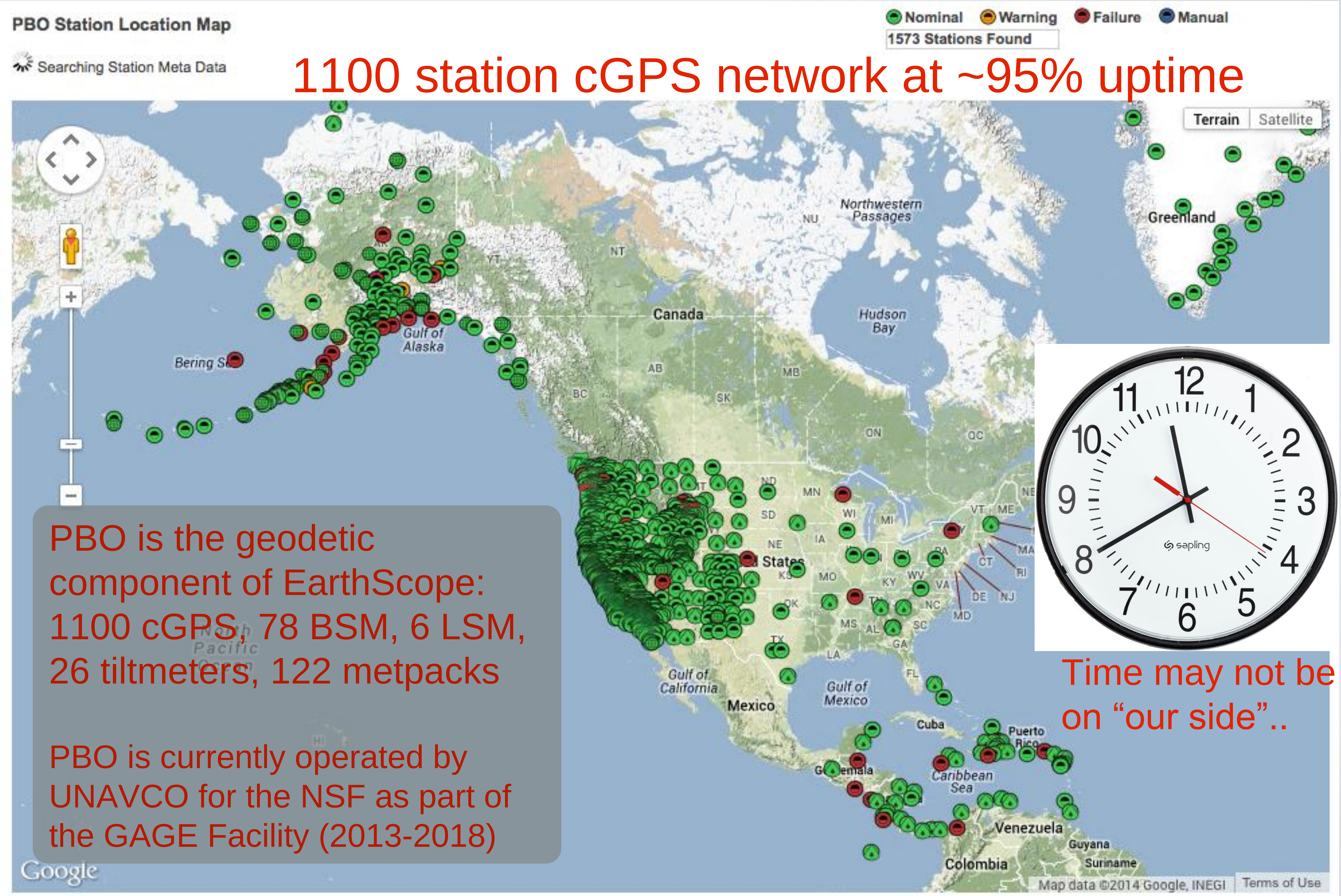

earthscope

PLATE BOUNDARY OBSERVATORY


PBO FACILITY HIGHLIGHTS



GI AC will use recommendations from NSF Community Workshops to refine and guide UNAVCO going forward…



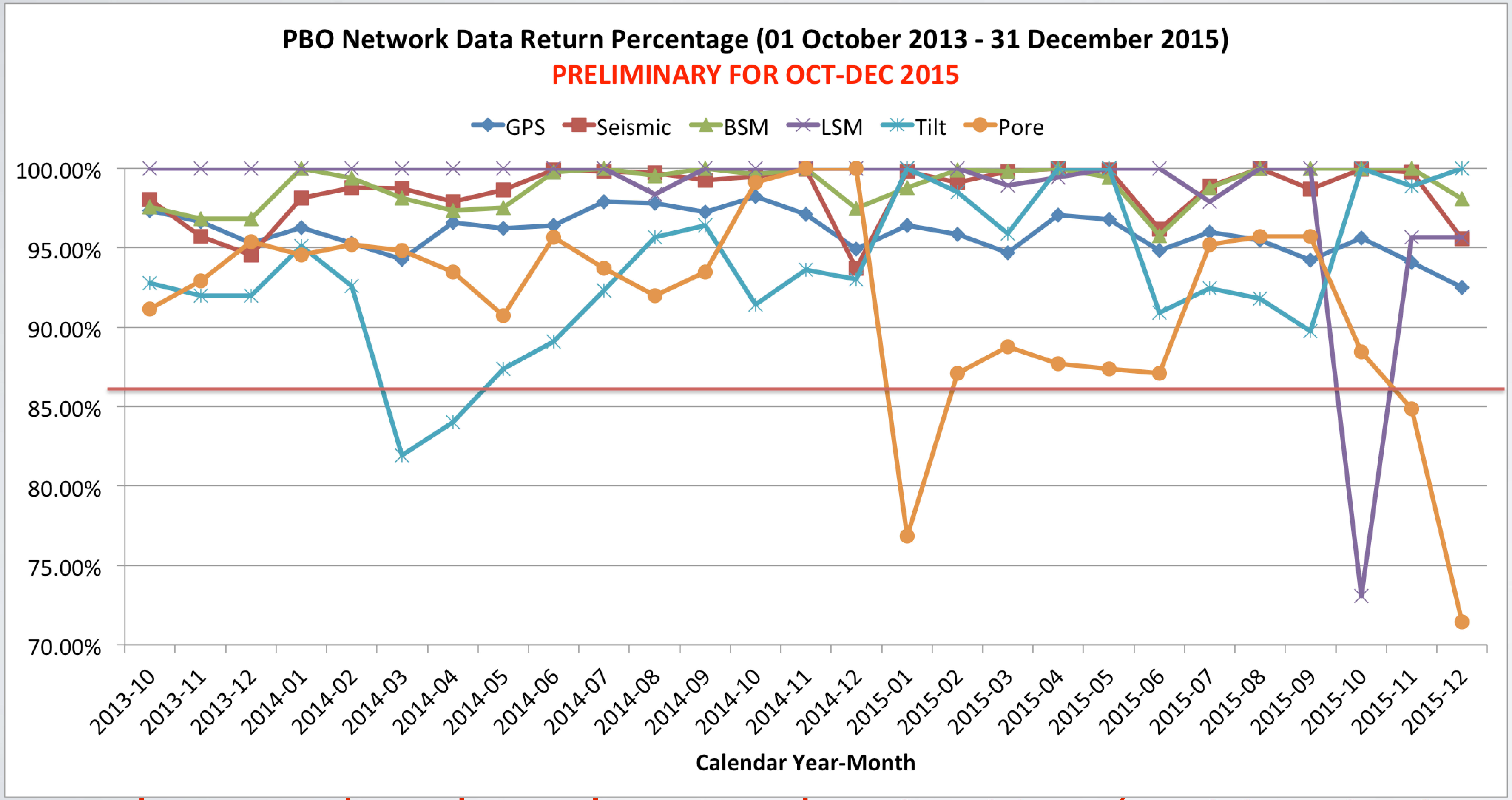
1100 station cGPS network at ~95% uptime

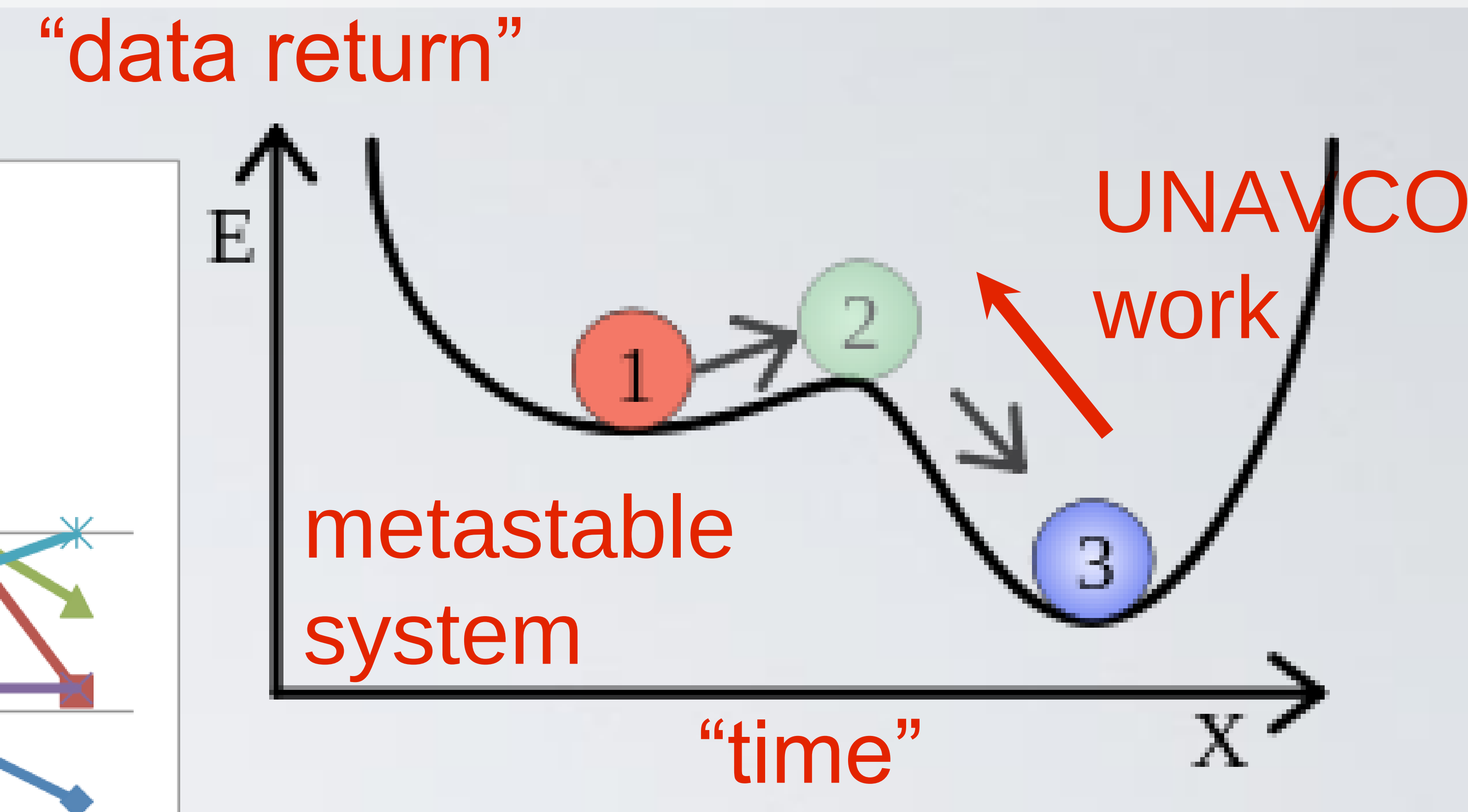
PBO is the geodetic component of EarthScope: 1100 cGPS, 78 BSM, 6 LSM, 26 tiltmeters, 122 metpacks

PBO is currently operated by UNAVCO for the NSF as part of the GAGE Facility (2013-2018)

Time may not be on “our side”..

PBO SENSOR DATA RETURN



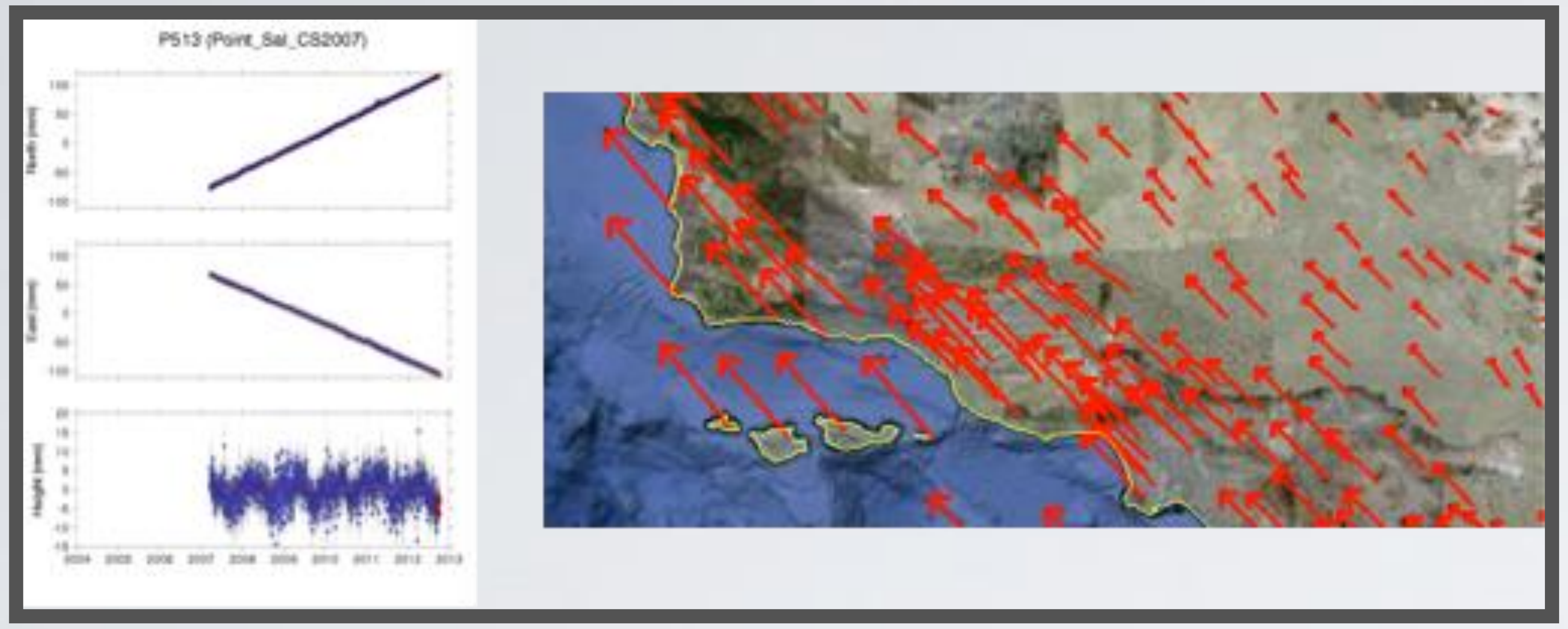


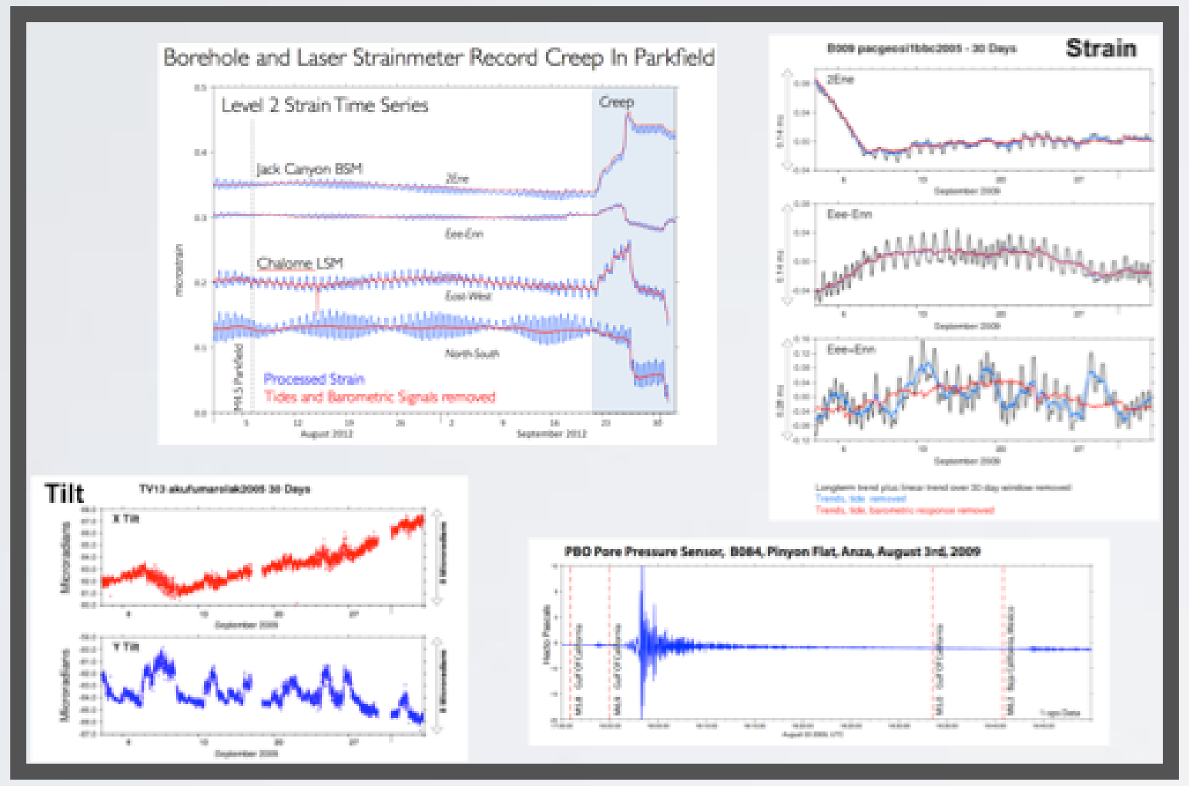
Cumulative data return for the PBO network since the beginning of the O&M period (FY2009) is:

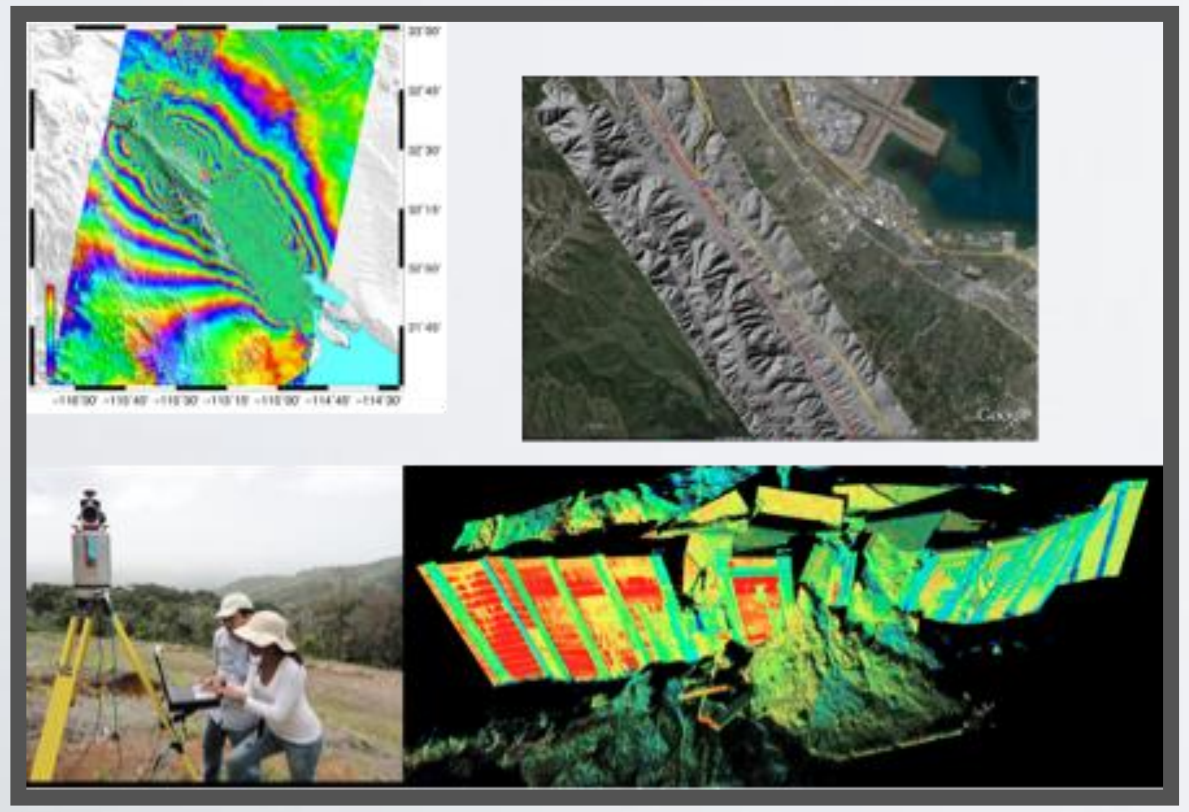
- 99% for GPS/Met
- 96% for seismic
- 98% for BSM
- 100% for LSM
- 92% for pore pressure
- 86% for tilt.

