UNAVCO's Network of the Americas (NOTA)

Background, Current Status, and Science Applications

Sarah Doelger, NOTA Eastern Region Manager, UNAVCO

GAGE
National Science Foundation's Geodetic Facility for the Advancement of Geoscience

Operated by UNAVCO

ION – CGSIC Virtual Presentation – September 19, 2022

Presentation Outline

1. UNAVCO history, the GAGE Instrumentation Program

2. PBO, TLALCONet, COCONet -> Network of the Americas (NOTA)

3. Components of a typical NOTA station

4. UNAVCO data products and science applications

UNAVCO Background

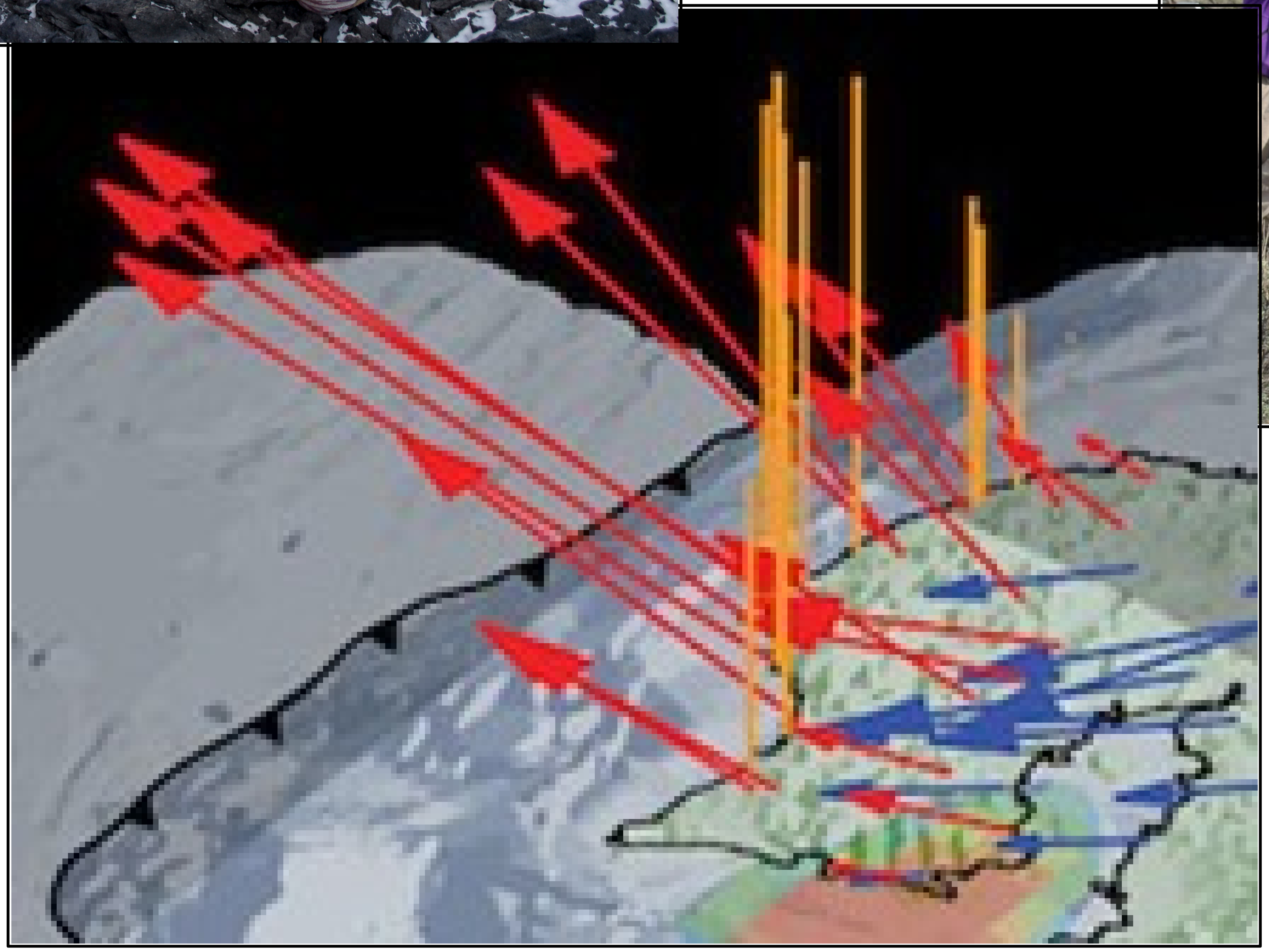
- UNAVCO: a non-profit university-governed consortium, started in 1984
- Mission: Facilitate geoscience research and education using geodesy
- Comprised of 128 U.S. Academic Members
- 134 Associate Members in the U.S. and abroad in over 120 countries
- Membership has increased over 9% since 2016

GAGE Facility - Services

INFRASTRUCTURE

EDUCATION AND COMMUNITY ENGAGEMENT

DATA CENTER



GAGE Geodetic Infrastructure Program

Continuously Observing Networks

Network Of The Americas (GNSS and borehole operations)

POLENET: GNET (Danish Contract) & ANET

NASA Global GNSS Network (GGN)

Principal Investigator Support

NSF EAR & OPP funded PI and community projects

RAPID Instrument Response

Campaign and long-term GNSS deployments

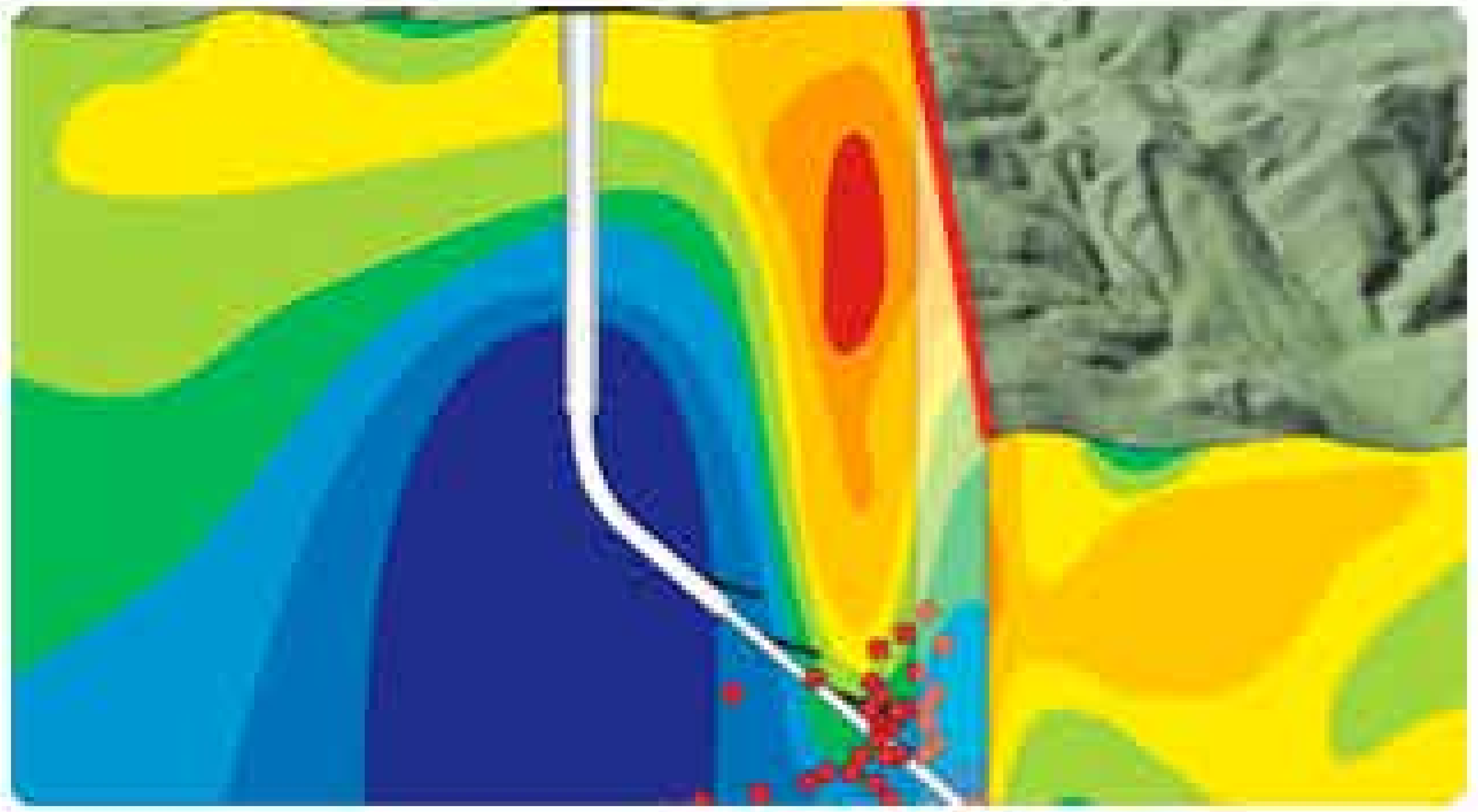
Geodetic Instrumentation Testing & Support