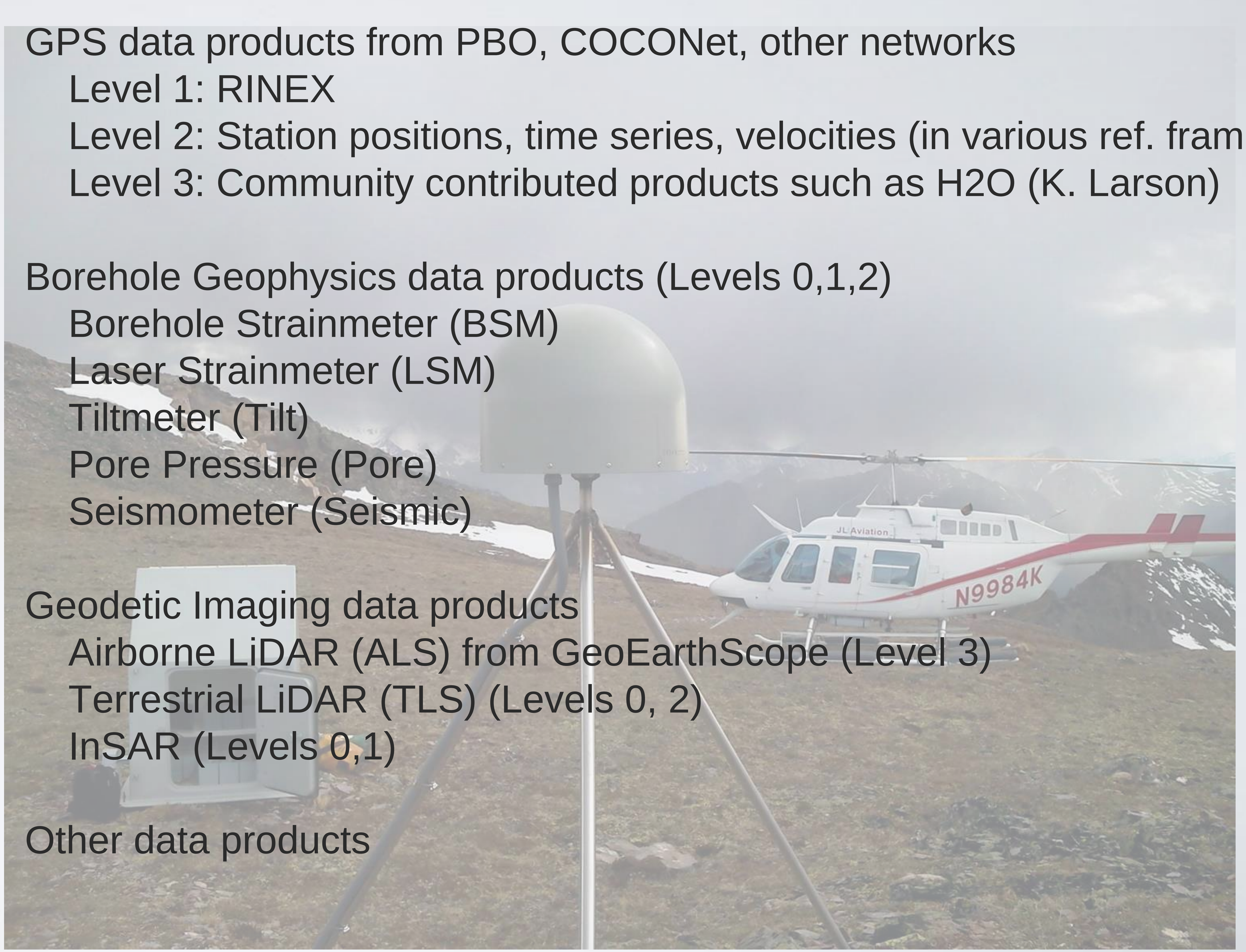
Metrics complete through December 31, 2015 (YR8Q1- GAGE YR3Q1)

GAGE-PBO Data Products









GPS data products from PBO, COCONet, other networks
- Level 1: RINEX
- Level 2: Station positions, time series, velocities (in various ref. frames
- Level 3: Community contributed products such as H2O (K. Larson)

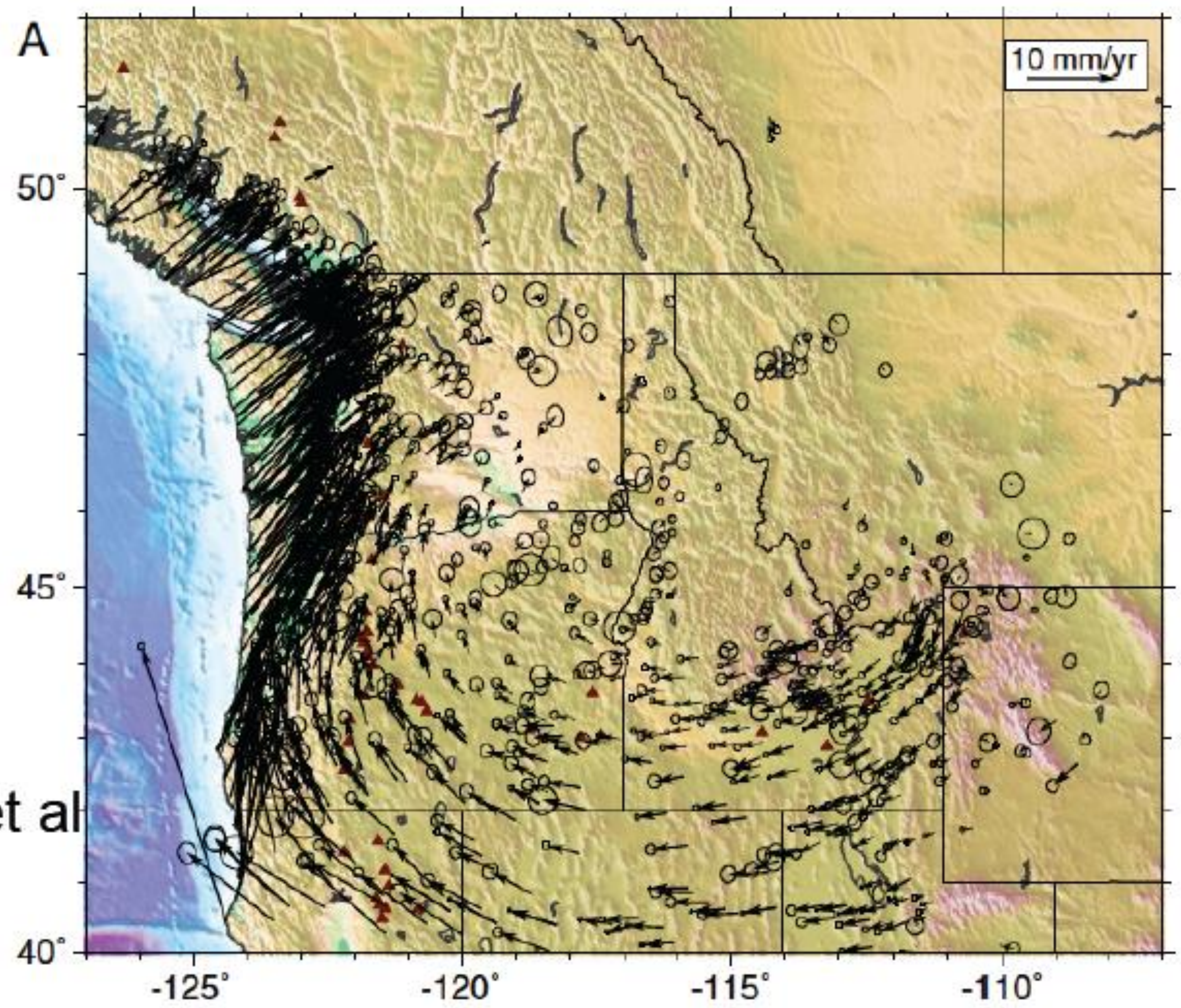
Borehole Geophysics data products (Levels 0,1,2)
- Borehole Strainmeter (BSM)
- Laser Strainmeter (LSM)
- Tiltmeter (Tilt)
- Pore Pressure (Pore)
- Seismometer (Seismic)

Geodetic Imaging data products
- Airborne LiDAR (ALS) from GeoEarthScope (Level 3)
- Terrestrial LiDAR (TLS) (Levels 0, 2)
- InSAR (Levels 0,1)

Other data products

PNW block rotation, translation and strain

- Combines cGPS and eGPS measurements
- Uses PBO cGPS data
- Constrains “block” motion and strain/locking along faults

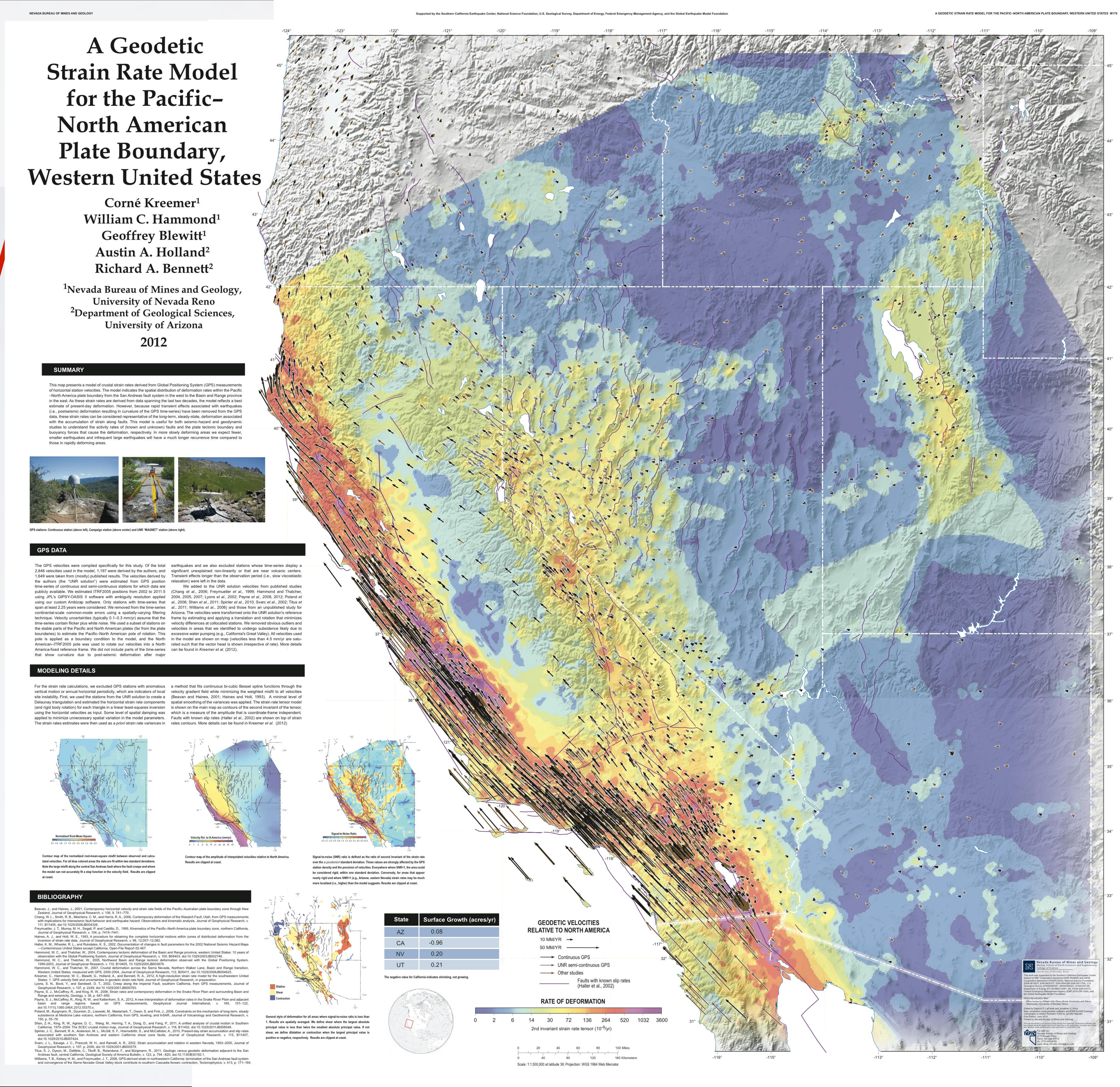


McCaffrey et al JGR 2013

TAKING A BROADER VIEW

- Combines cGPS and eGPS measurements
- Uses PBO cGPS data
- Constrains "block" motion and strain/locking along faults

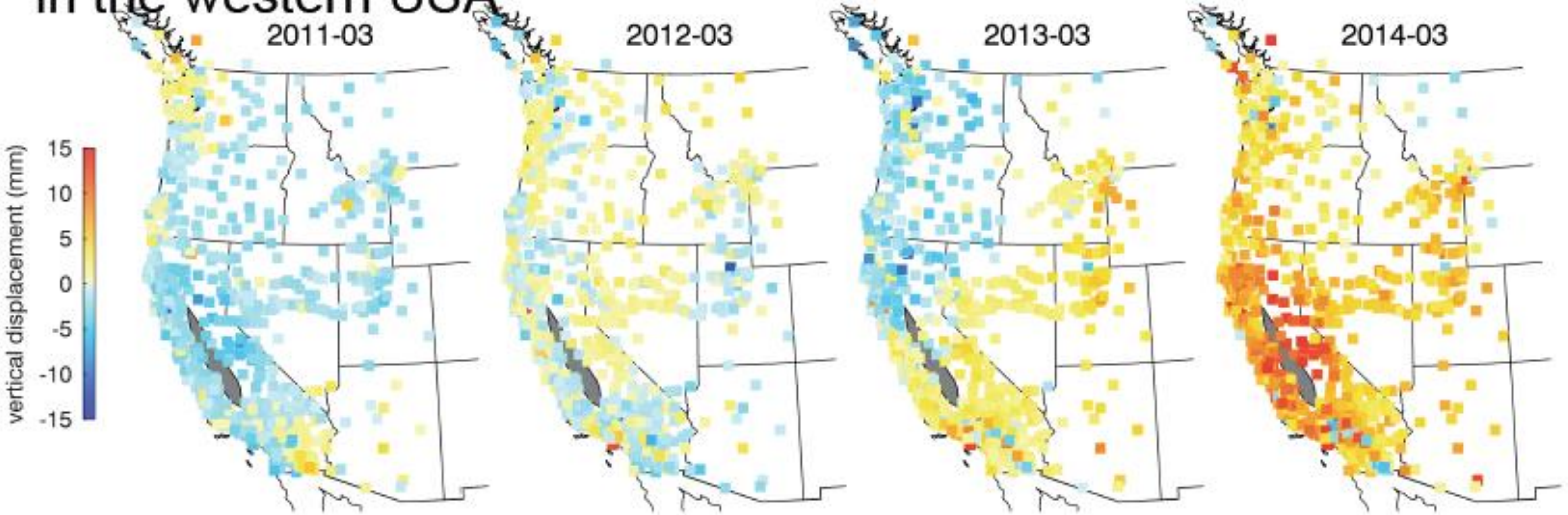
Kreemer, Hammond, Blewitt, Holland & Bennett, 2012



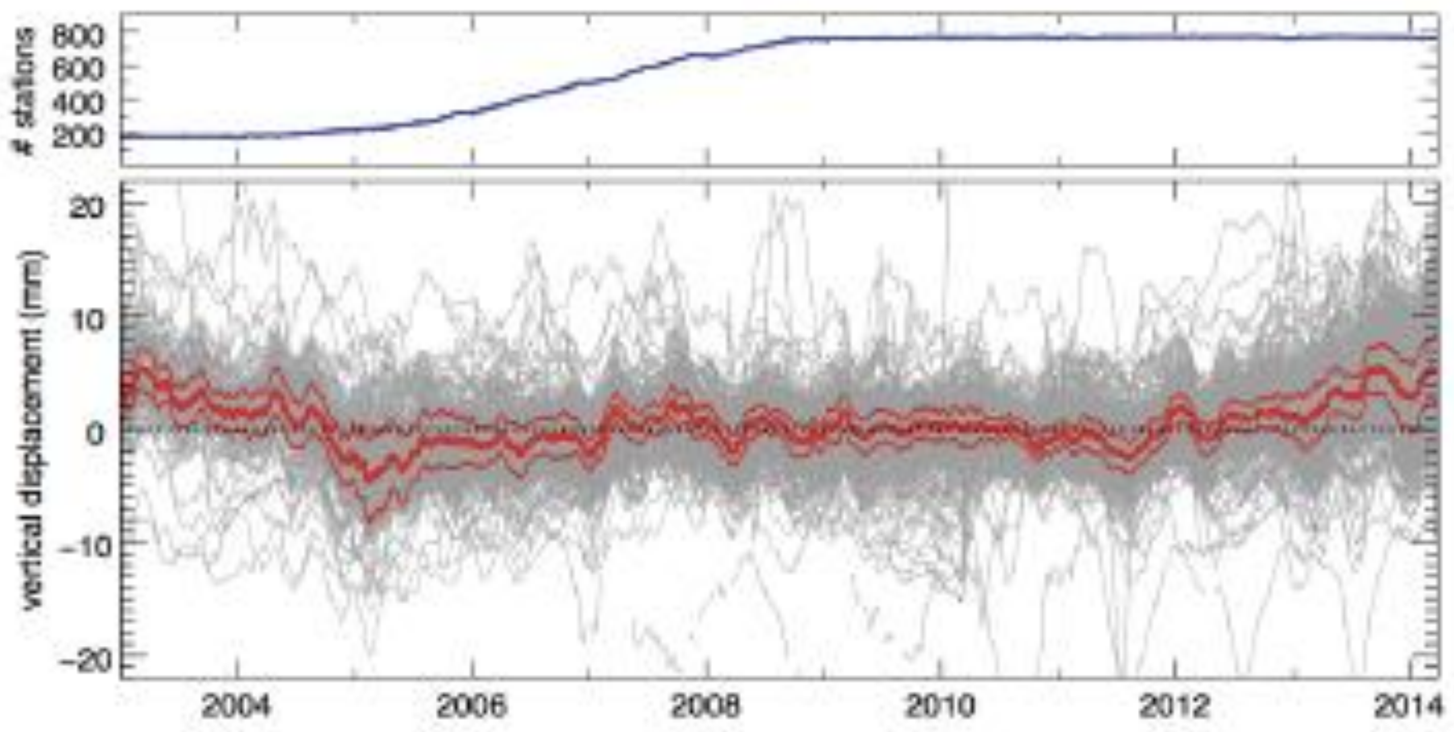
PBO - DROUGHT SENSOR

PBO observations of hydrological loading in the western USA

Borsa, Agnew, Cayan, *Science*, 2014

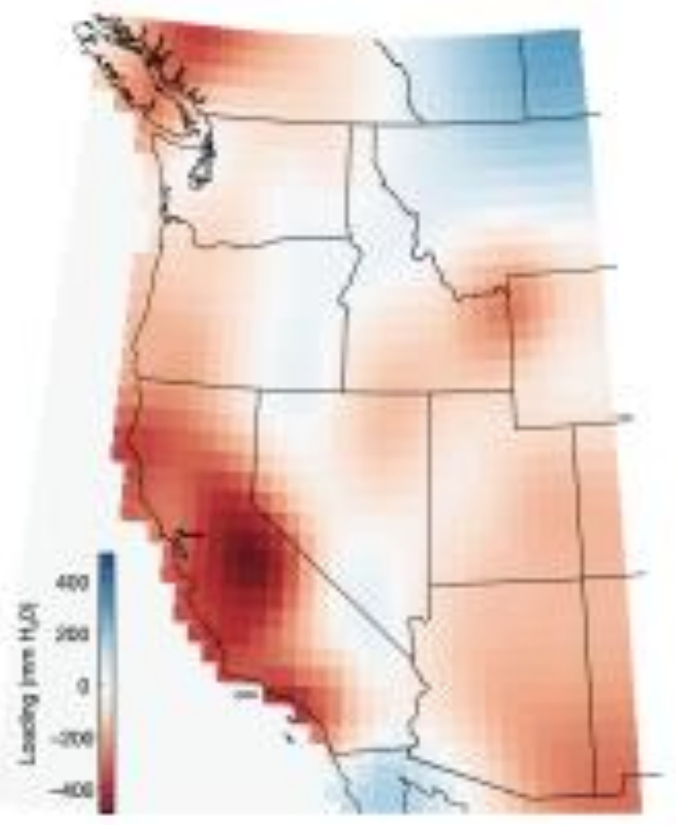


Spatial distribution of the GPS vertical displacements as of March 1 for the years 2011 through 2014. Yellow-red colors indicate uplift; subsidence is indicated by shades of blue. Gray region shows the area of stations excluded in the Central Valley. Water unloading due to the current drought is responsible for the strong uplift observed in 2014-03.

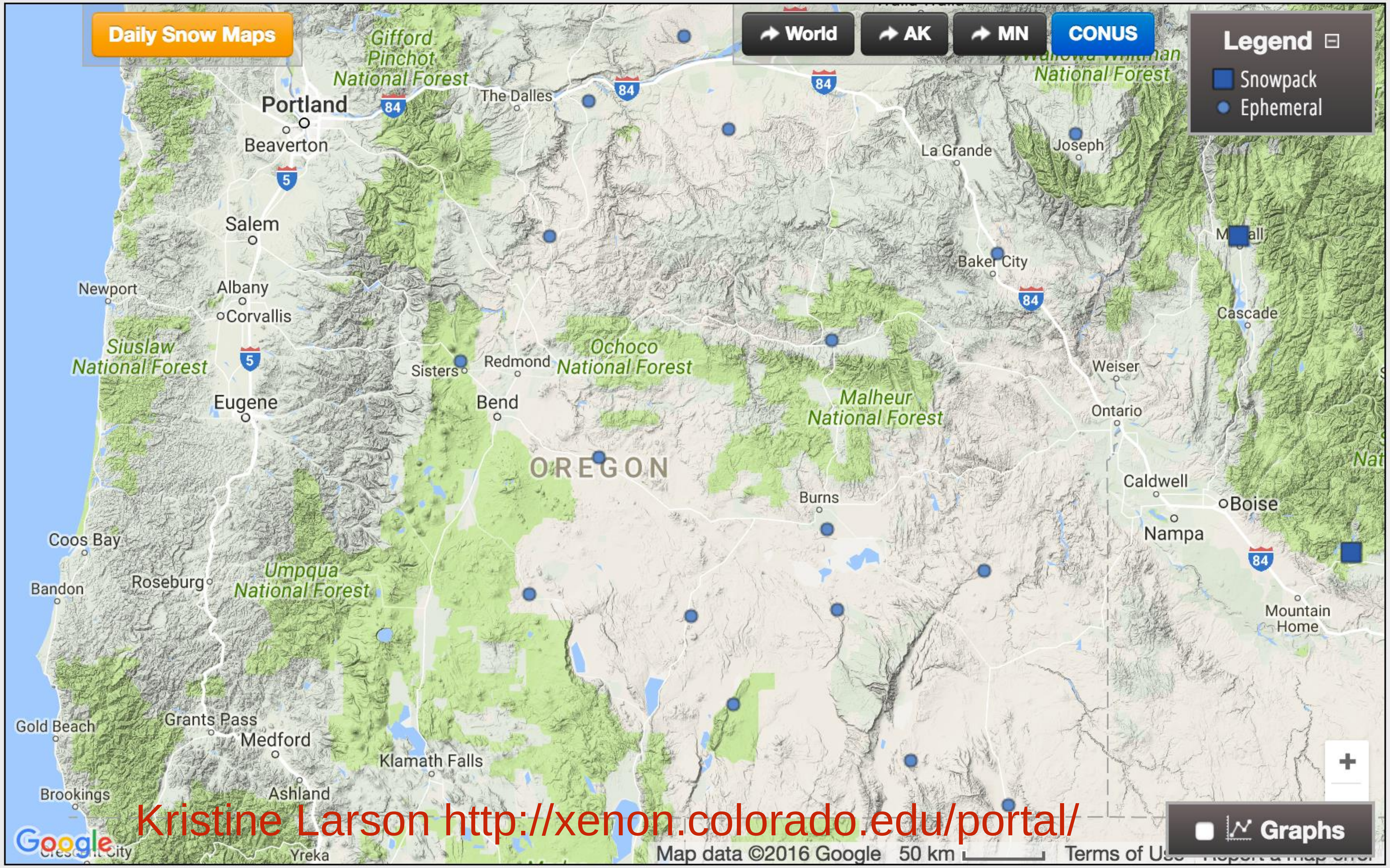


Seasonally-adjusted GPS vertical time series used above.

Water loading model inverted from the 2014-03 panel (above-right) assuming a spherical earth elastic response.

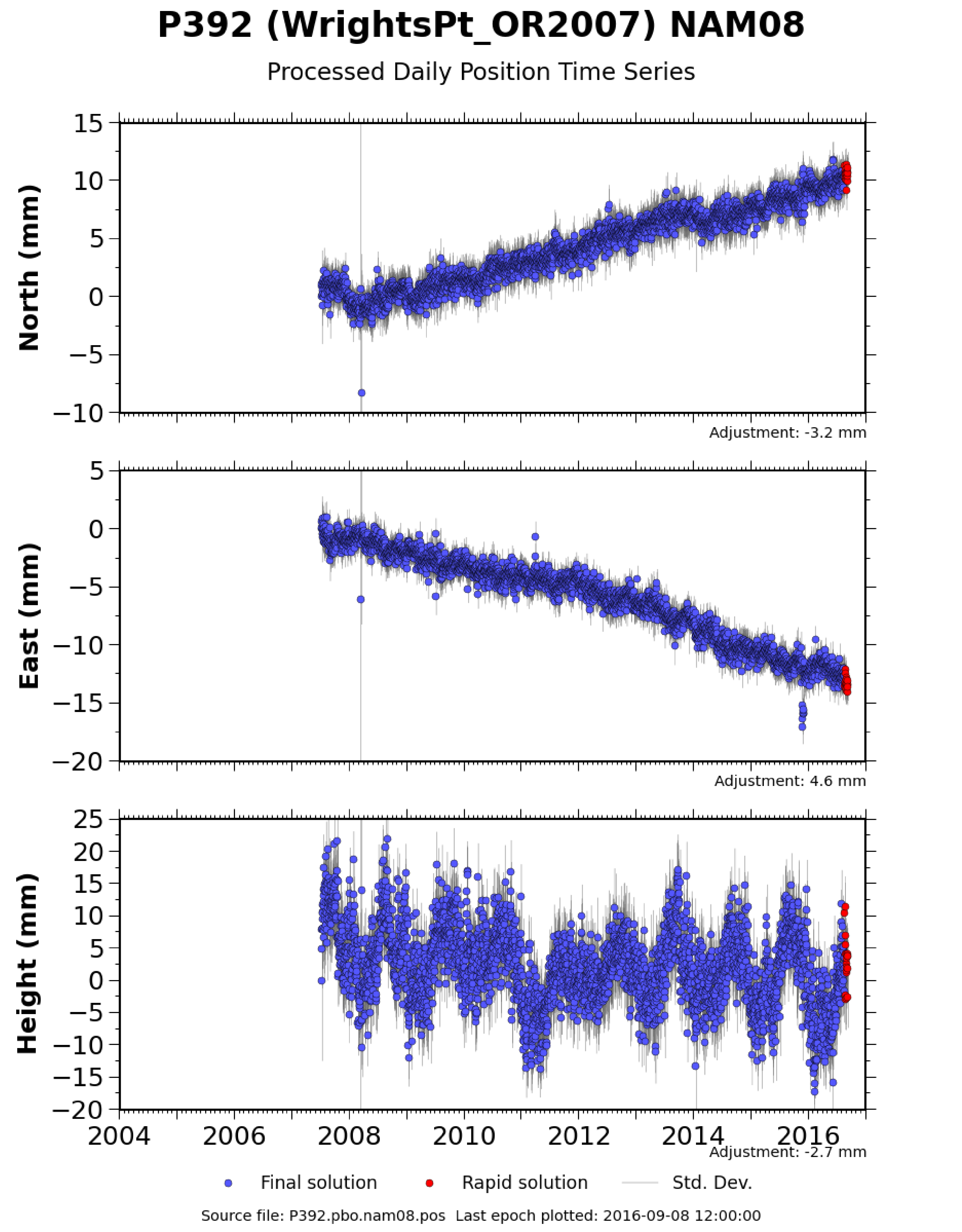


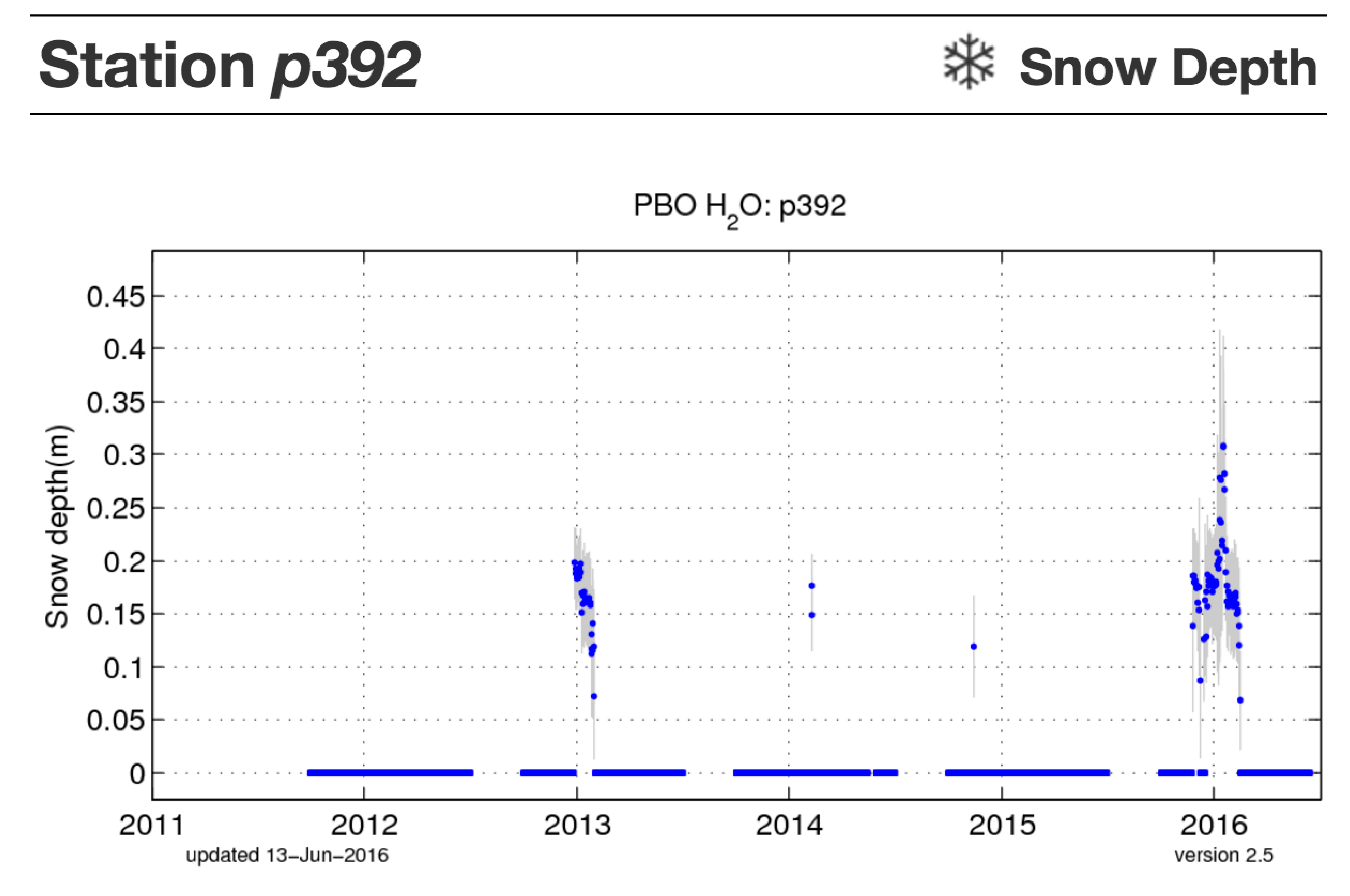
PBO H2O SNOW STATIONS



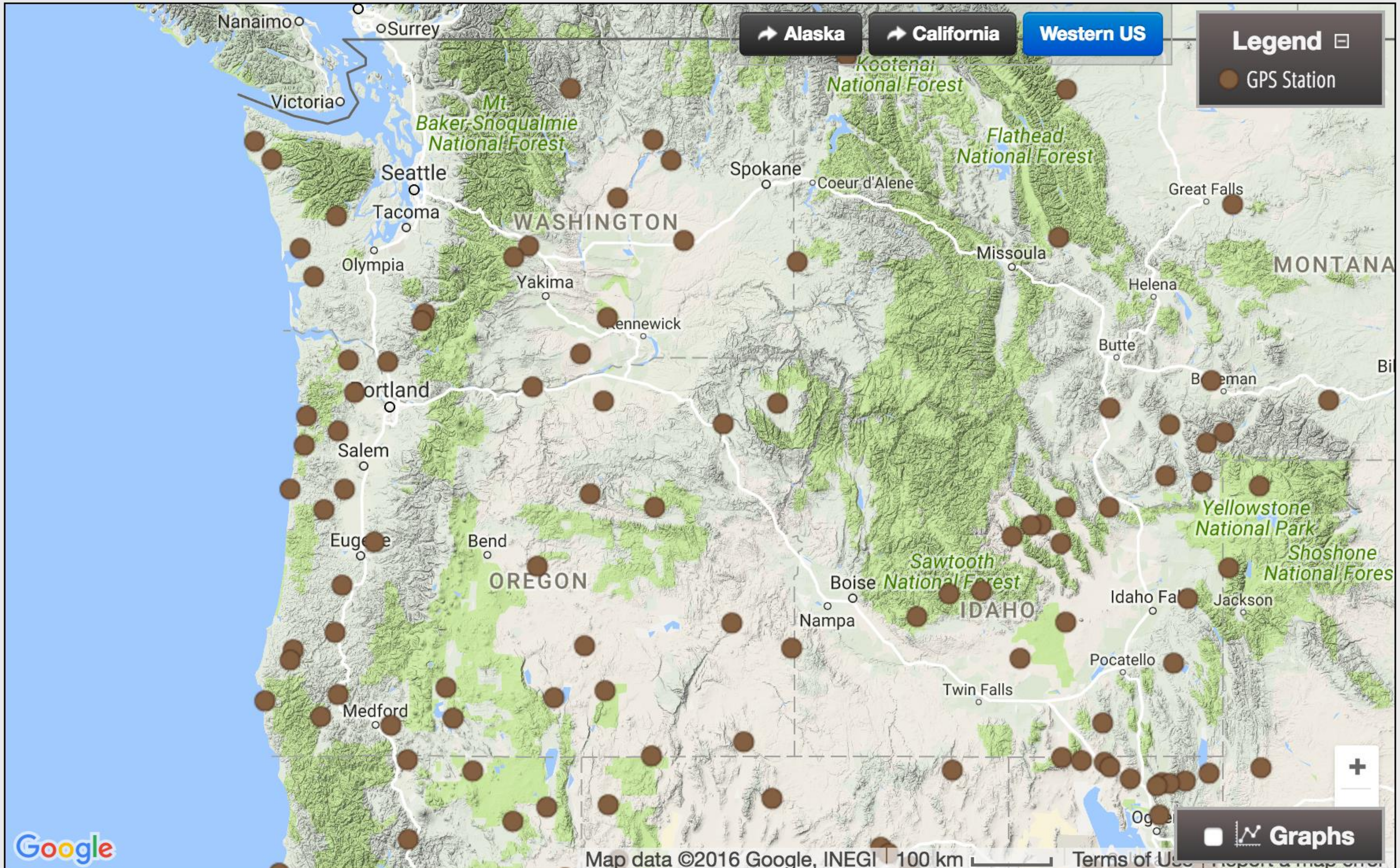
Kristine Larson http://xenon.colorado.edu/portal/

P392 SNOW DATA



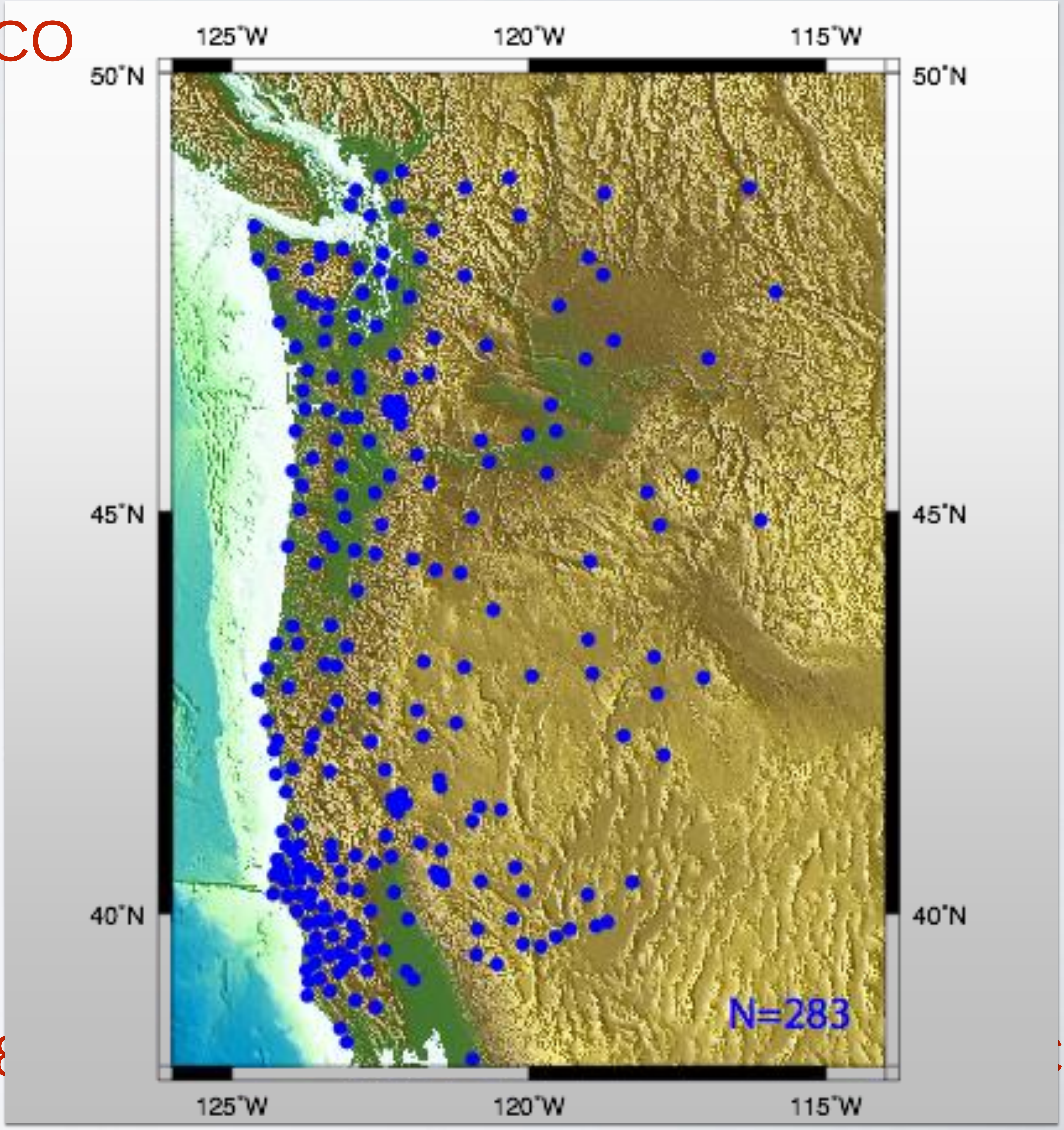


PBO H2O VEGETATION STATIONS



NSF INVESTMENT IN PBO: CA AND CASCADIA

~1632 cGPS (processed and/or maintained) by UNAVCO



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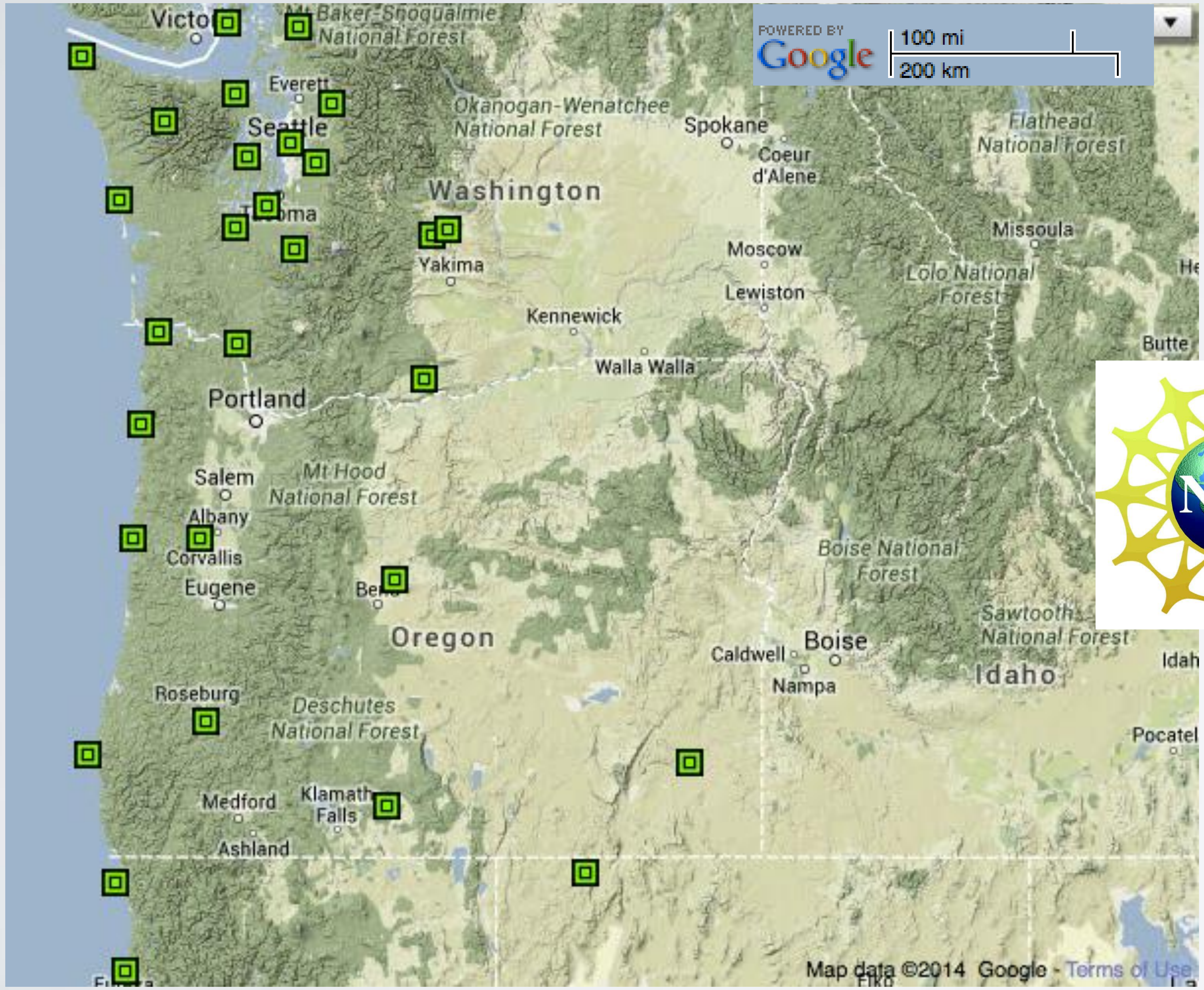
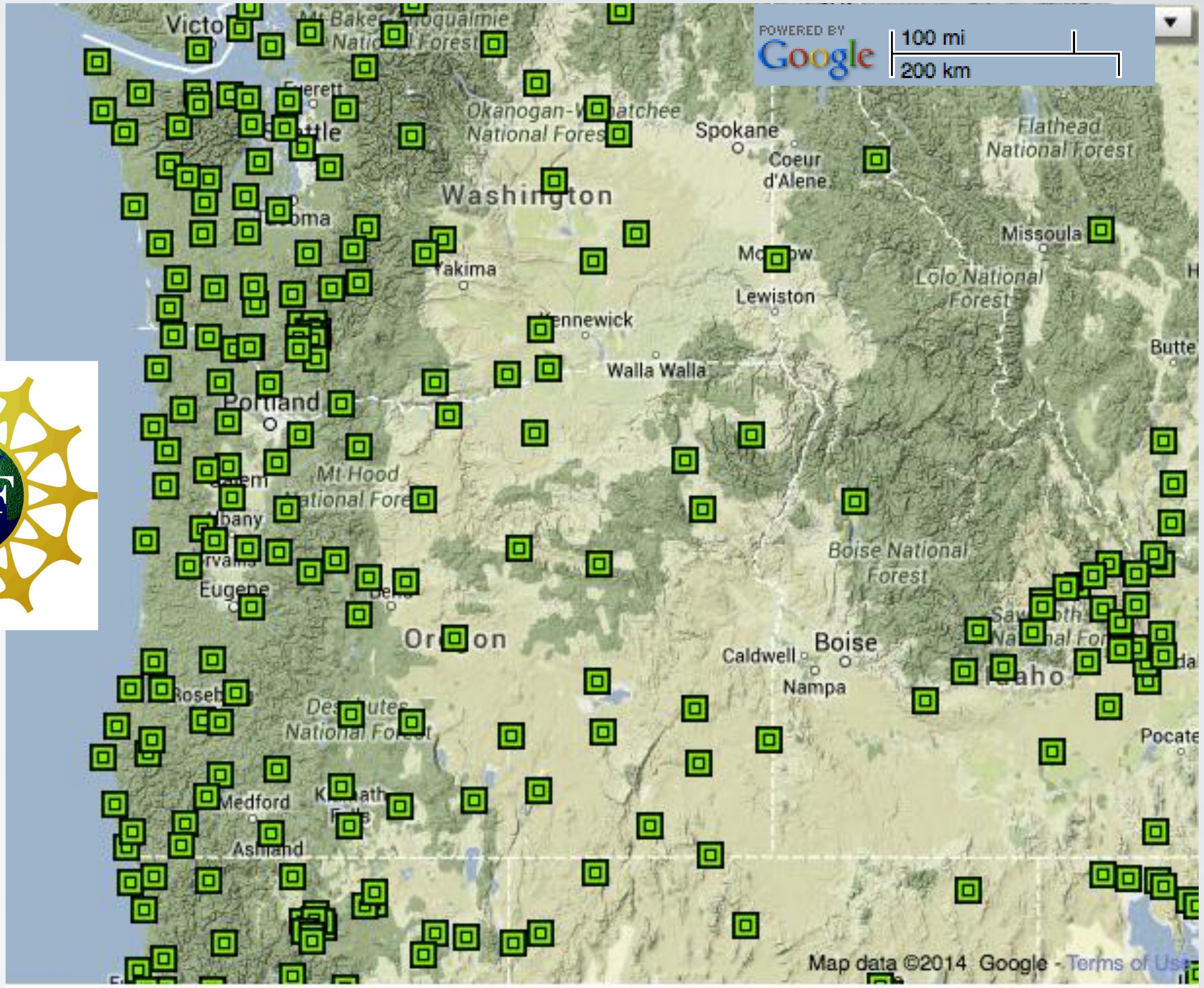
CASCADIA PBO ASSETS: INITIAL AND SUPPLEMENTAL INVESTMENTS