EarthScope Background

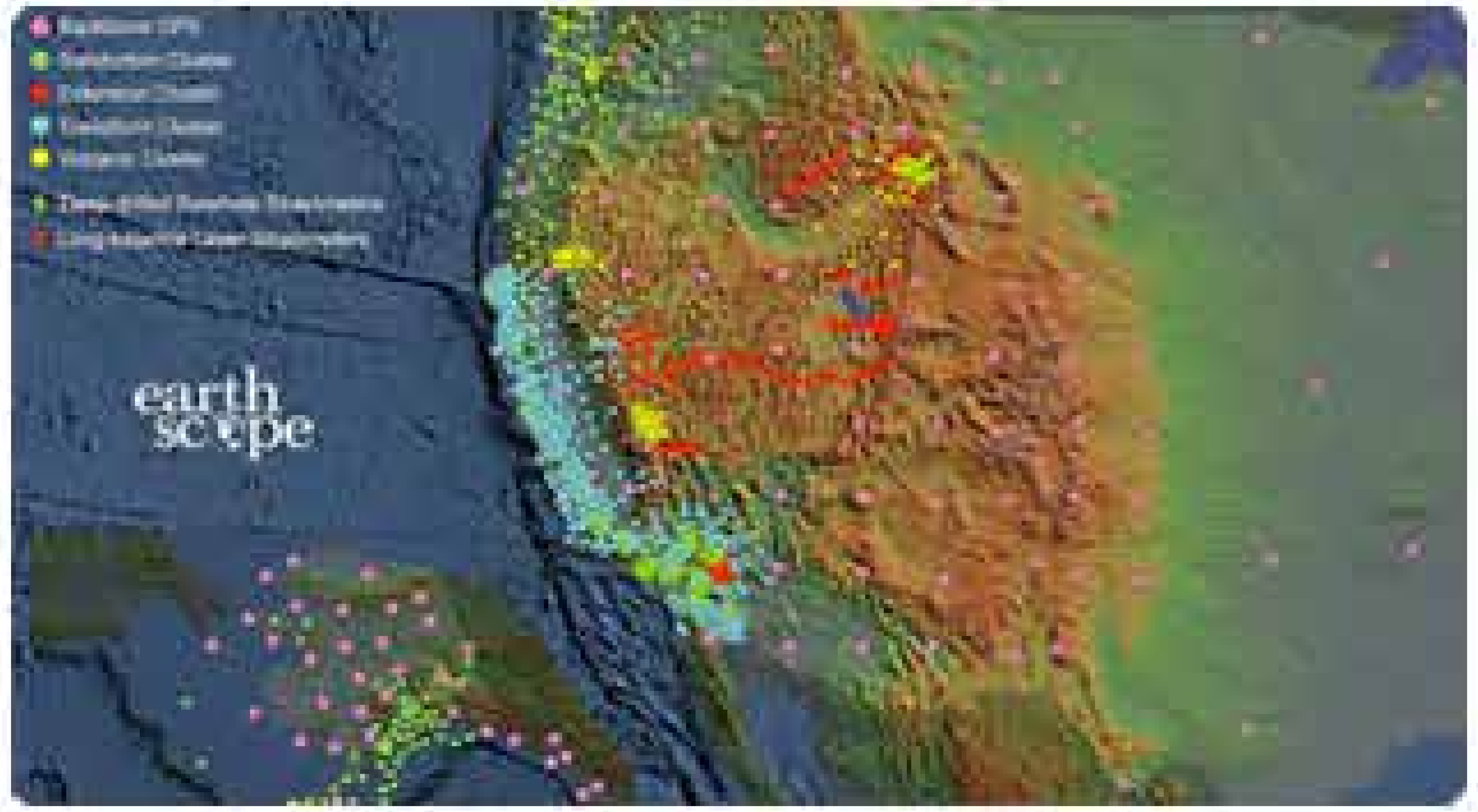
Purpose: To study the structure and evolution of the North American continent and the processes that cause earthquakes and volcanic eruptions

- **Funded by NSF**
- **Project timeline 2003-2018**
- **Three components: geodetic, seismic, and drilling**
- **Total budget: $500 M over the life of the project**
- **Deploy thousands of GPS, seismic, and other geophysical instruments**