cGPS stations operated, processed, and maintained by UNAVCO

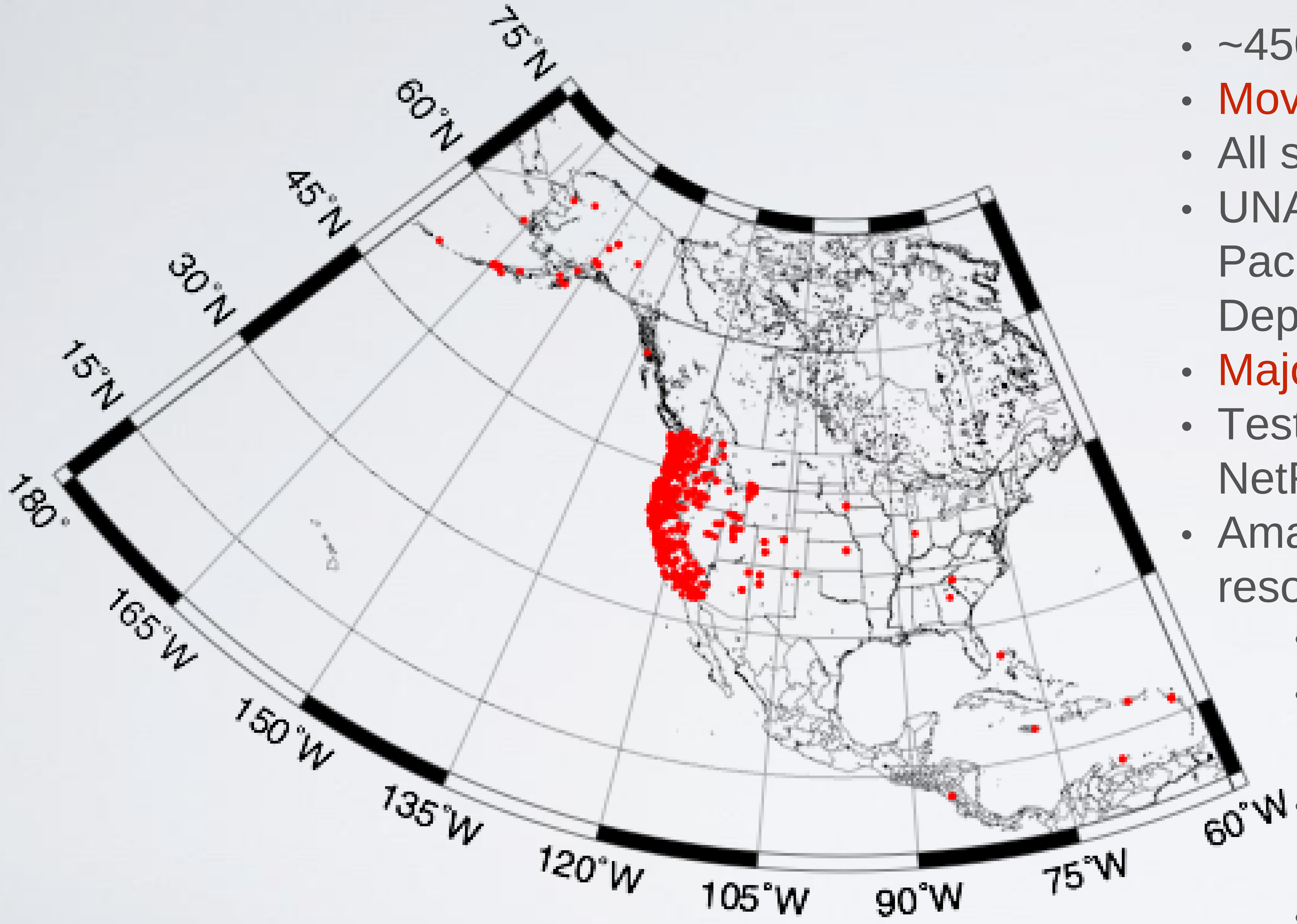


Original 29 PANGA cGPS stations



Current 234 PBO cGPS stations

RT-GPS - CURRENT NETWORK



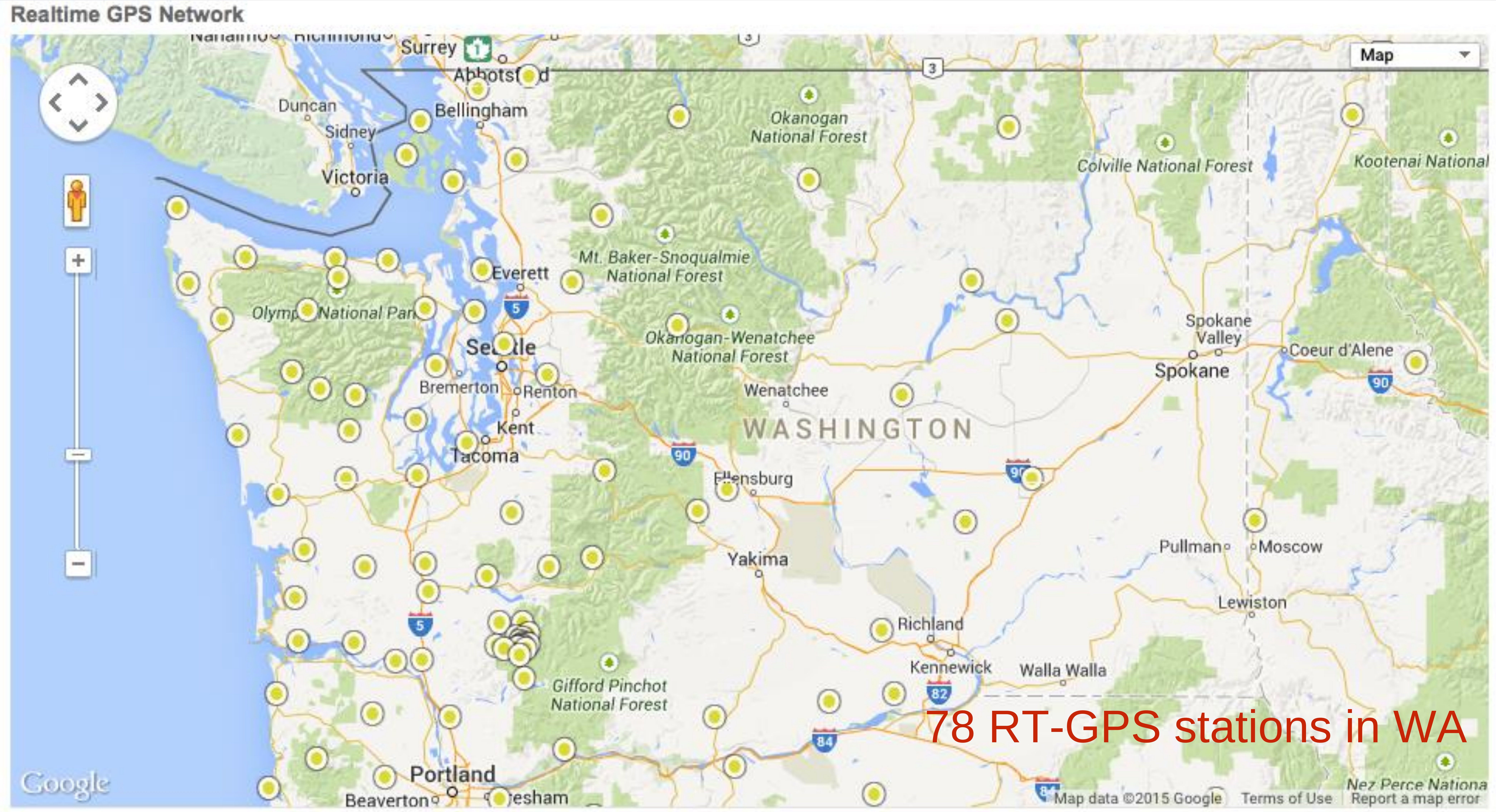
Current Network

- ~450 Real-time stations
- Moving towards archiving all data at 1 Hz
- All sites producing RTX point positions
- UNAVCO also participating in initiative for open Pacific wide data, NASA is leading through the State Department
- Major upgrade to PIVOT is underway
- Test of archive quality streams in process (limited to NetR9)
- Amazon grant received to test ~250 sites with all resources in the cloud.

Concerns

- Network side capacity for > 1 Hz data
- Archiving multiple data sets for same sample rate and station. (How to present this).
- *Very low dedicated resources (GAGE YR1 - 1 FTE)*
- Ill defined formats for processed real-time positions (UNAVCO will propose an EYRO/BNX hybrid - still need for SEED analog)

RT-GPS - CURRENT PBO NETWORK IN WA



78 RT-GPS stations in WA

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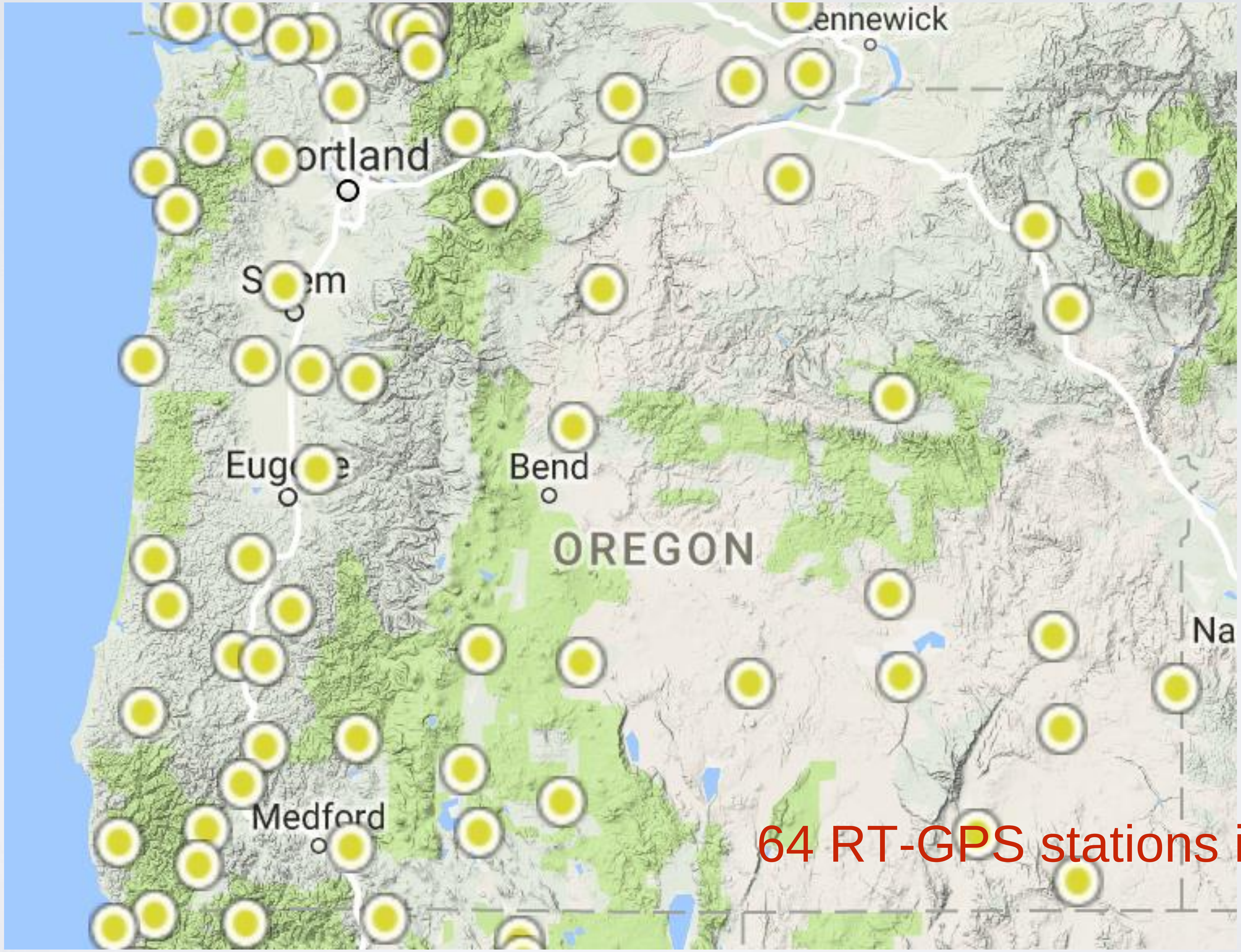
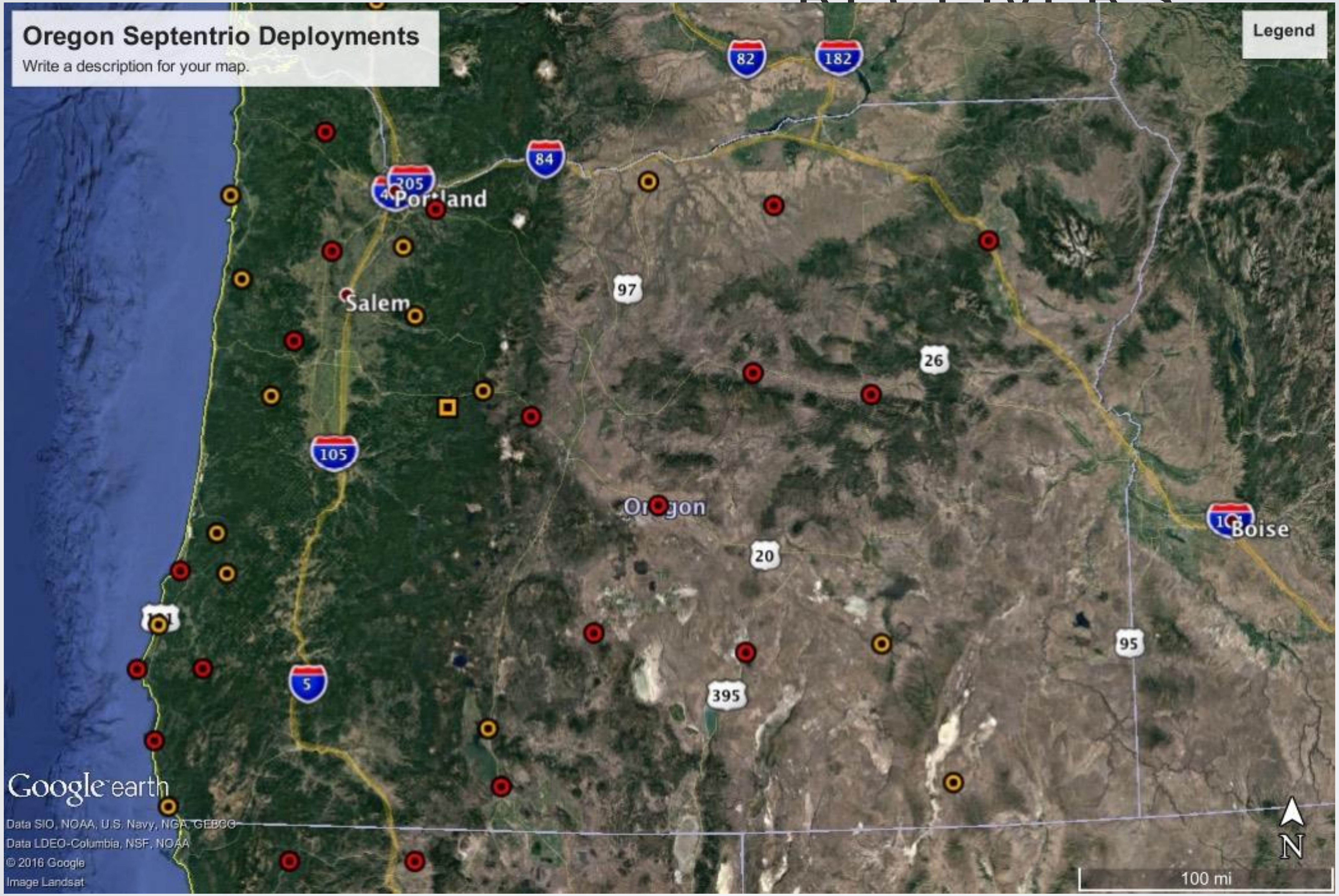
RT-GPS - CURRENT PBO NETWORK IN OR



64 RT-GPS stations in OR

100 SEPTENTRIO RECEIVER DEPLOYMENTS

ODOT CONTRIBUTED SEPTENTRIO RECEIVERS



PARTNERSHIPS

- ODOT Provided 19 Septentrio Receivers
- UNAVCO Provided the Antenna Upgrades

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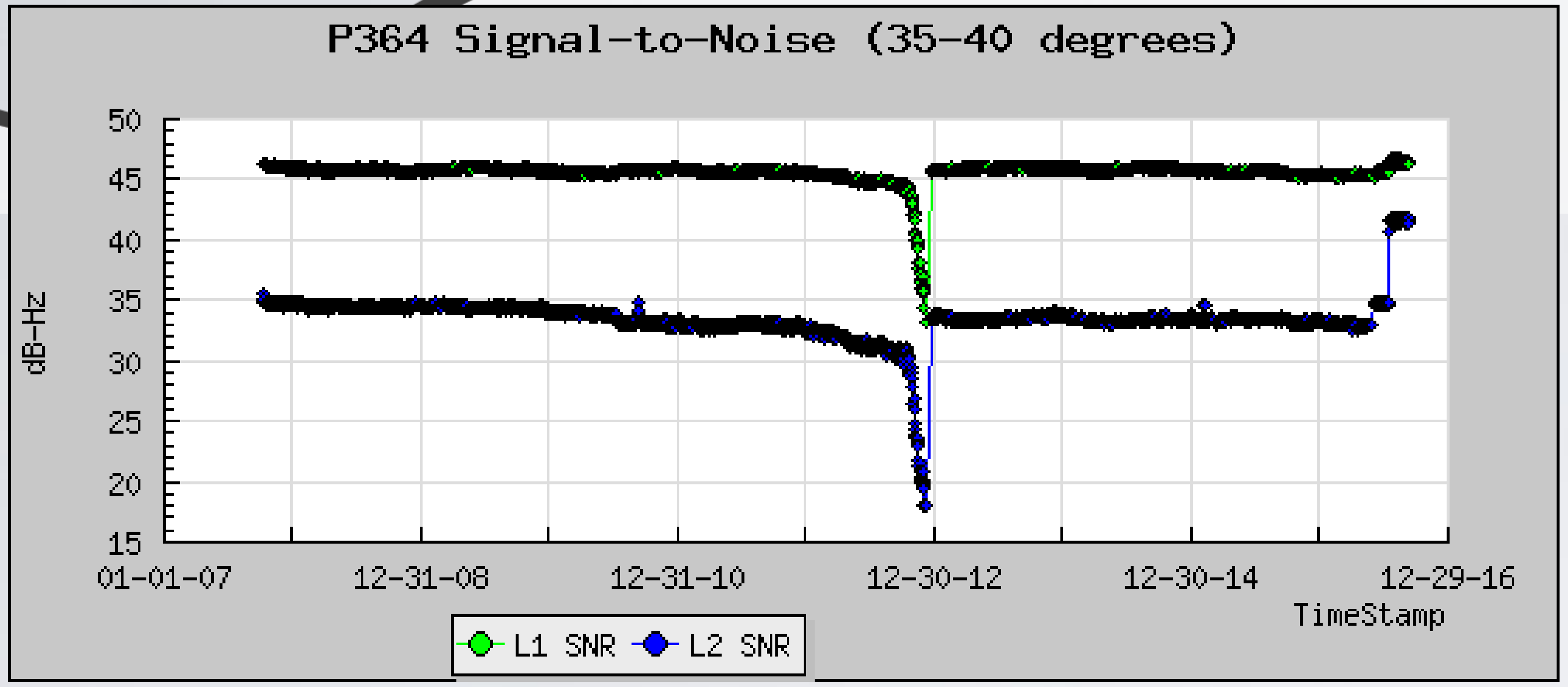
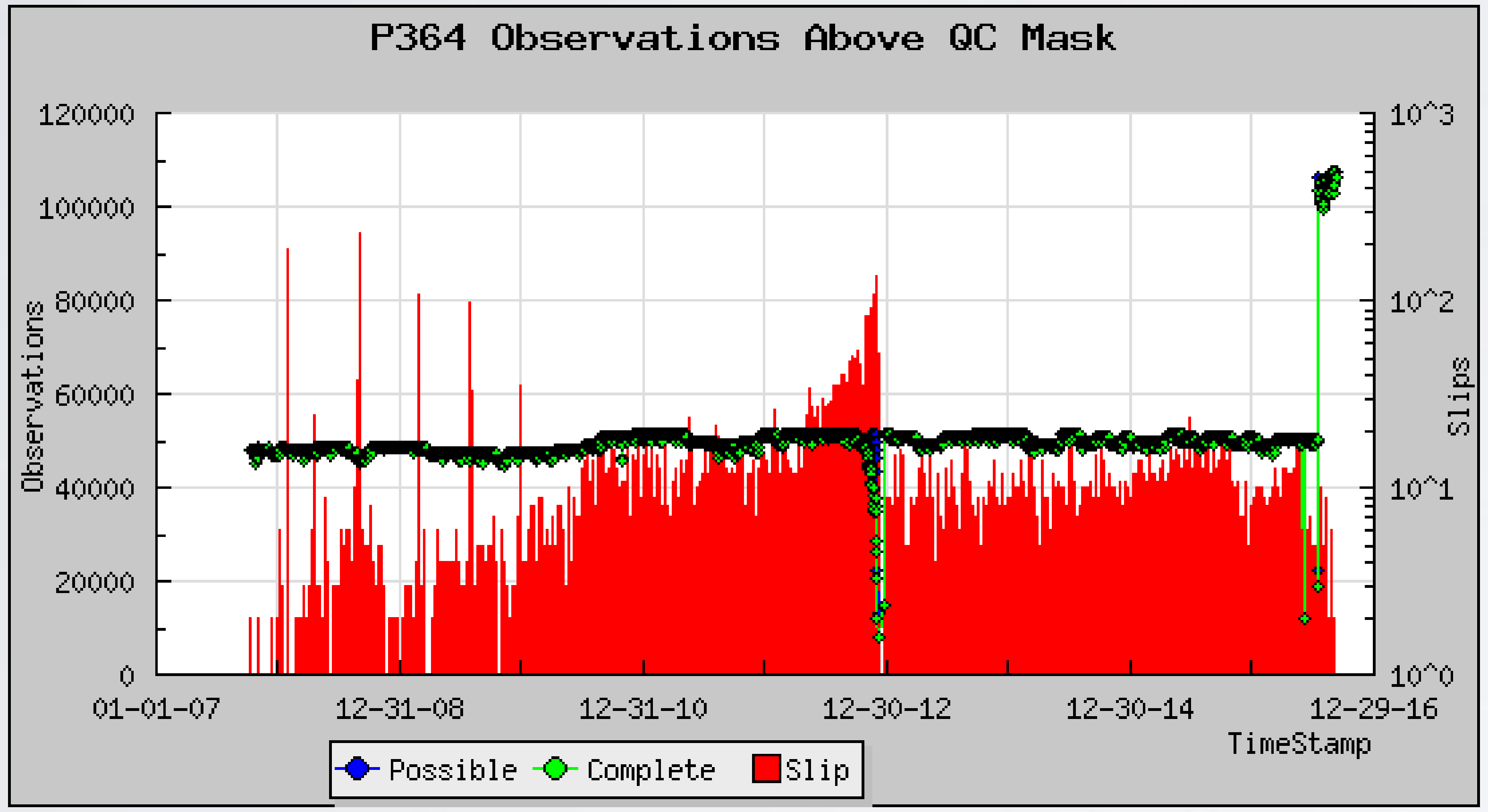
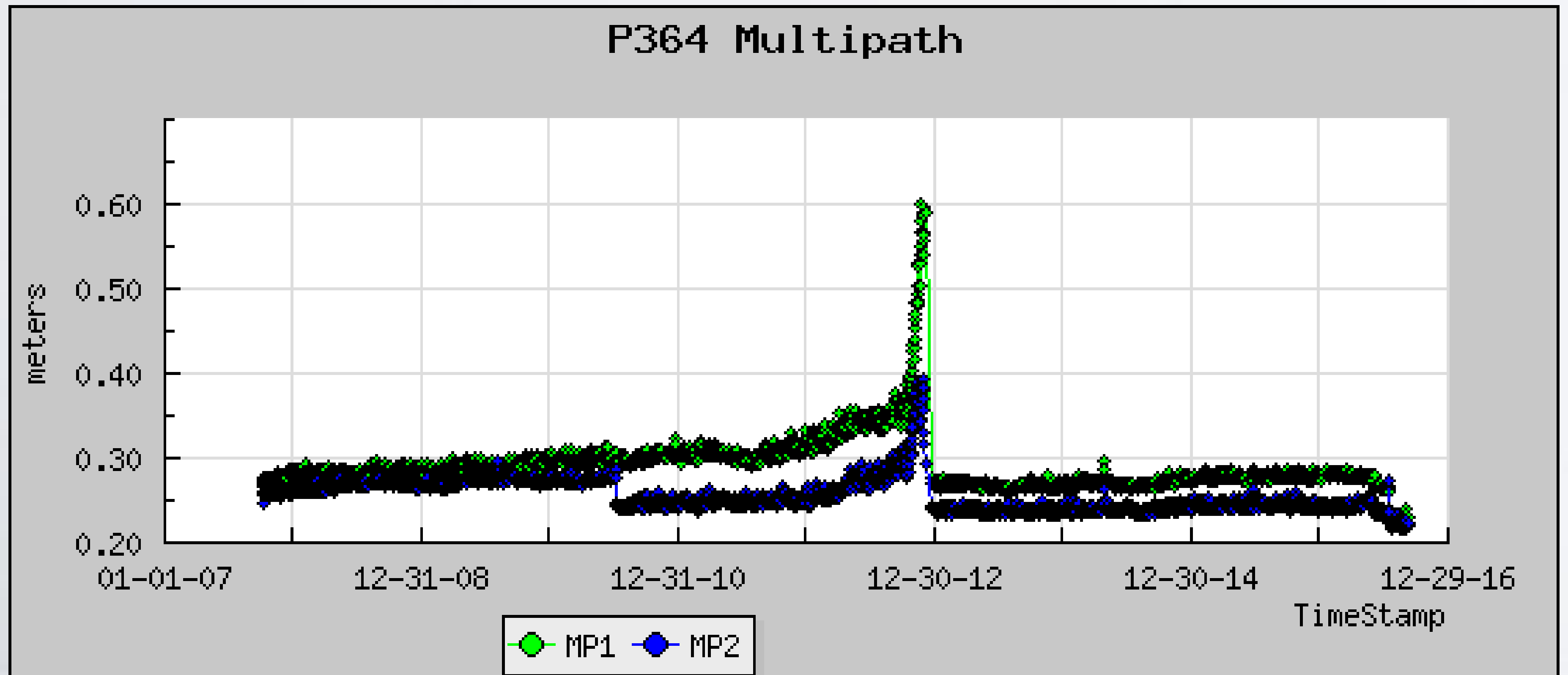
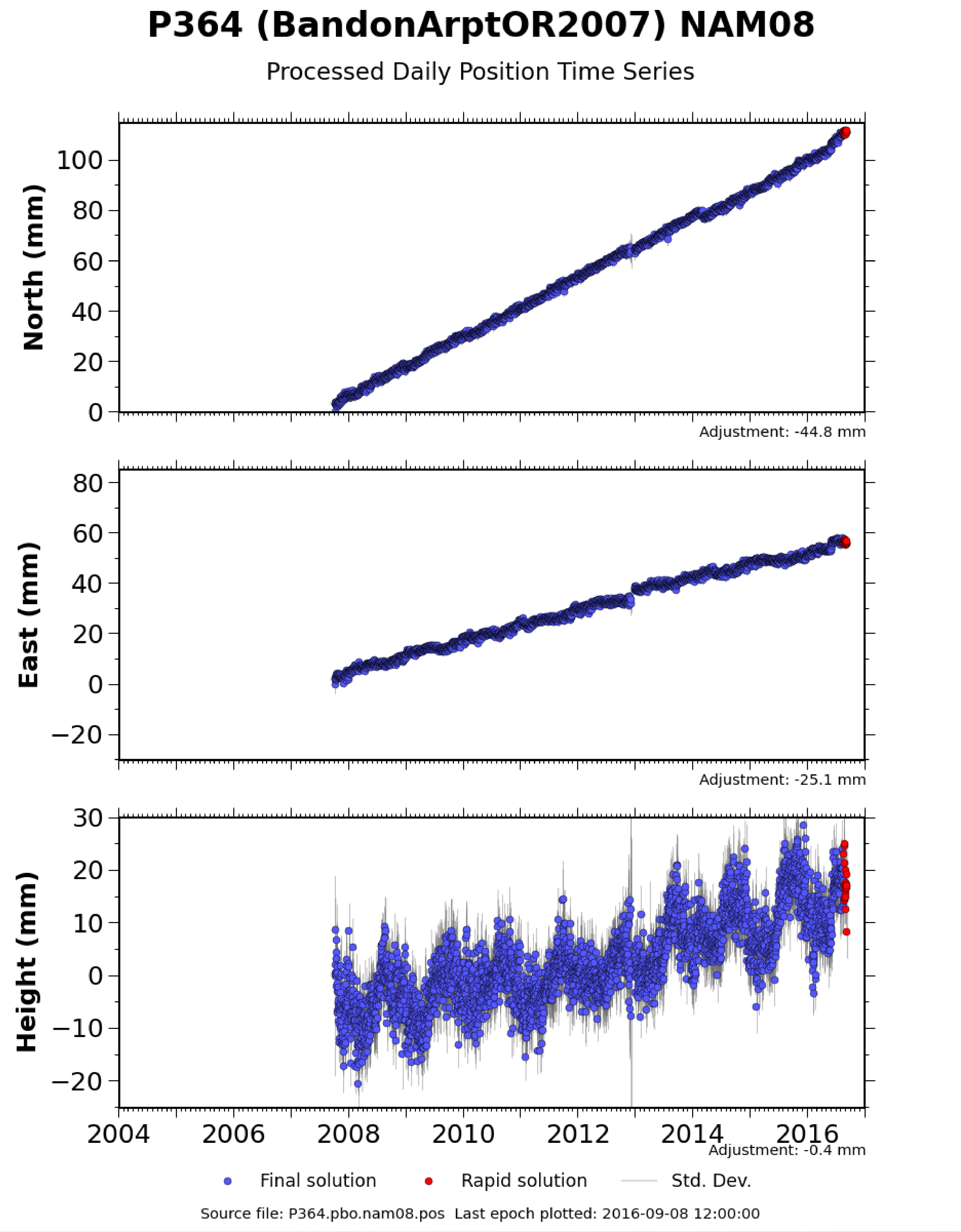
P364 SEPTENTRIO UPGRADE

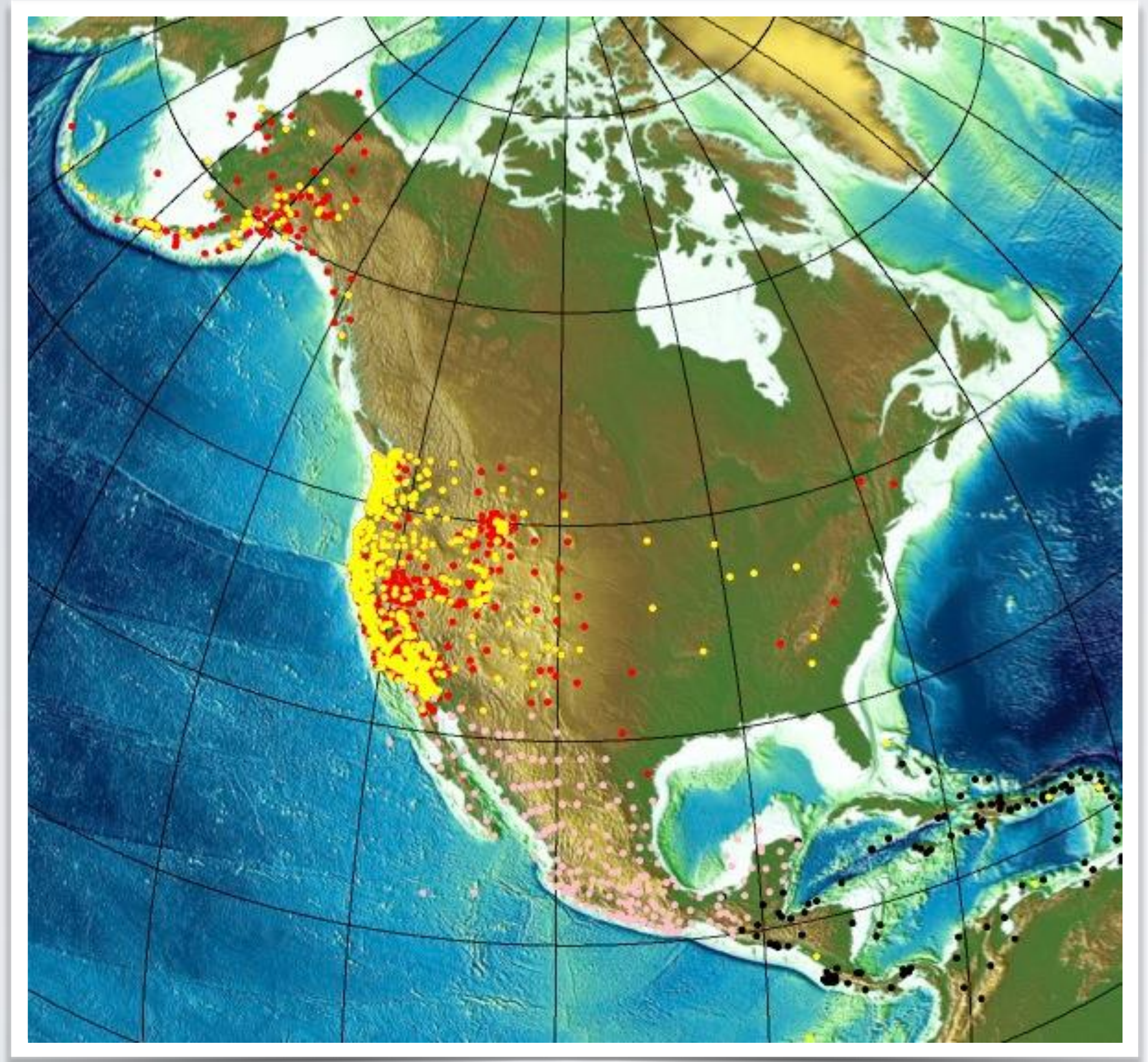


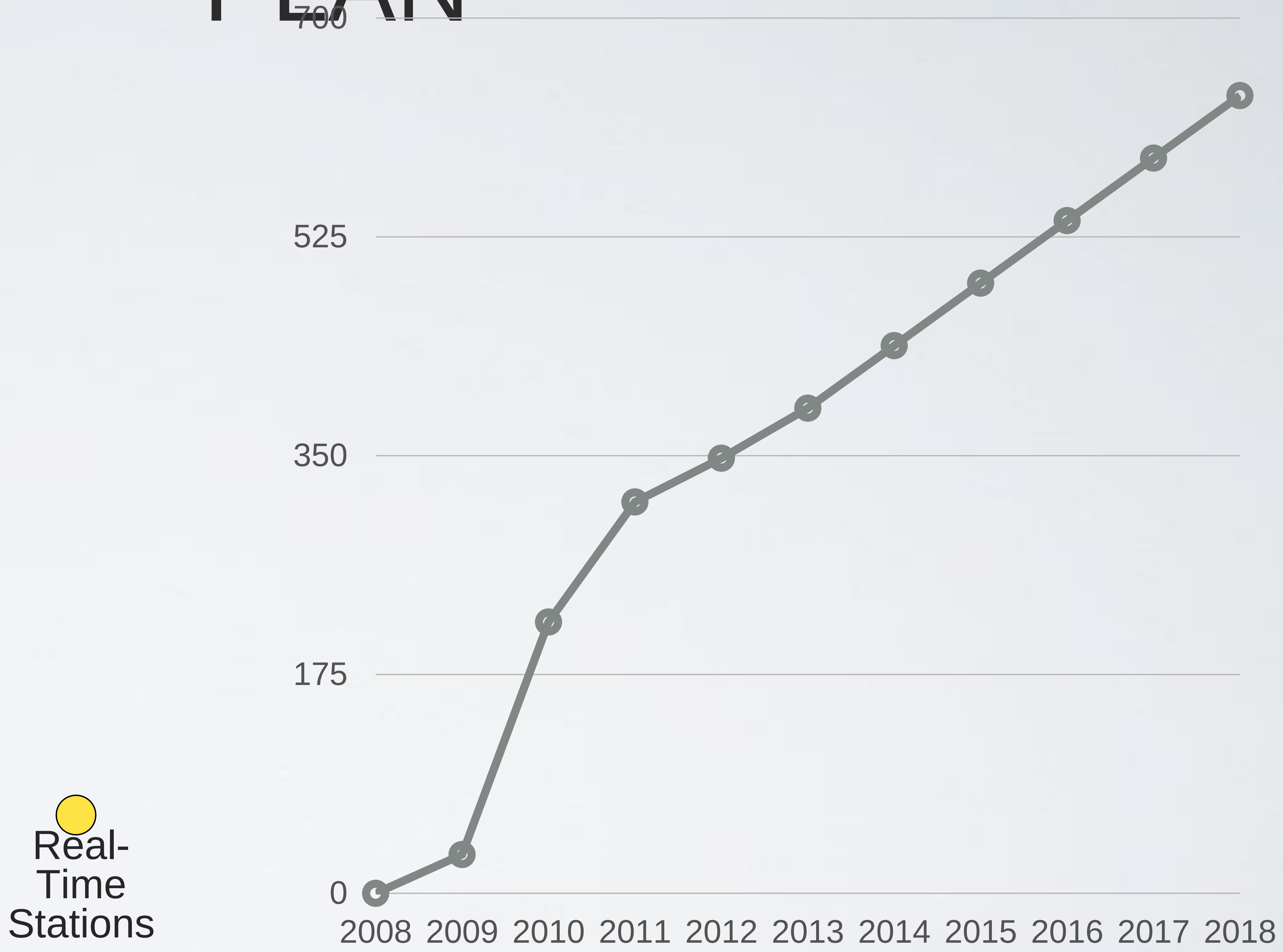




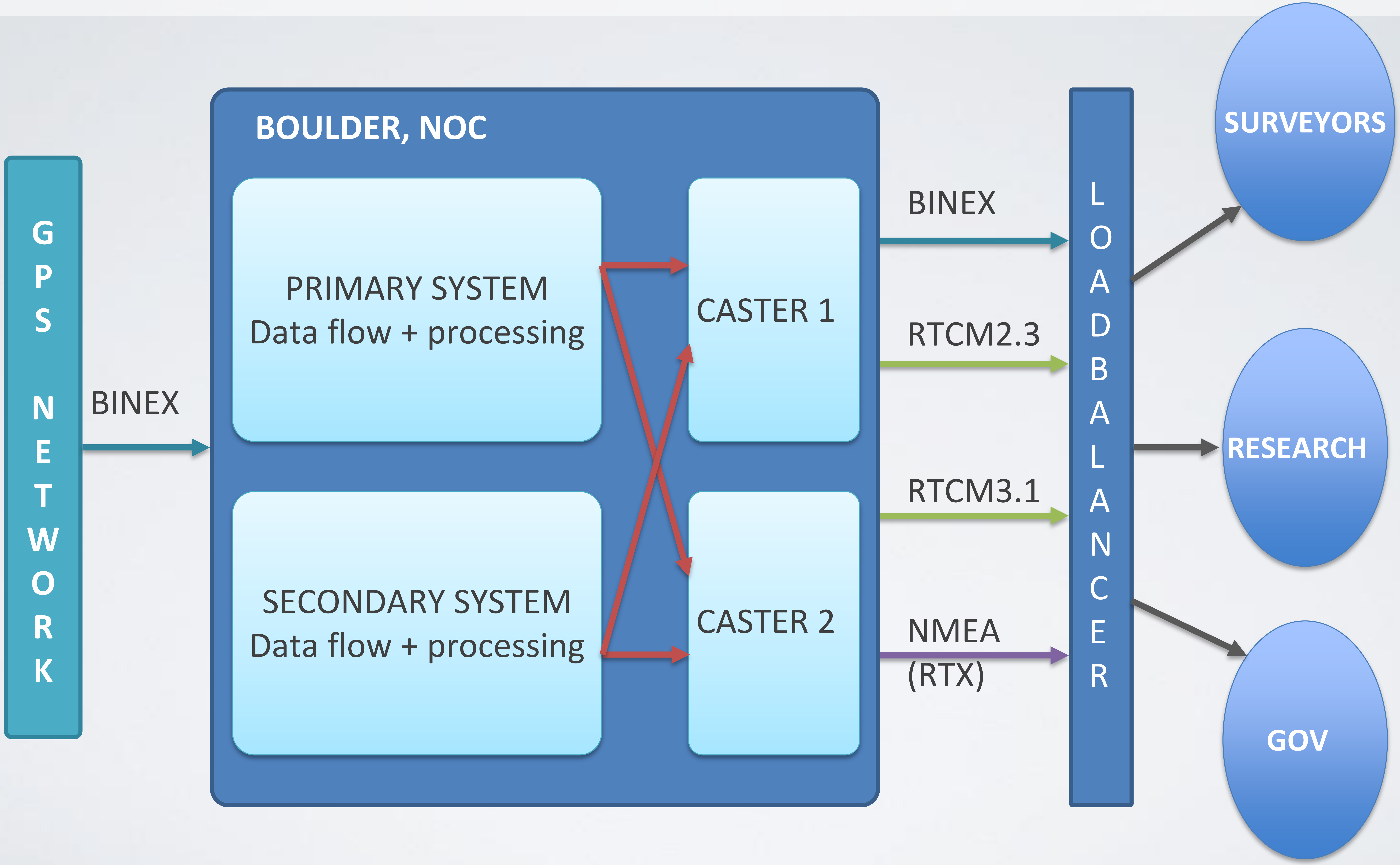


GAGE: REAL-TIME GPS/GNSS UPGRADE PLAN





REALTIME GPS DATAFLOW AT UNAVCO



Primary and secondary systems provide redundancy, both run simultaneously

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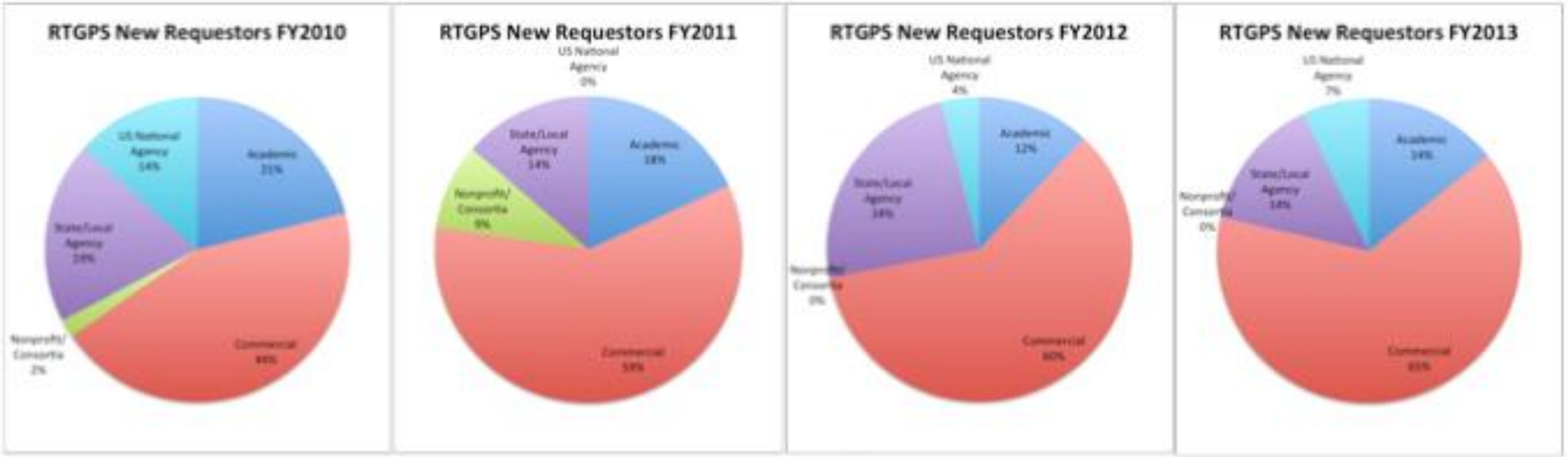
PBO REAL-TIME GPS/GNSS USERS



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.