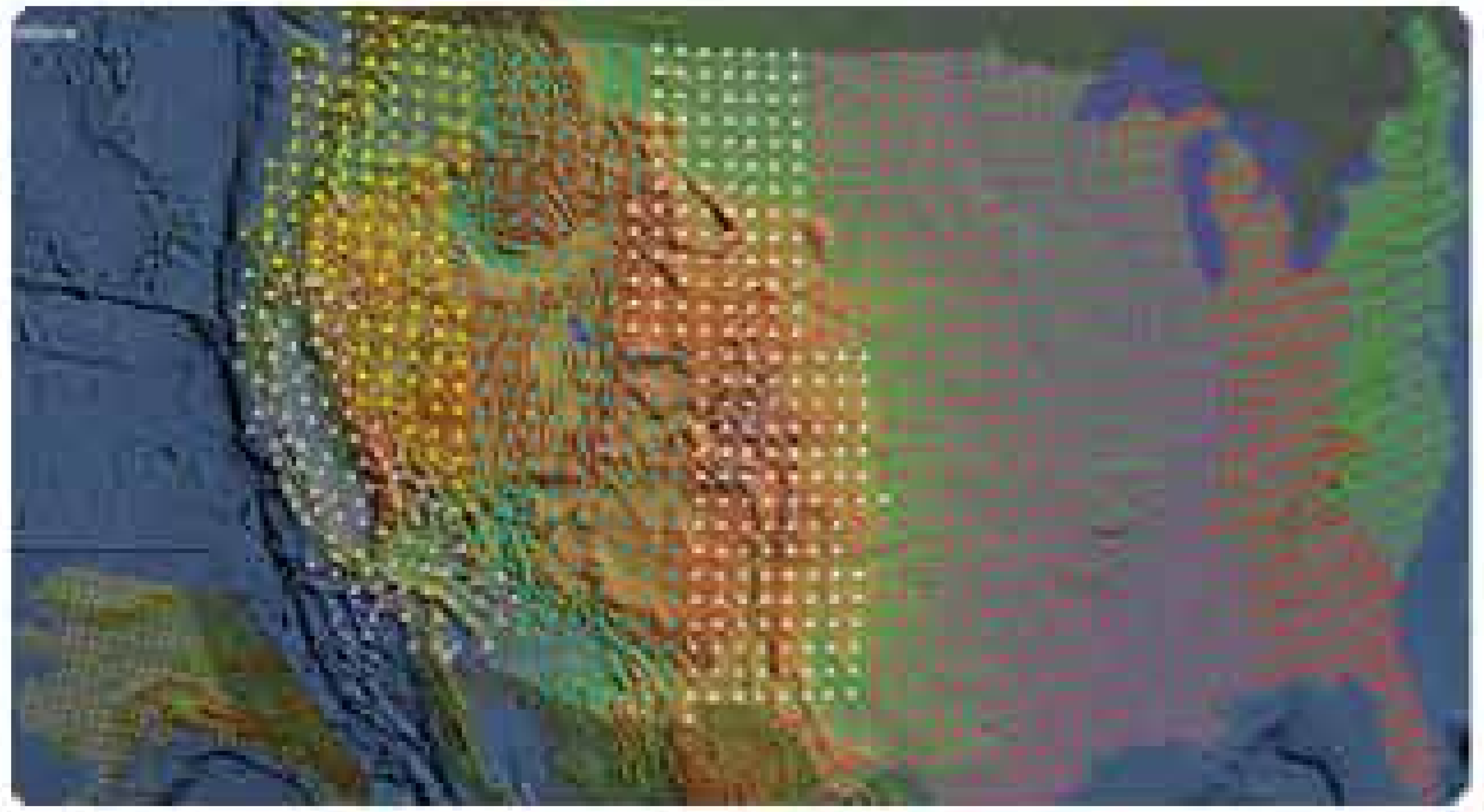
SAFOD – Drilling Component



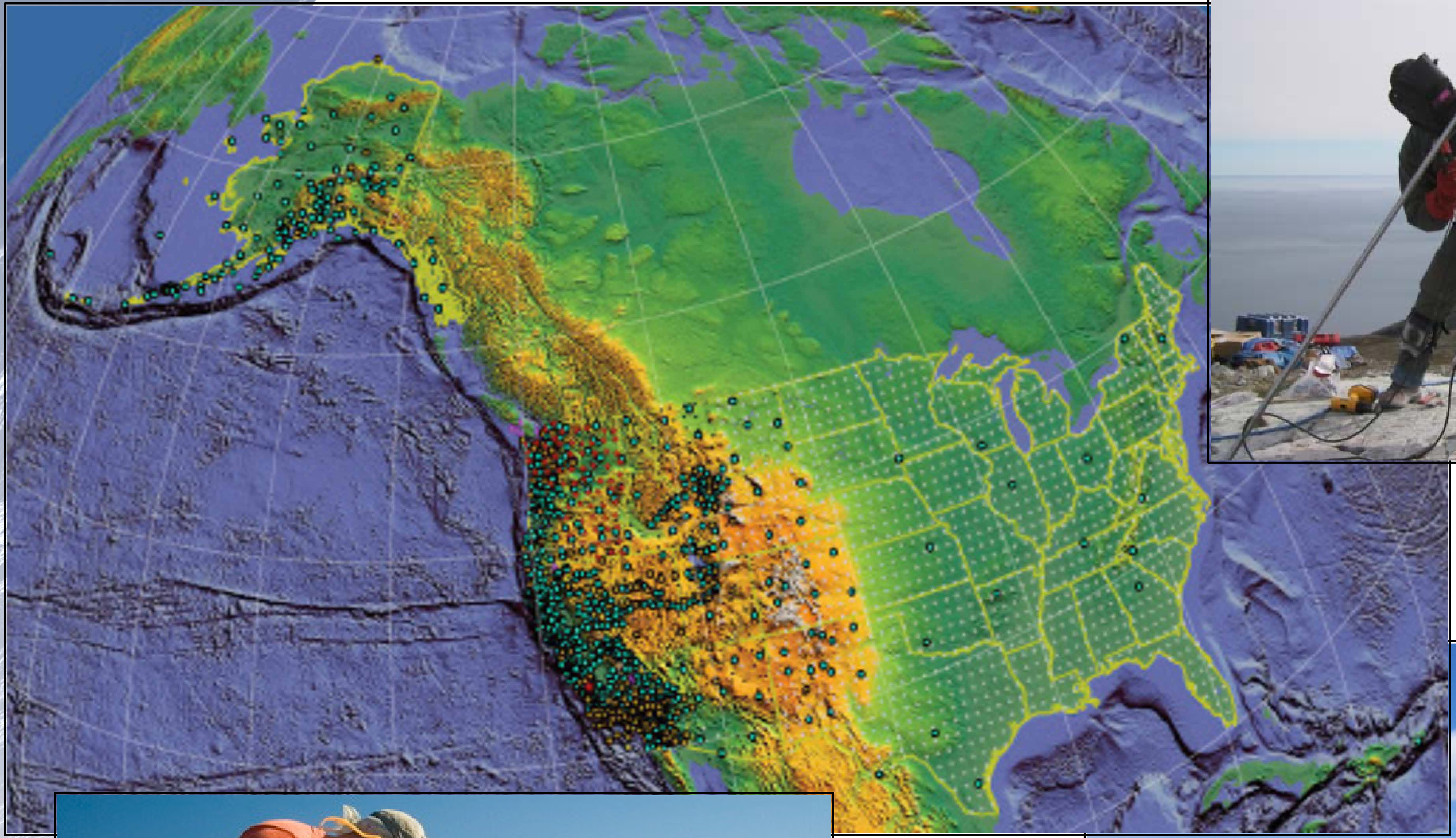
PBO – GPS Component



US Array – Seismic Component



EarthScope Plate Boundary Observatory (PBO)



$200 M invested by NSF over 15 years:

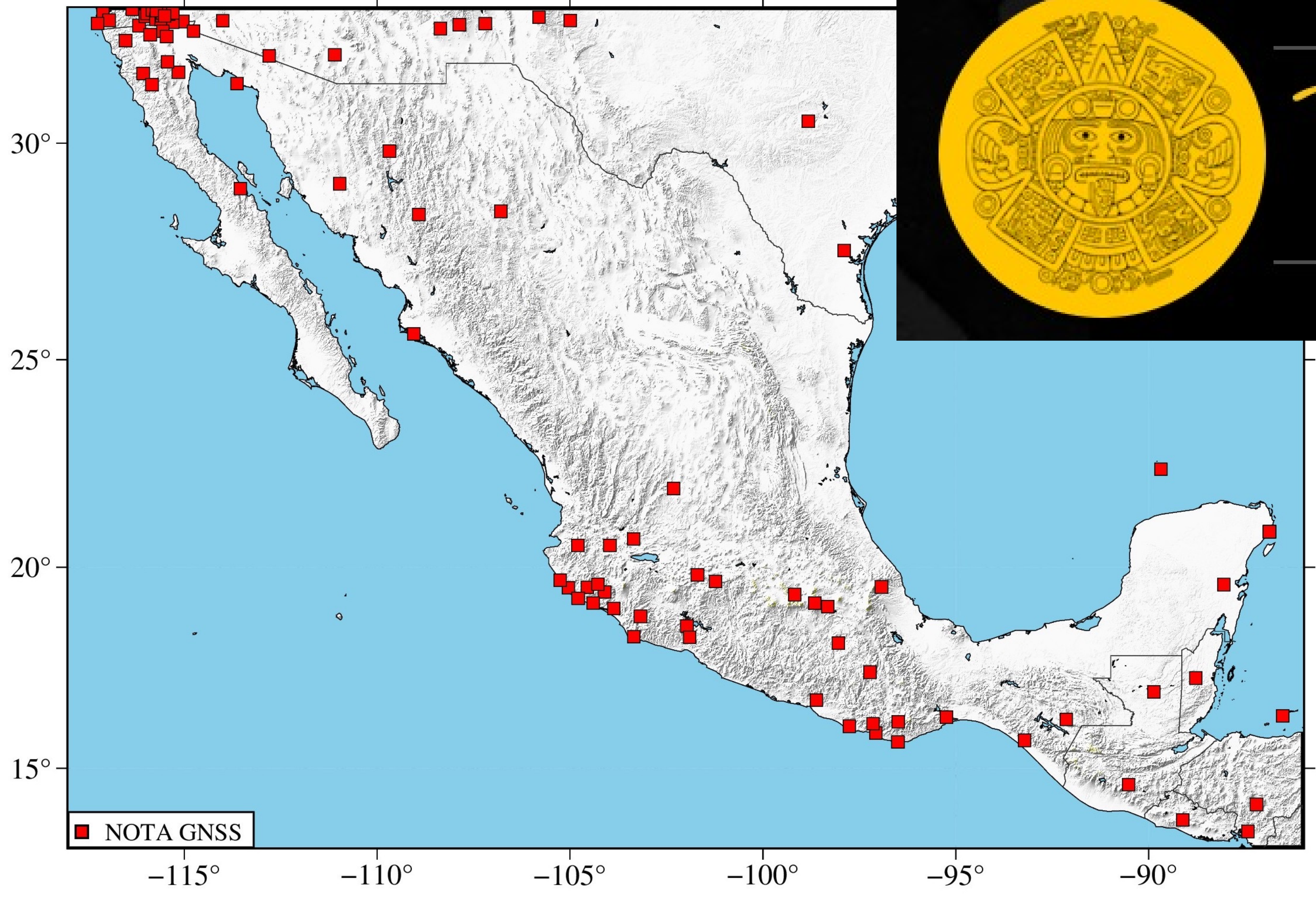
- Construction phase (2003-2008) – $100 M
- O+M phase 1 (2008-2013) - $54 M
- O+M phase 2 (2013-2018) - $46 M

Tectonically strategic deployment of:

- 1131 cGPS
- 78 borehole strainmeters
- 5 long baseline strainmeters
- 26 tiltmeters
- 145 meteorological instruments

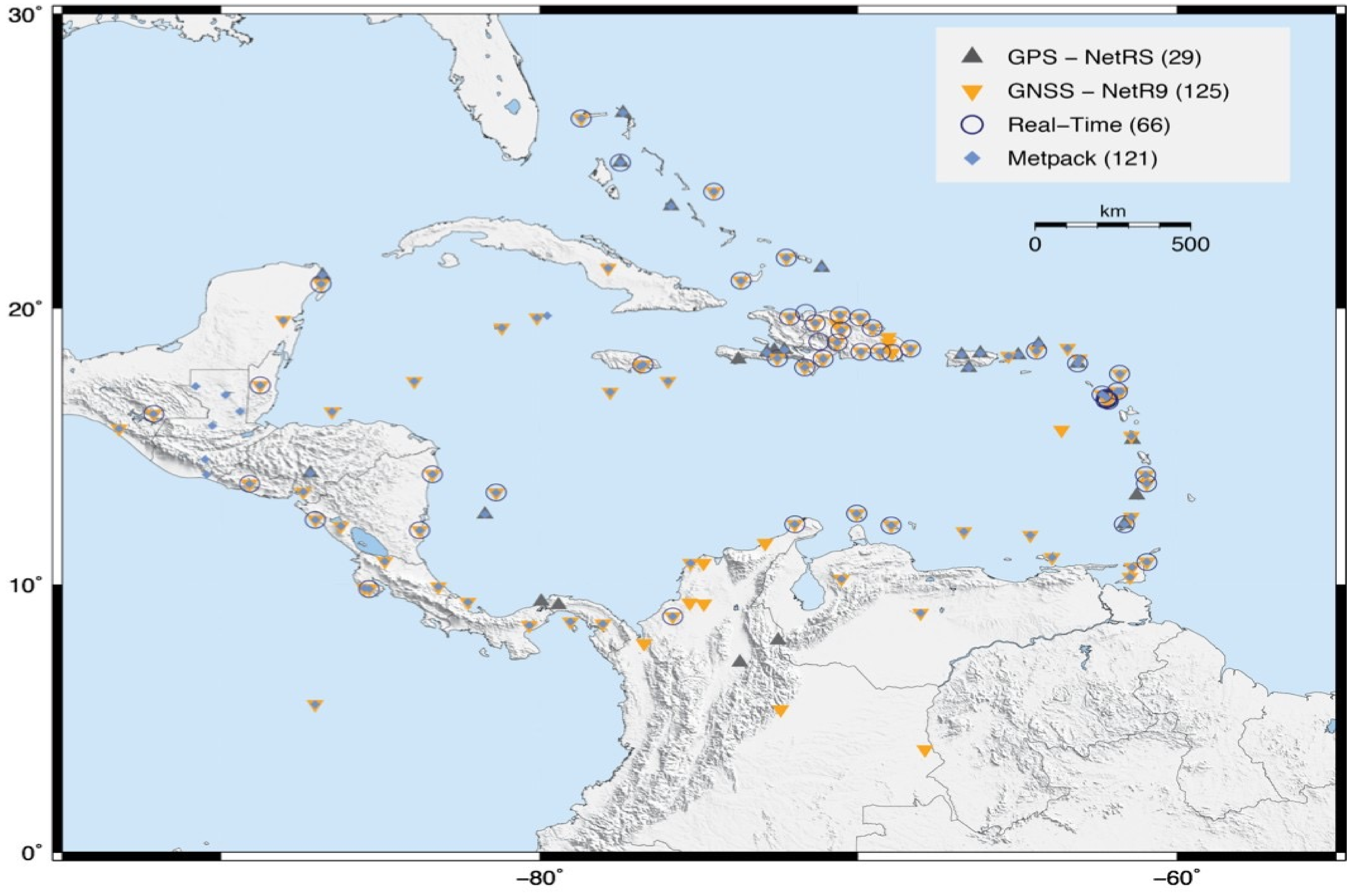
TLALOCNet (Tnet) and COCONet

- Combined cGPS-Met networks in Mexico and the Caribbean Basin for the study of climate, atmospheric processes, the earthquake cycle, and tectonic processes
- COCONet 2010-2018 ~$6M
- 42 participating partners
- Build 50 new stations, upgrade 50 existing stations
- TLALOCNet 2015-2018 ~$2M
- Build 6 new stations, upgrade 18 existing stations