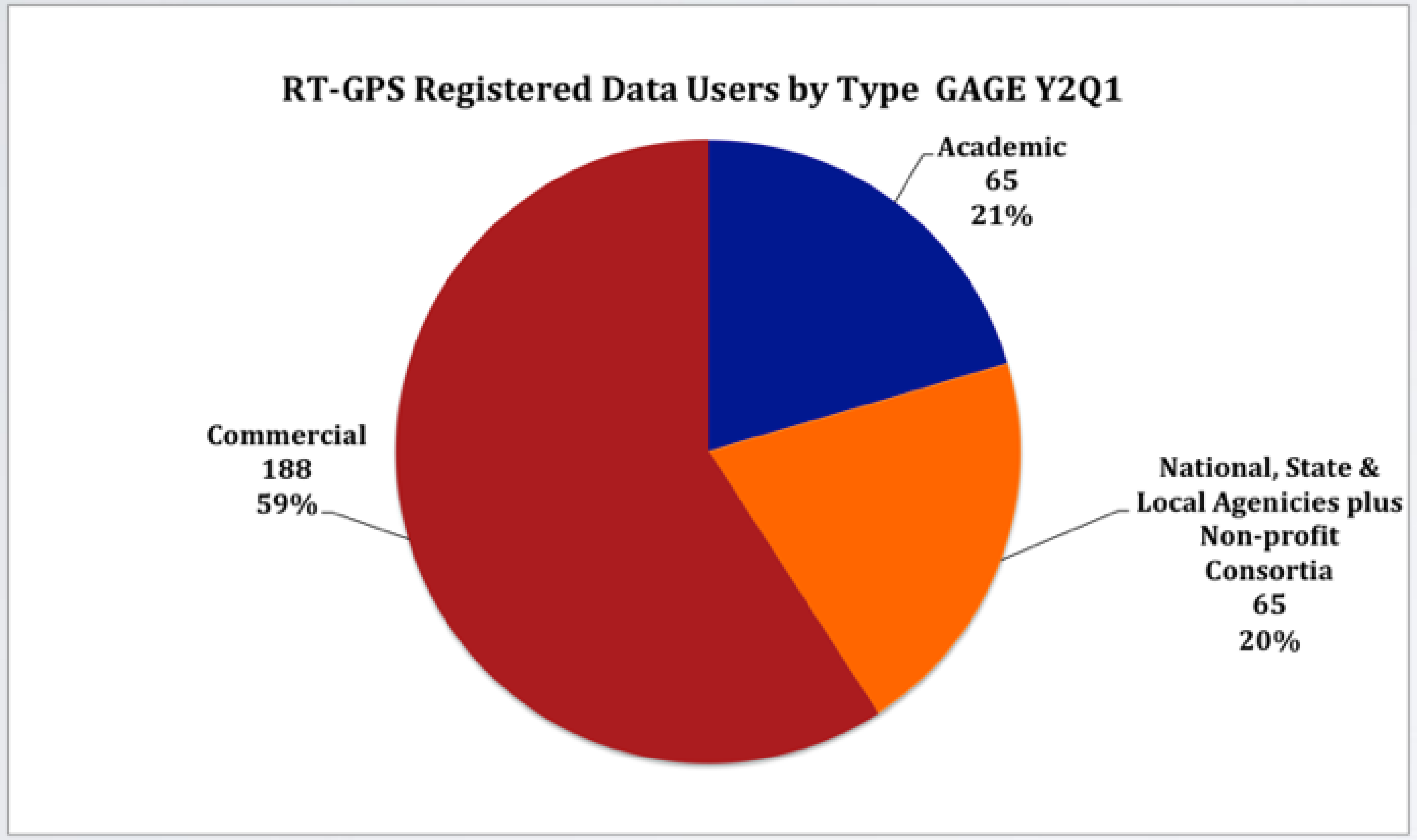
Interpretation: there are more commercial users than academic users of RTGPS data, but academic users access larger volumes of data.

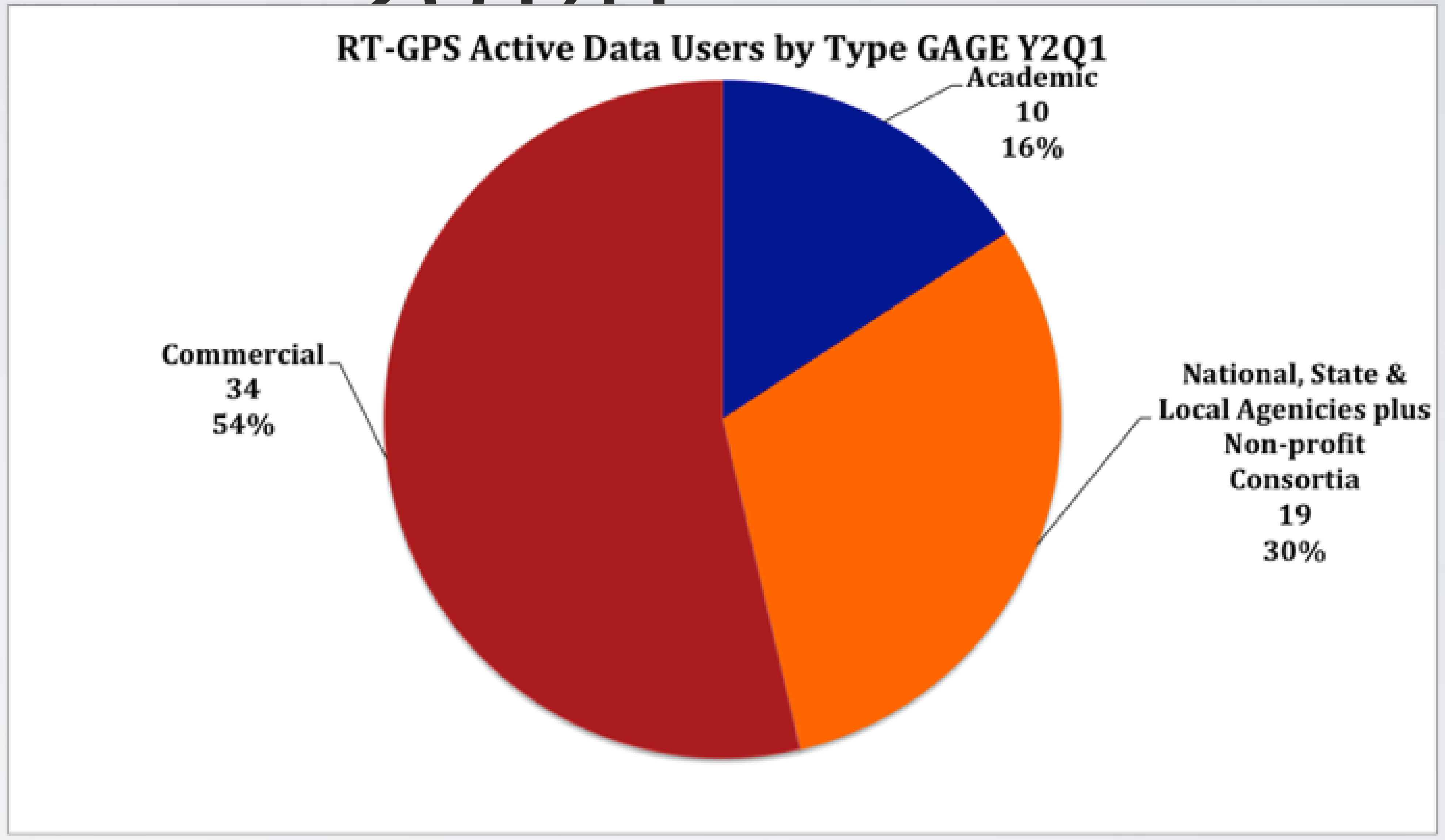
Trends in PBO RT-GPS usage:

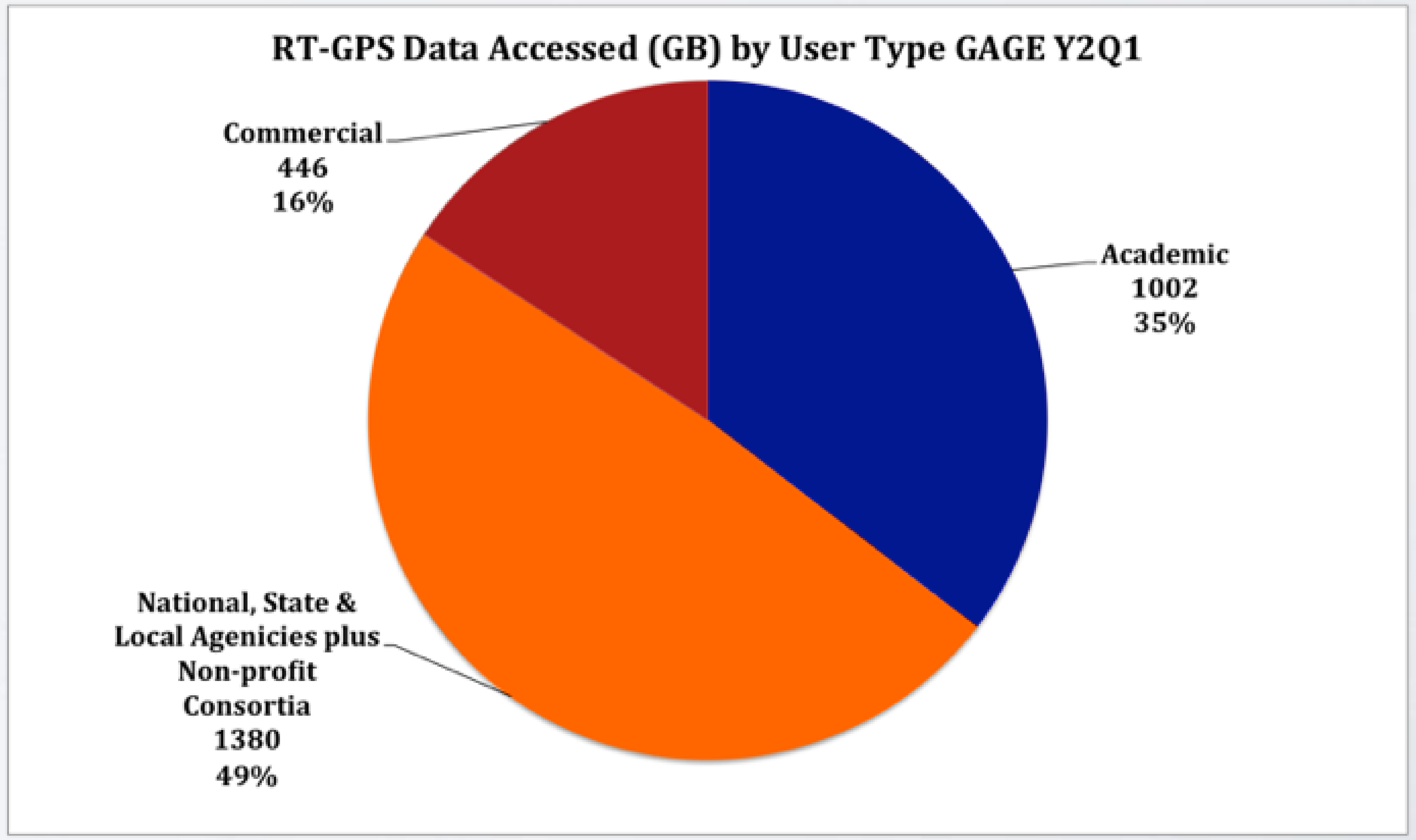
Increase in the number of new commercial sector users from 2010 to 2013

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

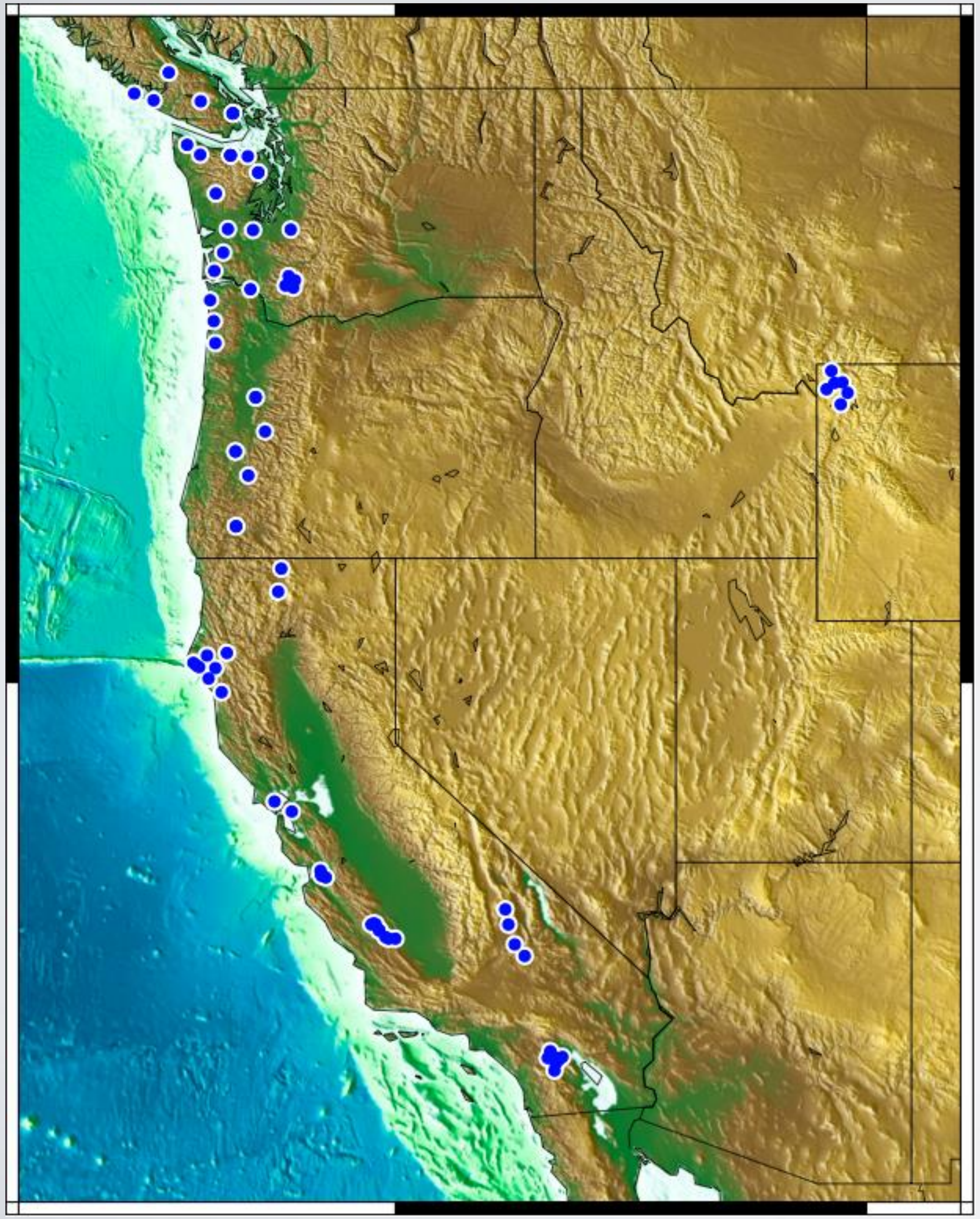
RT-GPS DATA USER METRICS (OCT-DEC 2014)







EARTHSCOPE: STRAINMETERS, SEISMOMETERS AND TILTMETERS



Concerns

- Strain workshop identified need for improved data processing outreach (workshops, etc.)
- Need real-time processed strain products (cleaned, translated to SEED).
- Antelope License changes - concern is resources to support multiple concurrent streaming platforms now required.

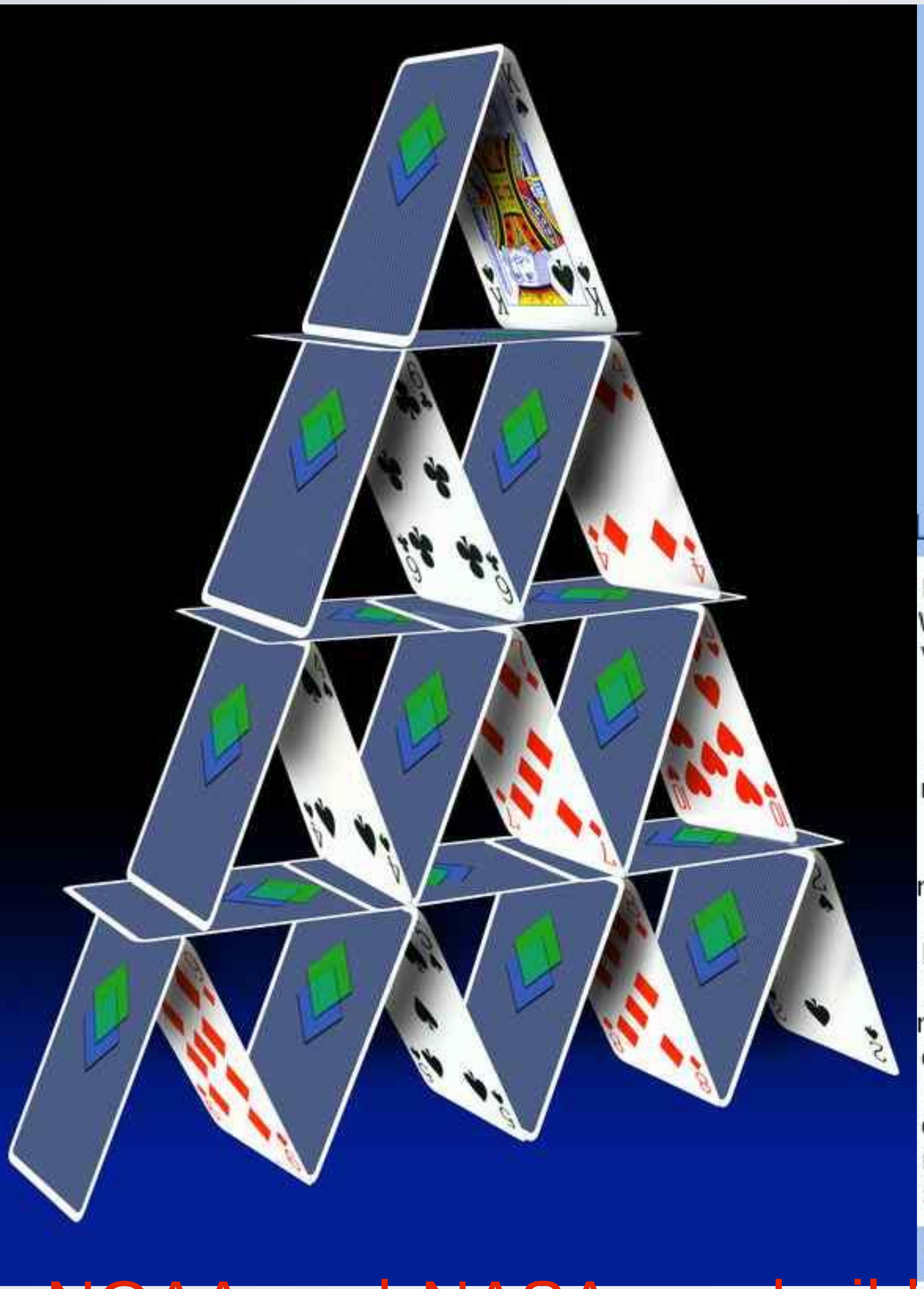
New Data-Related Initiatives

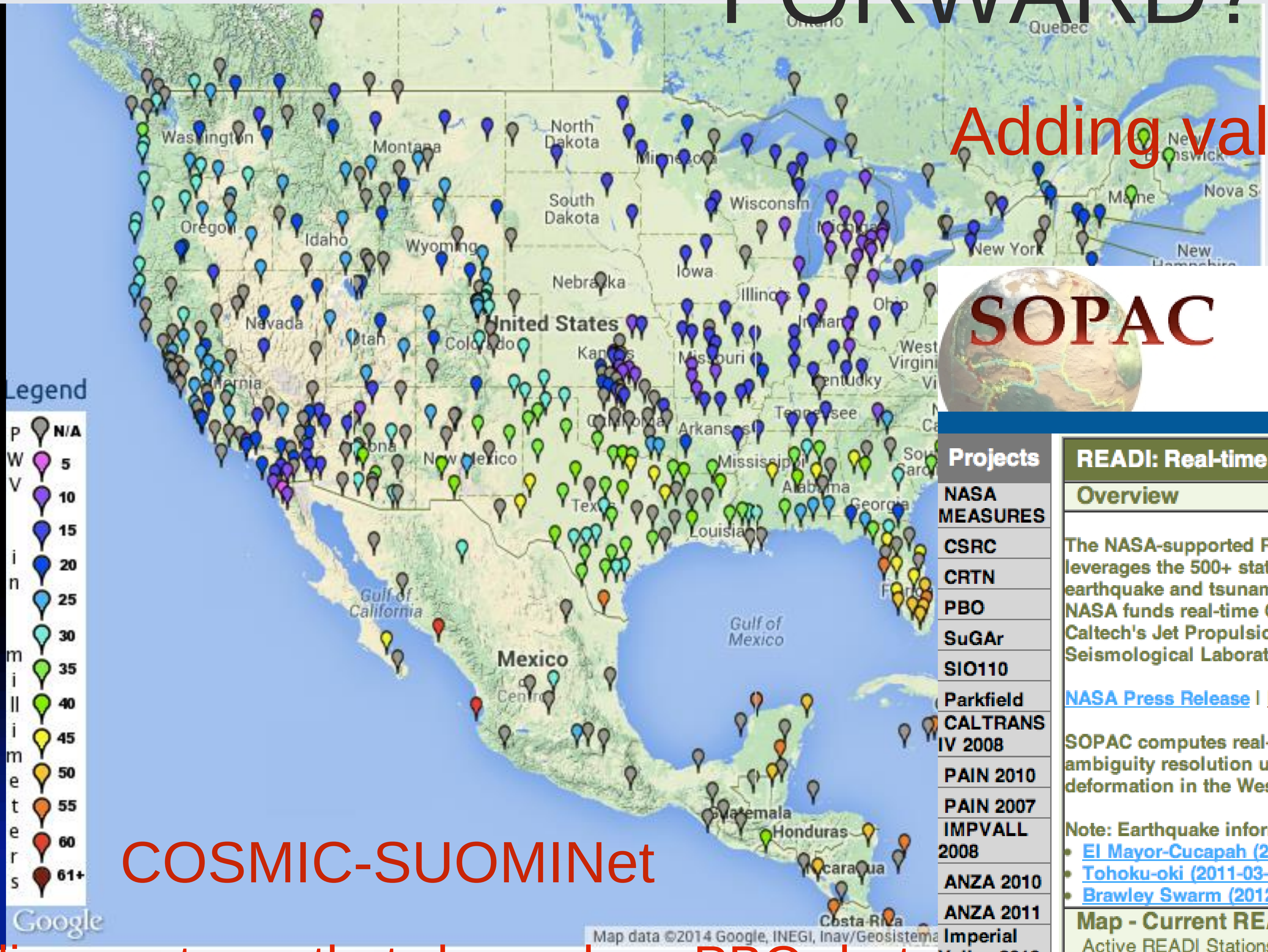
- Realtime strain data (on hold until summer while we focus on RT-GPS)
- Improved strain data quality (review two stations a week with engineers)
- Integration into Web Services (Level 2 Data Products)
- Move streaming data from Antelope to SEEDlink (beta is operational)

DRIVING THE PBO AND OTHER CGPS NETWORKS: MONITORING VS. SCIENCE?