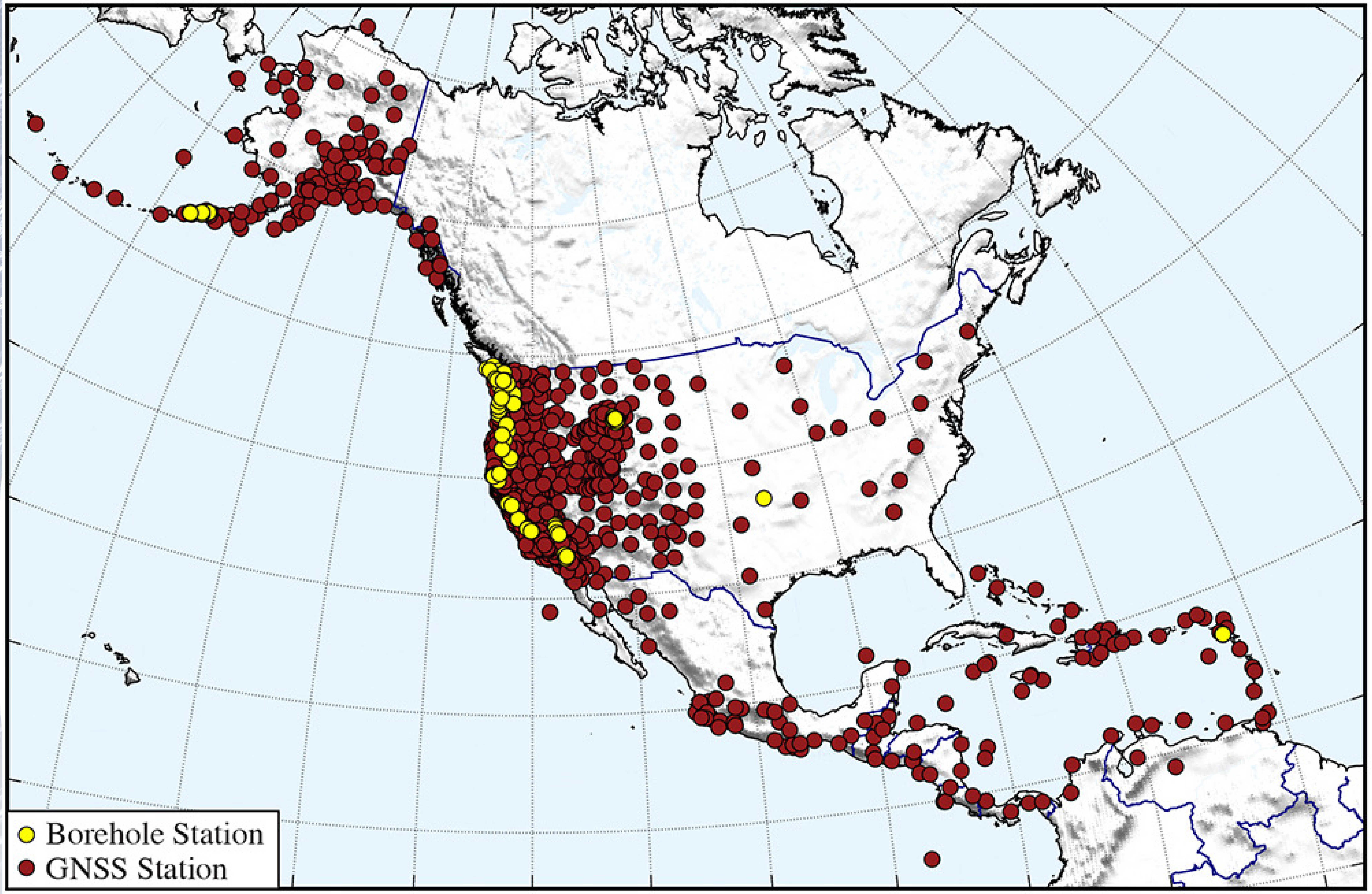
TLALOCNET
a continuous GPS-MET array in Mexico for atmospheric, climatic, and seismotectonic research in the Americas

COCONet
CONTINUOUSLY OPERATING CARIBBEAN GPS OBSERVATIONAL NETWORK



Network of the Americas

Federation of NSF-funded cGNSS networks across the Americas



- PBO + TLALOCNet+COCONet = NOTA
- Federated in 2018
- Funding $71.4 M until 2023
- Currently 1148 cGNSS stations distributed
- across 31 countries
- 789 stations are fully GNSS capable and 985 are RT capable
- 87% uptime

NOTA GNSS Station, Monuments

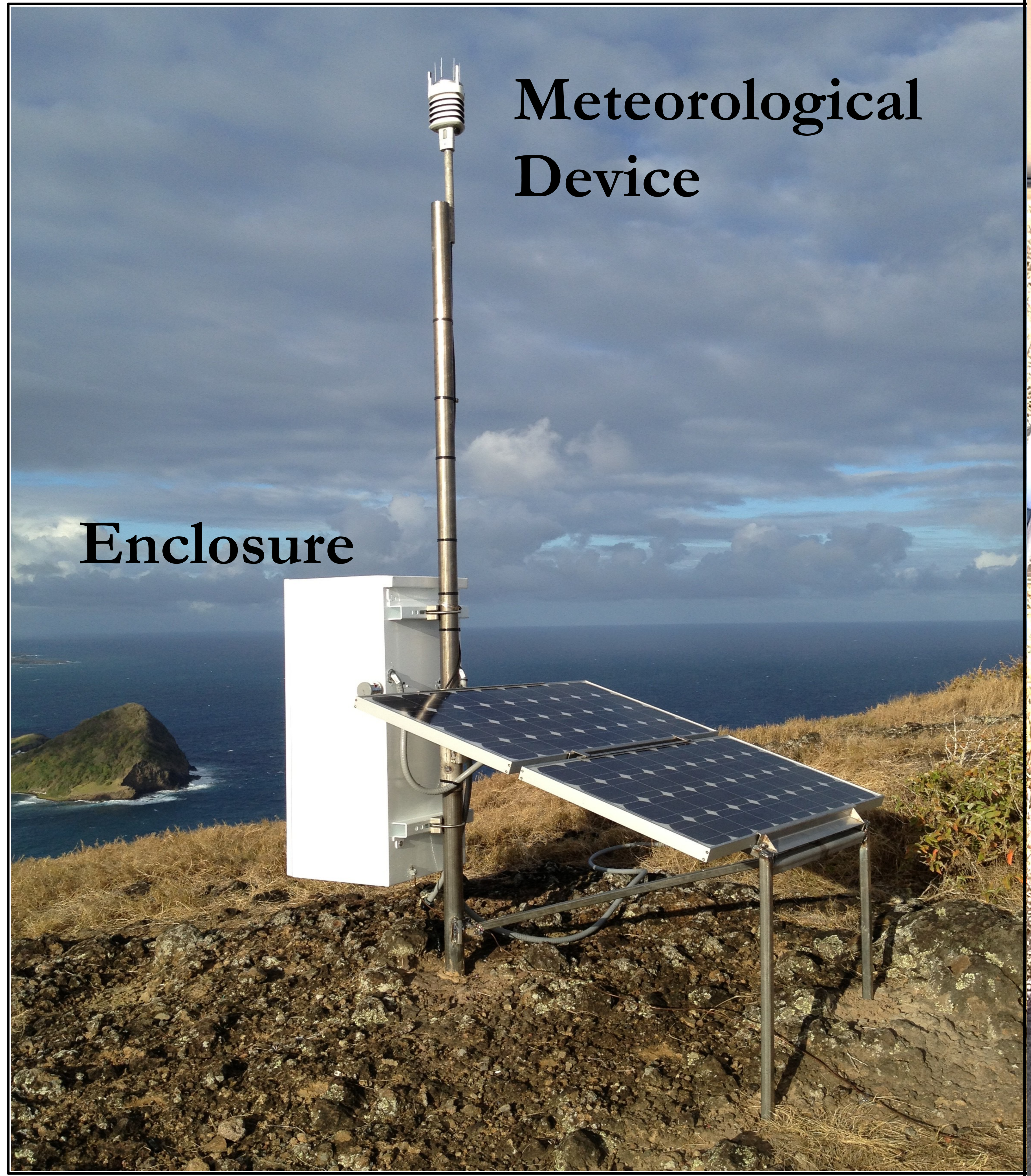
Deep Drilled Braced Monument (DDBM)

Short Drilled Braced Monument (SDBM)

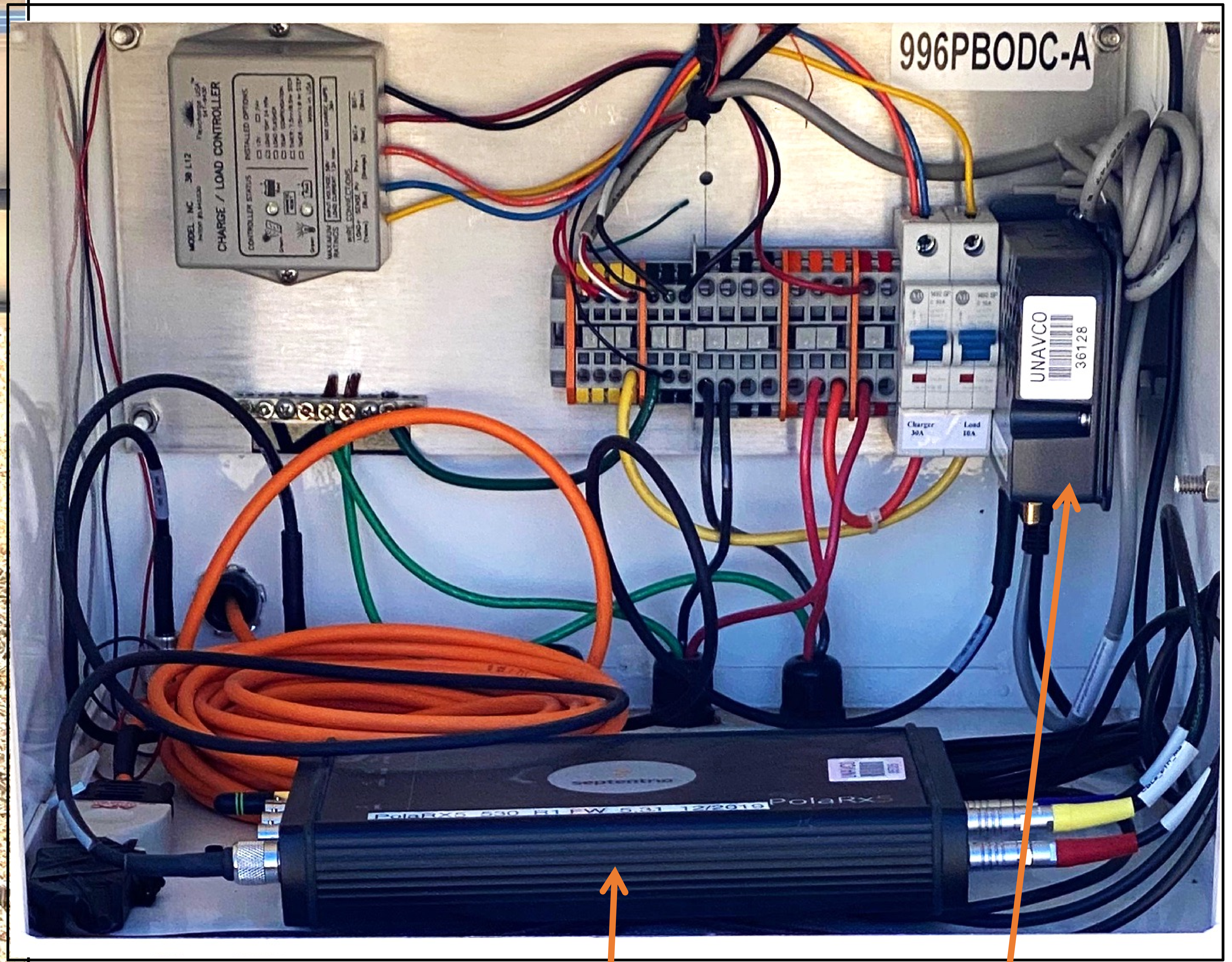
GNSS Antenna cross section

Rooftop Monument

NOTA GNSS Station, Power



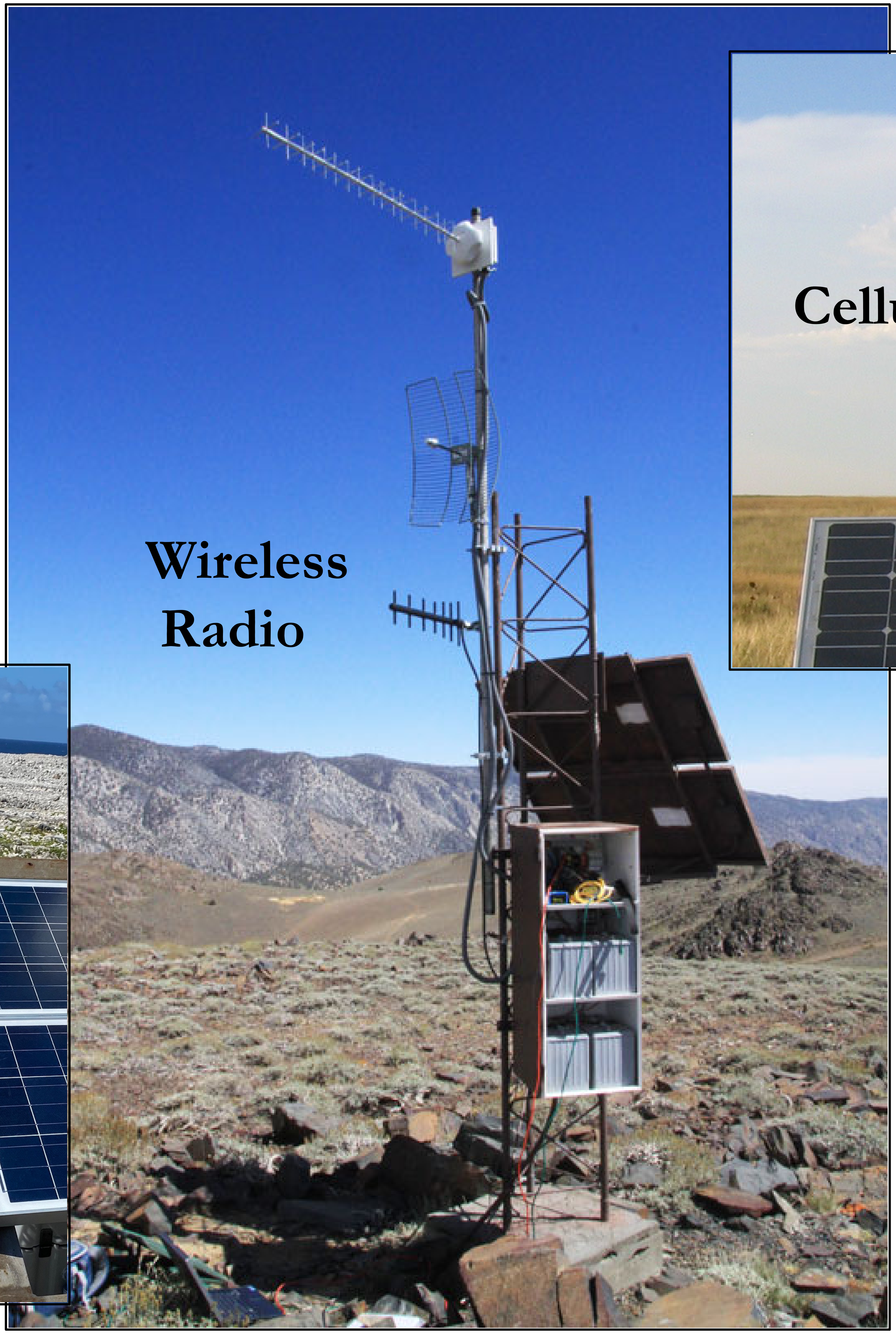