- What is monitoring and how has it changed over time?
  - Intermittent observations with single sensors (past); selected continuous observations with selected multiple sensors (current); spatially dense observations over the entire deformation frequency spectrum with validated data available on any platform of choice (future).
- What are the values and benefits of monitoring?
  - Validated geophysical “monitoring” data condition “scientific” discovery; new “scientific” models can drive the need for additional “monitoring” data and systems; experimental (physics-based) model may not apply to most geophysical observations - earth system is complex and very interconnected…geohazards and concomitant risks are not constant in space and time!
- What challenges/opportunities exist in managing, maintaining, and providing access to monitoring data in a ‘real-time’ world, to multiple users?
  - Continuous (geodetic) sensor observations combined with open data model serves the broadest possible number of stakeholders and applications; but why pay for the cow when you can get the milk for free?

FUTURE OF PBO - HOW DO WE MOVE FORWARD?





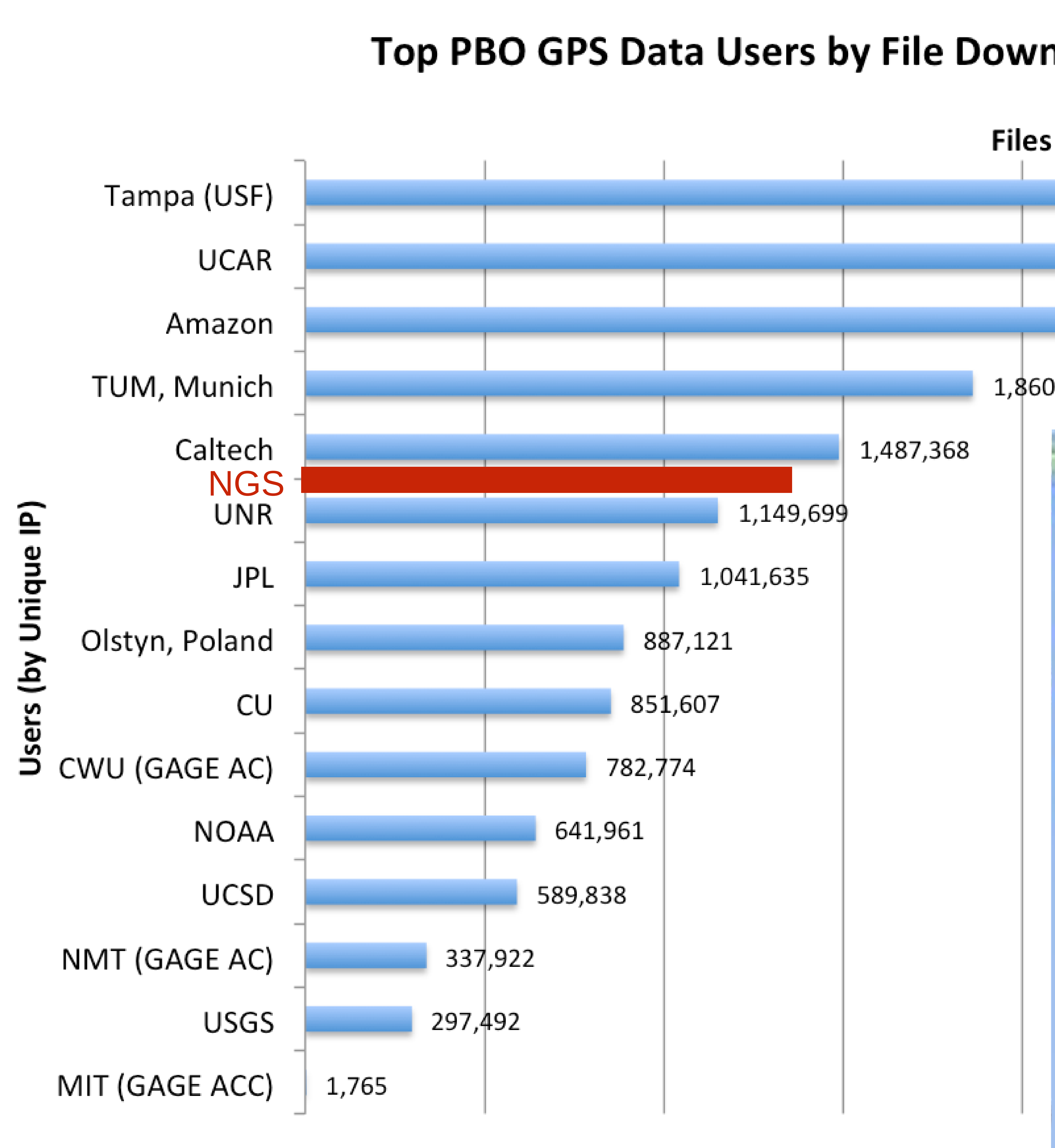
Adding value and creating dependency

COSMIC-SUOMINet

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...

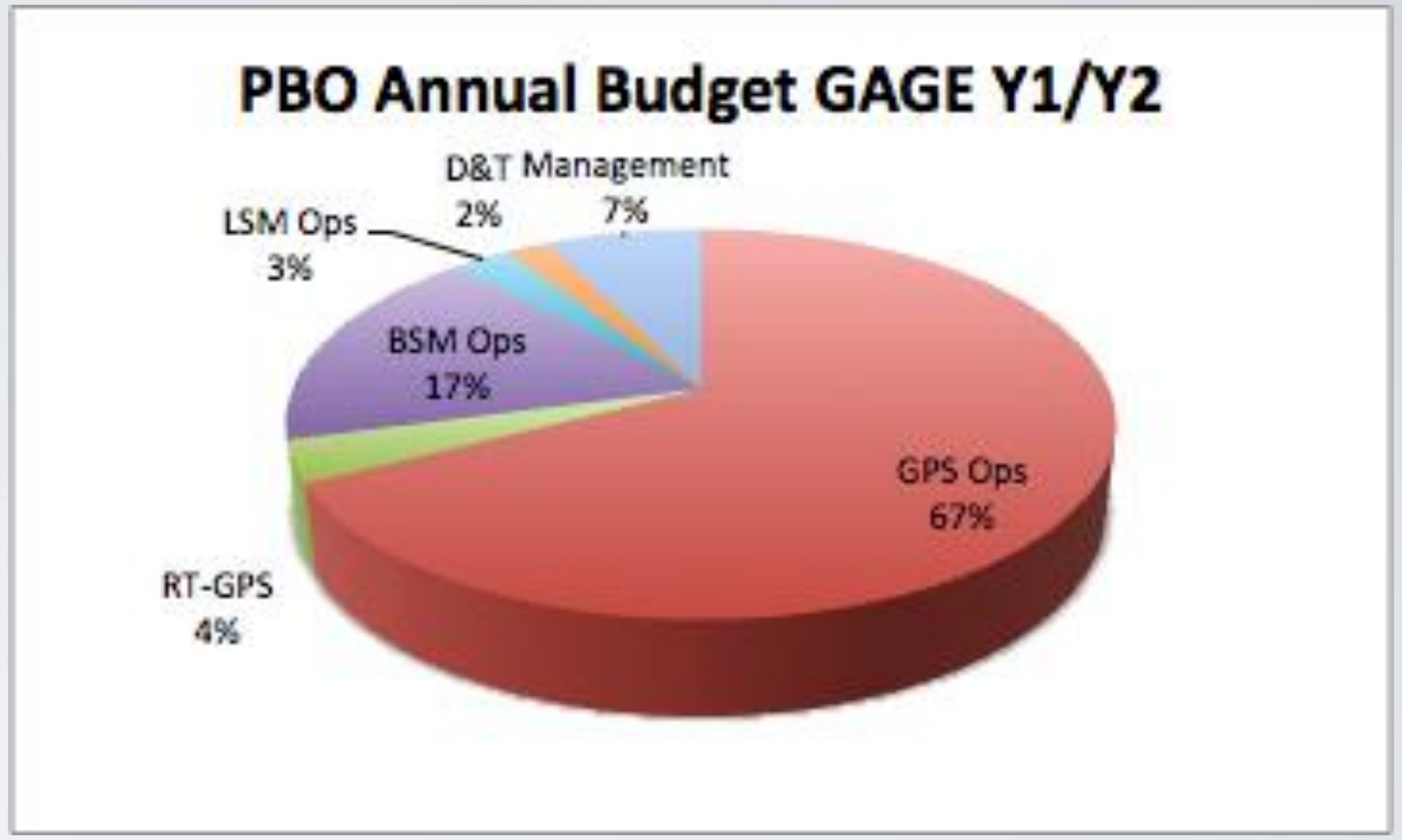
NGS - CORS & OPUS: PBO DATA REDISTRIBUTION

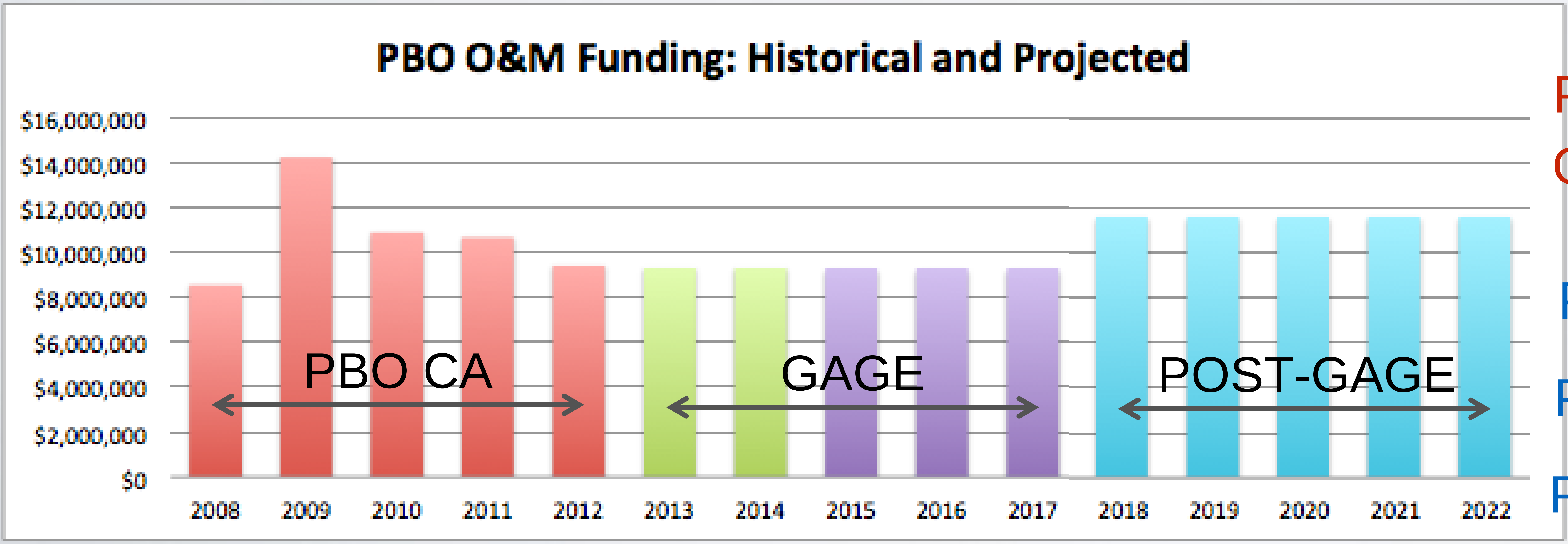


1,217,172 CORS archive via FTP and custom download (UFCORS)

GAGE PBO BUDGET - O&M HISTORY AND YR1&2

PBO Component	GI budget	GI FTE	GDS budget	GDS FTE	Total budget
GPS Ops	$ 4.55 M	16.20	$ 1.65 M	7.00	$ 6.20 M
RT-GPS	-	-	$ 0.32 M	1.64	$ 0.32 M
BSM Ops	$ 1.07 M	3.75	$ 0.52 M	2.85	$ 1.59 M
LSM Ops	$ 0.24 M	1.00	-	-	$ 0.24 M
D&T	$ 0.19 M	1.74	-	-	$ 0.19 M
Management	$ 0.56 M	2.50	$ 0.10 M	0.60	$ 0.66 M
Total	$ 6.61 M	25.19	$ 2.59 M	12.09	$ 9.20 M





PBO CA: $53.7M; $10.7M/yr average

GAGE: $46.4M; $ 9.3M/yr average

POST-GAGE: 25% reduction?

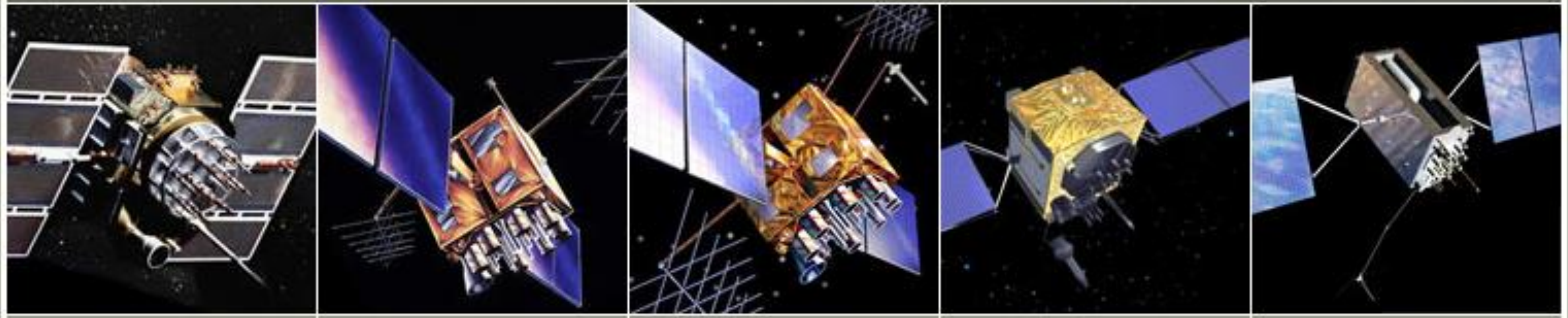
POST-GAGE: Flat-funded?

POST-GAGE: 25% increase?

UNAVCO

GPS MODERNIZATION - IMPLICATIONS FOR PBO

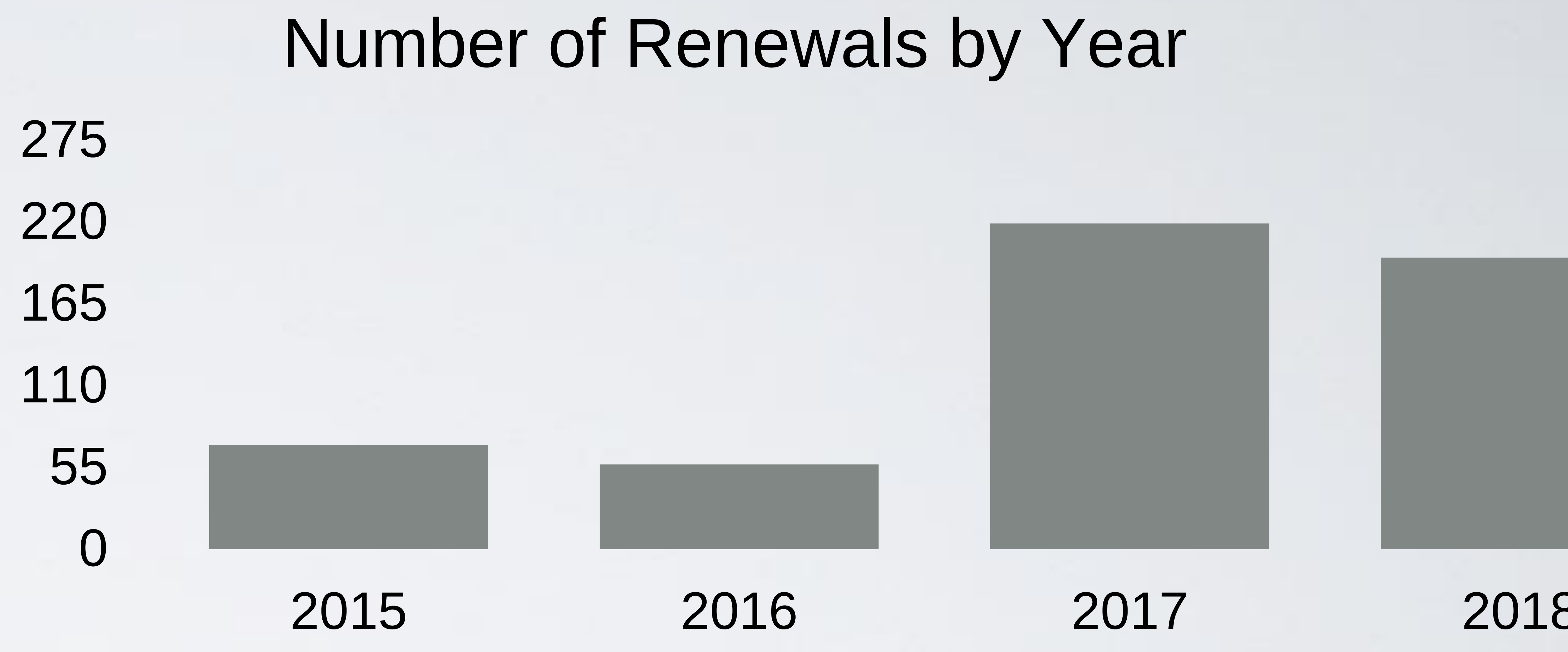
- Total of 15 L2C-capable SVs in orbit now
- Total of 8 L5-capable SVs in orbit now
- Block III SVs to begin launch in 2016
- DoD/DoC announced phase-out of civil access to P(Y) on L1/L2 effective 2020 to drive commercial sector to L2C/L5 applications
  - PBO has ~900 Trimble NetRS deployed - only can encode L2C & no GNSS signals (all are EOL/EOS); most EAR/PLR pool receivers are the same vintage technology
  - PBO/COCONet/TLALOCNet has ~250 Trimble NetR9 deployed - can encode L2C, L5, +GNSS
- UNAVCO RFP for new GNSS receiver preferred vendor was finalized in June 2015 with Septentrio, Inc. 119 new instruments purchased (19 by ODOT) in 2016 and ~60 deployed to date.

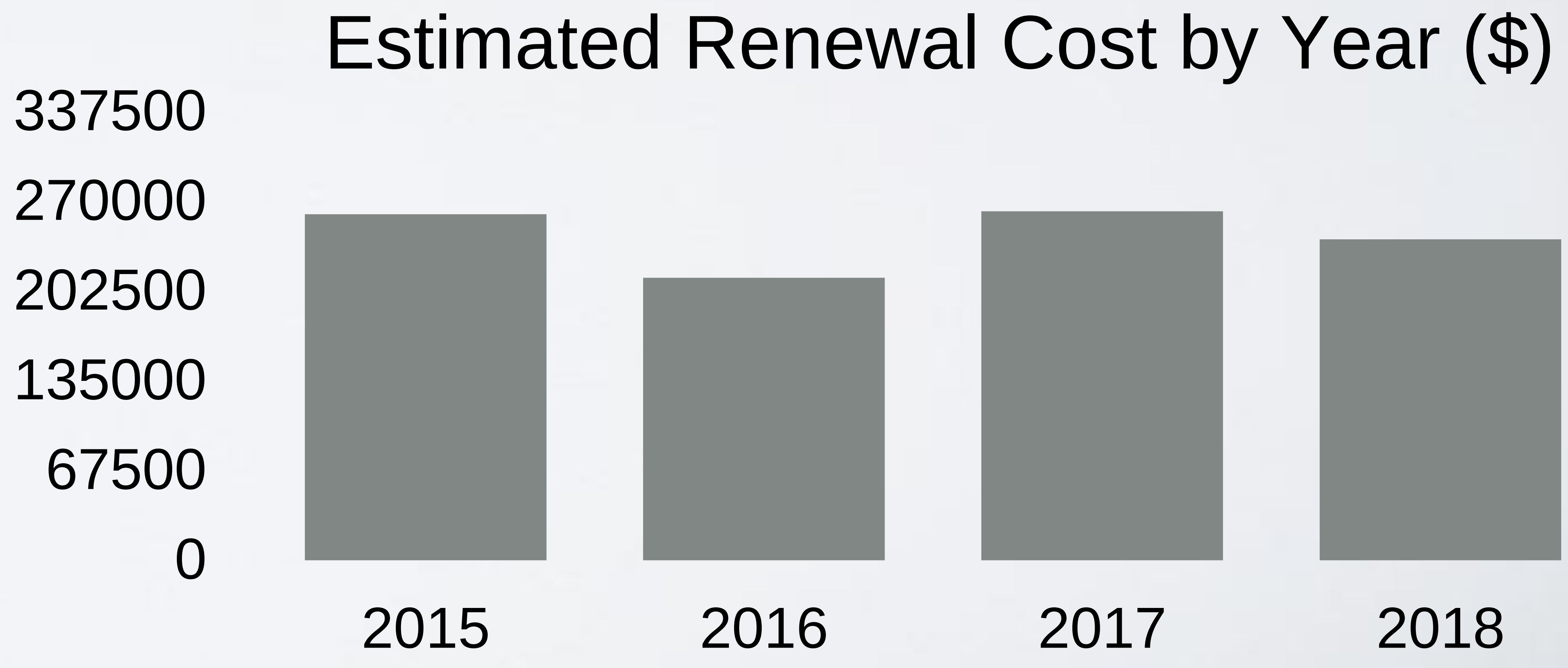


LEGACY SATELLITES		MODERNIZED SATELLITES		
BLOCK IIA	BLOCK IIR	BLOCK IIR(M)	BLOCK IIF	GPS III
3 operational	12 operational	7 operational	8 operational	Now in production
▪ Coarse Acquisition (C/A) code on L1 frequency for civil users ▪ Precise P(Y) code on L1 & L2 frequencies for military users ▪ 7.5-year design lifespan ▪ Launched in 1990-1997	▪ C/A code on L1 ▪ P(Y) code on L1 & L2 ▪ On-board clock monitoring ▪ 7.5-year design lifespan ▪ Launched in 1997-2004 VIEW AIR FORCE FACT SHEET	▪ All legacy signals ▪ 2nd civil signal on L2 (L2C) LEARN MORE ▪ New military M code signals for enhanced jam resistance ▪ Flexible power levels for military signals ▪ 7.5-year design lifespan ▪ Launched in 2005-2009 VIEW AIR FORCE FACT SHEET	▪ All Block IIR(M) signals ▪ 3rd civil signal on L5 frequency (L5) LEARN MORE ▪ Advanced atomic clocks ▪ Improved accuracy, signal strength, and quality ▪ 12-year design lifespan ▪ Launched since 2010 VIEW AIR FORCE FACT SHEET	▪ All Block IIF signals ▪ 4th civil signal on L1 (L1C) LEARN MORE ▪ Enhanced signal reliability, accuracy, and integrity ▪ No Selective Availability LEARN MORE ▪ Satellites 9+: laser reflectors; search & rescue payload ▪ 15-year design lifespan ▪ Begins launching in 2016

PBO PERMITTING STATUS

- James Downing hired in September, 2014 to manage UNAVCO Contracts and Permitting issues.
- 1.3 FTE currently allocated for the permit renewal process. This is a nearly two-fold increase in LOE from PBO CA and GAGE YR1
- Developed a permitting renewal plan which will require an evenly distributed budget with projections between $212k and $262k each year through 2018.
- The number of permit renewals expected in 2017 and 2018 remains high due to clauses that prohibit renewals sooner than 9-12 months before the stated expiration date.