DC Backpanel

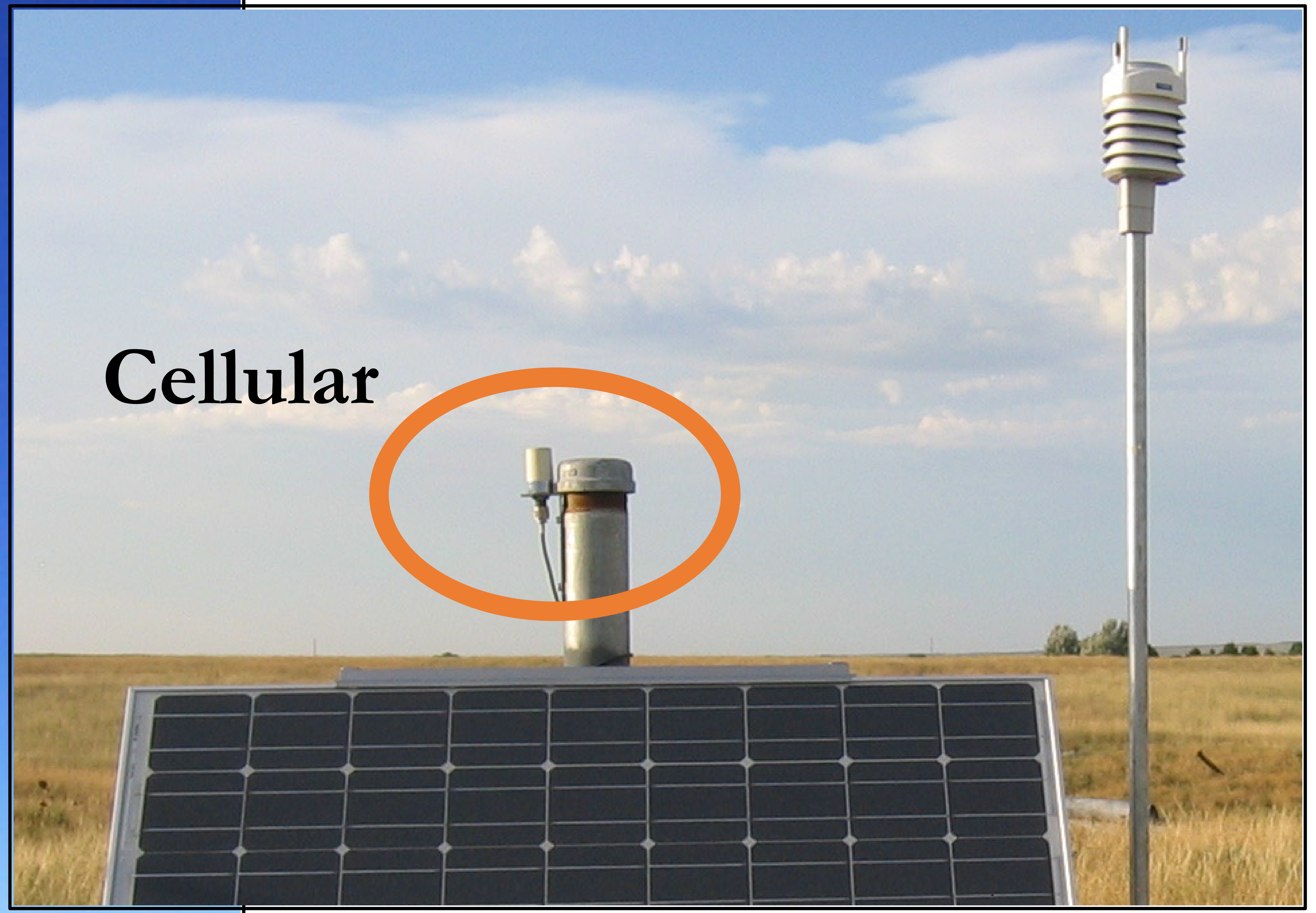


NOTA GNSS Station, communications

Very Small Aperture Terminal (VSAT)

Broadband Global Area Network (BGAN)