WORKSHOP ORGANIZING COMMITTEE AND TIMELINE

Glen S. Mattioli, UNAVCO GI and PBO Director, Chair and PI for NSF Workshop proposal
Rebecca O. Bendick, UNAVCO Board of Directors liaison to the GI AC
James H. Foster, Chair of the GI Advisory Committee
Jeffrey Freymueller, Chair of the PBO Working Group

Proposal submitted to NSF: March 18, 2014
Awarded: June 7, 2014, EAR-1441122; $60.4K
Workshop announced: June 26, 2014
Workshop convened: September 22-24, Breckenridge, CO
Participants: 66, including 17 UNAVCO staff members and NSF and USGS program managers

RECOMMENDED IMMEDIATE MANAGEMENT ACTIONS

- Regularize maintenance and service schedules in regions where transients are “less likely” (resulting in reduced uptime)
- Identify key regions (Cascadia) for immediate maintenance response where transients are “more likely”

- **Upgrade stations to real-time where cost-effective comms and adequate power are already available**
- **Upgrade a limited number of GPS to GNSS in strategic target areas of high scientific value, large user communities, and D&T**

- Encourage NSF staff to aggressively pursue federal agency cooperation at the highest possible level
- Explore all avenues for “upreach”

- **Seek partnerships to meet additional costs for earthquake early warning and other GNSS-enabled, high-rate, RT applications**

- Make immediate investments in the data management work flow to allow more data integration and sharing
- Expand UNAVCO’s ability to ingest and fully integrate or serve as a portal for data from non-PBO sources

- **Explore adoption of O&M costs or collaborative sponsorship of some sensors or sets of sensors by other entities**

- Leverage ECE to better engage the public and stakeholders in UNAVCO activities

- **Identify sites with the worst data quality and move to other location or decommission as possible (or do not renew permits)**
- **Otherwise, do not decommission GPS sites prior to 2018**

- Defer all maintenance of low-value borehole installations, or divest the sites only producing seismic data to regional seismic networks

SUGGESTED LONG-TERM ACTIONS

Positioning PBO for the future

- **Develop a strong GNSS (i.e. GLONASS) + real-time streaming pilot project**

- Develop a strong multi-timescale data products pilot (e.g. Mt. St. Helens) [multi dataset Google Earth for time series]
- Develop a pilot project to stream multiple sensor outputs and develop a flexible, generic data stream hardware + software system (leverage existing systems developed by Ocean Observing Initiative)

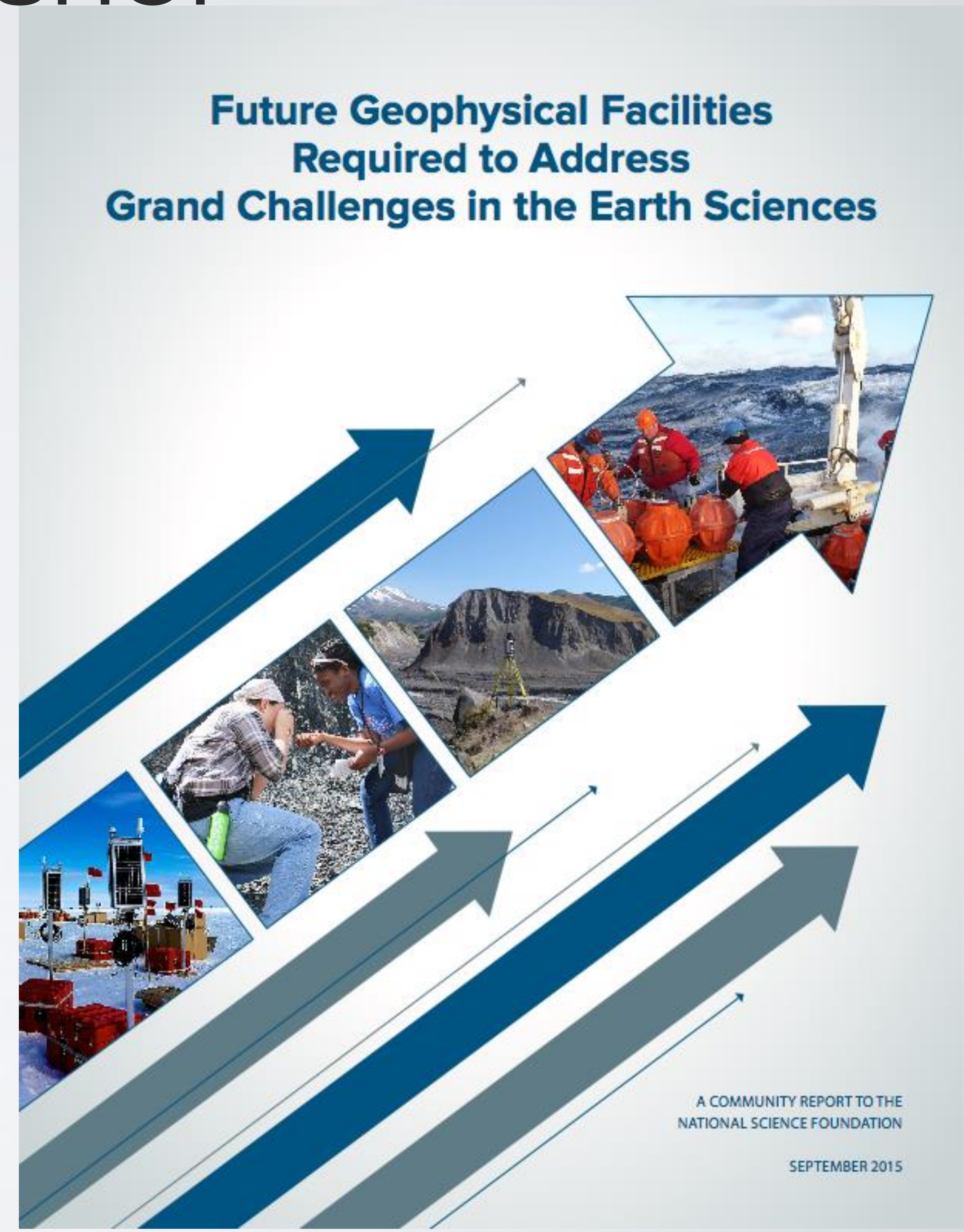
- **Develop pilot data products for nontraditional users**

- Build a management framework for institutionalizing adoption and sponsorship of sensors
- Collaborate with NASA for optimization and validation of NISAR and and cal/val for SMAP
- Adopt suggested prioritization for borehole and long baseline laser strainmeters (after incorporating additional input from the strainmeter user community)
- Explore alternative models for funding the strainmeter network
- Explore and test alternative methods of GPS data transmission and data flow models

FUTURE GEOPHYSICAL FACILITIES WORKSHOP

Workshop held in May 2015 in Leesburg, VA
>100 participants

- Report divides into three components related to seismo-geodetic facilities:
  - Existing Foundational
  - Emergent Foundational
  - Frontier



EXISTING FOUNDATIONAL

Capabilities that are fundamental and essential to present and near-term science directions, including the continuation of currently funded NSF projects.

1. Maintained permanent seismic, strainmeter, and geodetic networks
   - A global very broadband seismographic network
   - Permanent and continuously recording GPS networks
   - A network of borehole strainmeters

3. Deployable geodetic observation systems
   - GNSS instrumentation
   - Terrestrial lidar instrumentation
   - Continued installation and occupation of campaign-mode seafloor geodetic monuments

5. Data archiving, quality control, and distribution

6. Hosting of community-provided products and services

9. Workforce development

EMERGENT FOUNDATIONAL

Components that incorporate current technologies would drive significant progress on major science challenges and were judged to be high priority for the 2018–2023 time frame.

12. Instrumentation for rapid response

14. Operational GNSS processing

19. Expanded ocean bottom seismographic and geodetic capabilities

20. High-bandwidth and real-time global telemetry

21. Development of instrumentation and telemetry systems capable of supporting multidisciplinary environmental observatories

FRONTIER

Those capabilities that are, to varying degree, nascent, but are of significant interest to the community for their potential to enable transformative science and ensure continued scientific progress.

24. Seafloor and free-floating geophysical networks

26. Deep borehole access and instrumentation

27. Instrumentation for high-risk/high-benefit experiments

POST SAGE-GAGE VISION

For example, the community envisions a future that includes:

(1) near-real-time and daily maps of deformation derived from integrated seismic, Global Navigation Satellite System (GNSS) instrumentation, and orbiting radar satellite data;

(2) anchored and drifting seafloor and water column geophysical instrumentation distributed around the globe;

(3) arrays of fiber optic cables providing spatially continuous high-rate sampling of surface strain;

(4) aerial and marine drones that can be customized to host and/or deploy a range of instrumentation;

(5) large instrumentation pools that can be routinely deployed in diverse environments and across a range of scales to record the full spectrum of dynamic events, ranging from coseismic offsets, to slow deformation, to spatially unaliased seismic wavefields;

(6) global telemetry providing high-rate and low-latency sampling from any number of remote instruments; and

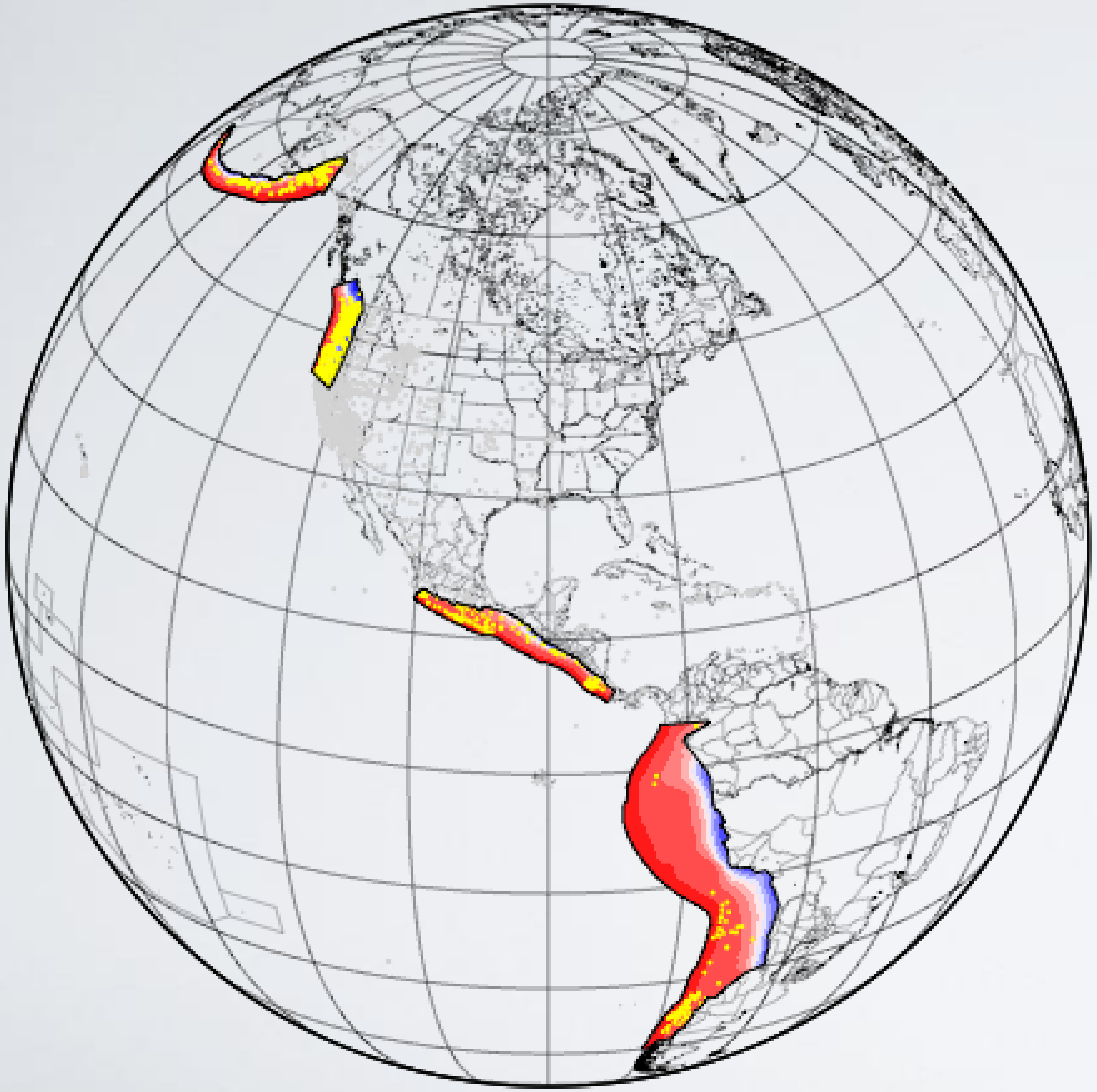
(7) routine access to high performance computing (HPC) and associated capabilities for data reduction and model inference on an unprecedented scale.

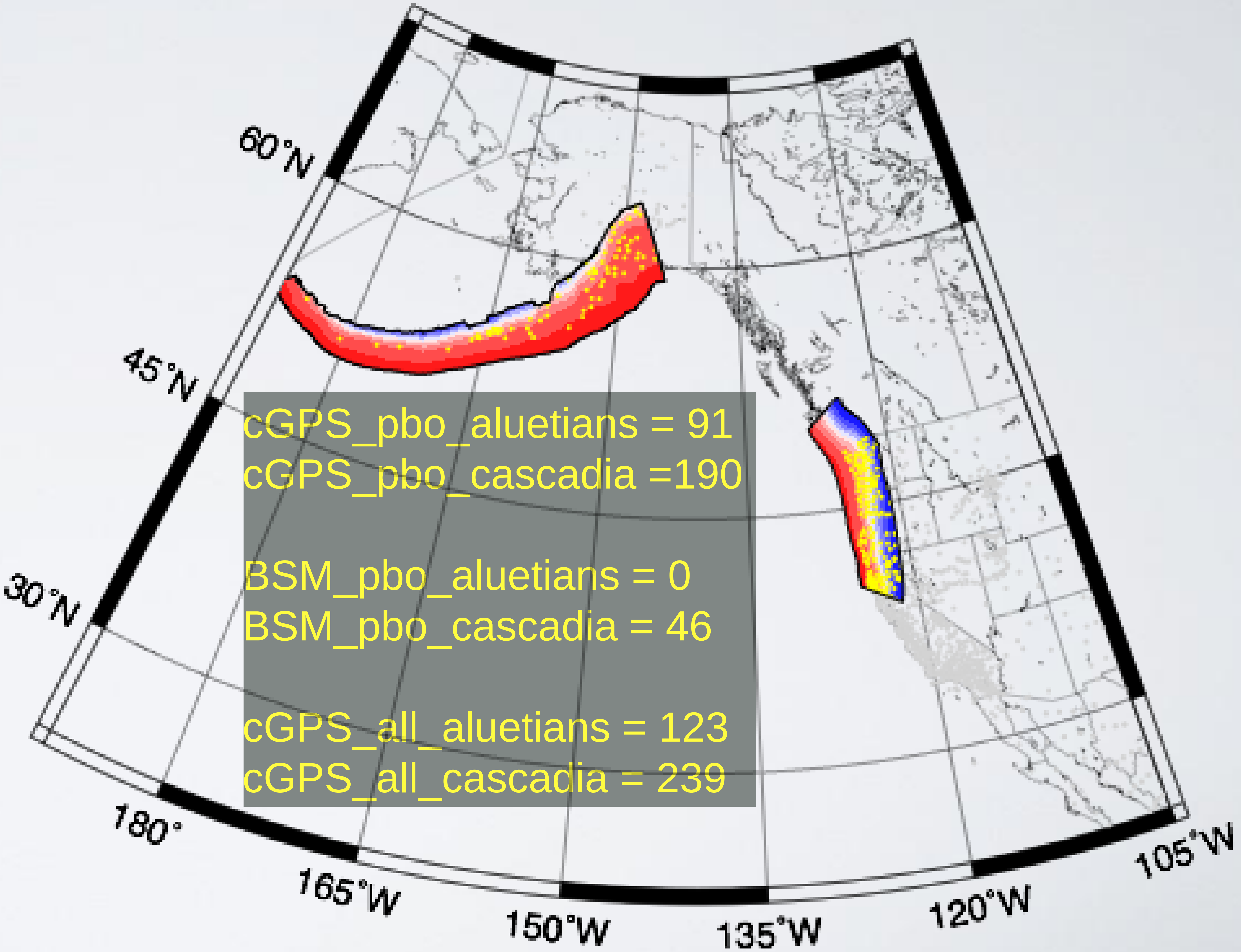
Other Continuous GPS Networks Supported by UNAVCO

- COCONet (76 new or upgraded, 61+ existing cGPS/Met stations plus 4 tide gauge stations installed in the Caribbean region)
- TLALOCNet (6 new, 18 upgrades to existing cGPS/Met stations in Mexico plus 13 contributed from UNAM)
- G-Net (42 cGPS stations in Greenland)
- A-Net (42 cGPS/seismic stations in Antarctica)
- LARISSA (10 cGPS stations in Antarctica)

Like PBO these networks will face critical technological and fiscal hurdles in the near future

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

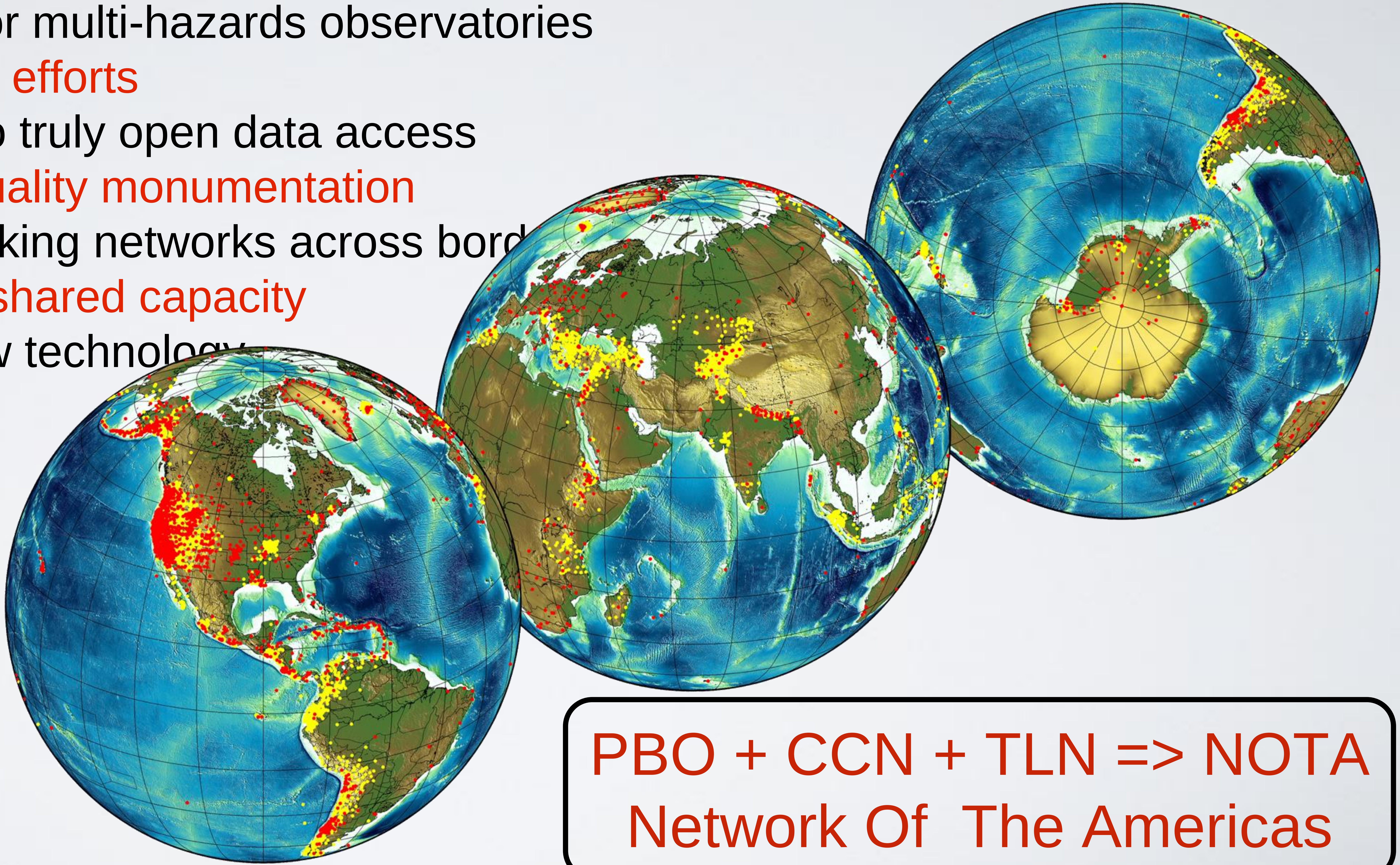




UNAVCO

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 bord
Disseminated archives for shared capacity
Driving development of new technology
for sea-floor geodesy



PBO + CCN + TLN => NOTA
Network Of The Americas

PBO: A CRITICAL NATIONAL RESOURCE: SUMMARY OF IMPORTANT CONCERNS

Aging PBO infrastructure - planned replacement in GAGE, not fully possible under current budget scenarios. Many EOL/EOS units will remain in place at close of GAGE Facility. Reduced O&M for PBO means possible loss of data and likely will decrease up-time in long-run.

Need for high-rate and real-time data streams and archived products to position UNAVCO for future (NSF and non-NSF) funding and relevance. PBO is now viewed as a "utility" by many critical stakeholders. Cost to renew and upgrade just PBO-AK stations to real-time would be considerable ($2.1M one-time funds and $1.0M/yr ongoing costs using current technologies).

- Geodetic Infrastructure is vital to multiple communities and agencies - how will it be sustained?
- NSF (and NASA/USGS to a lesser degree) has made the initial investment - but the need for sustaining partners remains paramount…

Impact of loss (descoping NSF project) or degradation of PBO assets (physical and human) on stakeholders are charged with *Safety of Life* warnings, *Initial Crisis Response*, and development and maintenance of state-wide *Spatial Reference Network* systems

QUESTIONS?