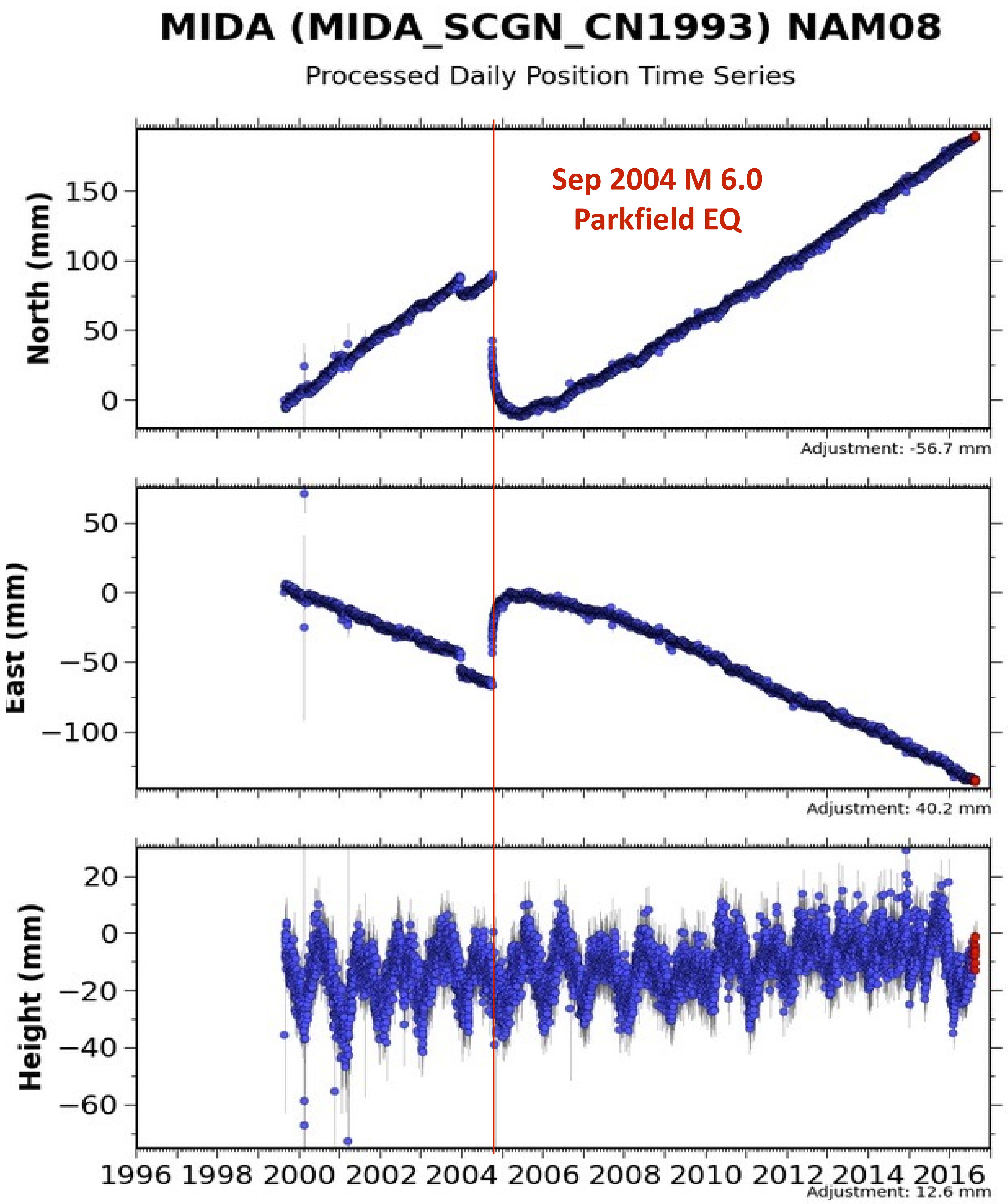
NOTA GNSS Data Products

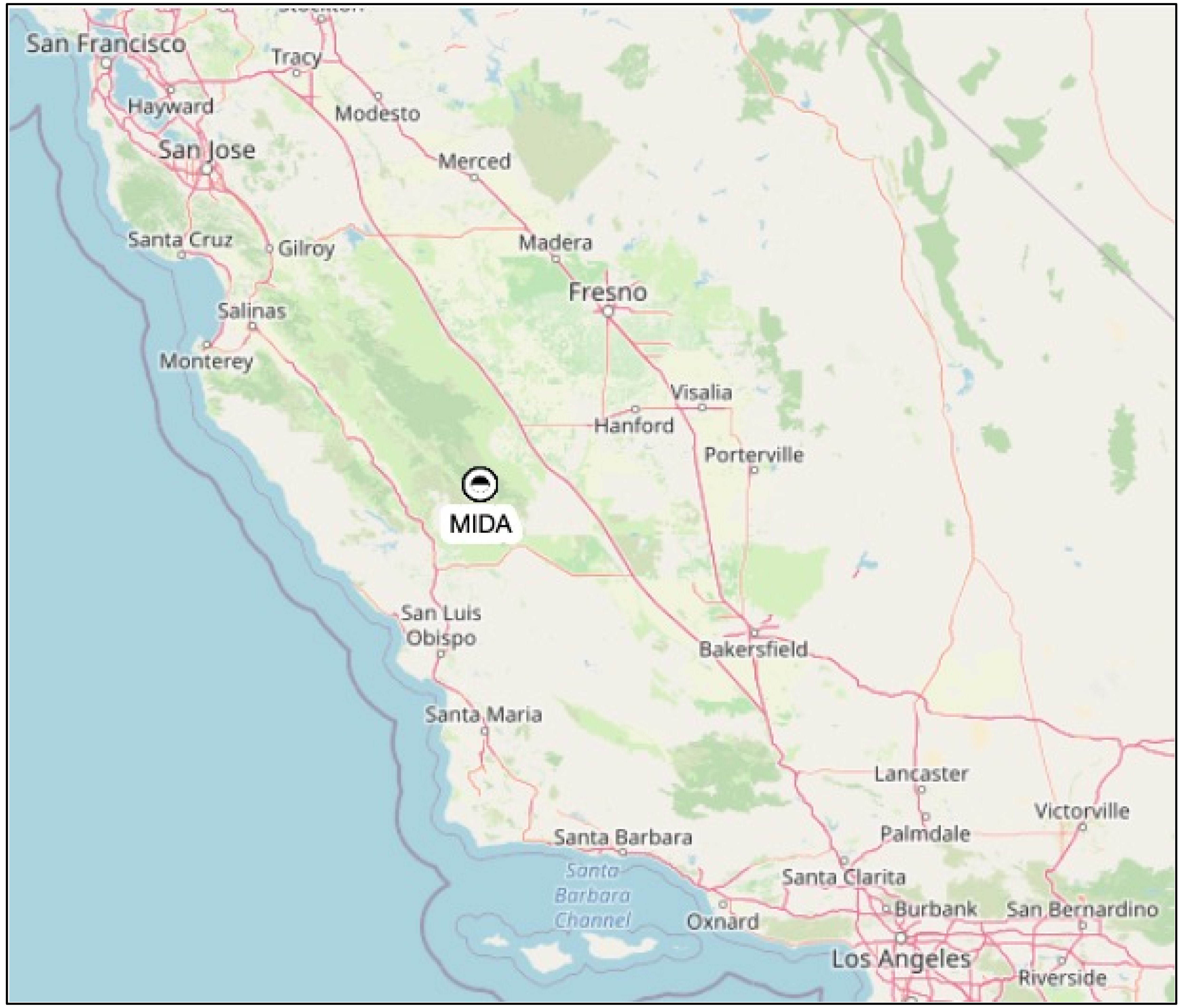
LEVEL	PRODUCT	FORMAT	FREQUENCY	ARCHIVE
0	Standard rate (15 sec)	Raw, BINEX	Hourly, daily	UNAVCO
	High rate (1, 2, 5 Hz)	Raw, BINEX	Hourly, daily	UNAVCO
	Real time stream (1 Hz)	RTCM, BINEX	Real time	UNAVCO
	Survey-mode (campaign)	Raw, RINEX	Daily, varies	UNAVCO

1	Standard rate (15 sec)	RINEX	Daily, varies	UNAVCO
	High rate data (1, 2, 5 Hz)	RINEX	Hourly, varies	UNAVCO
	Survey-mode (campaign)	RINEX	Daily, varies	UNAVCO

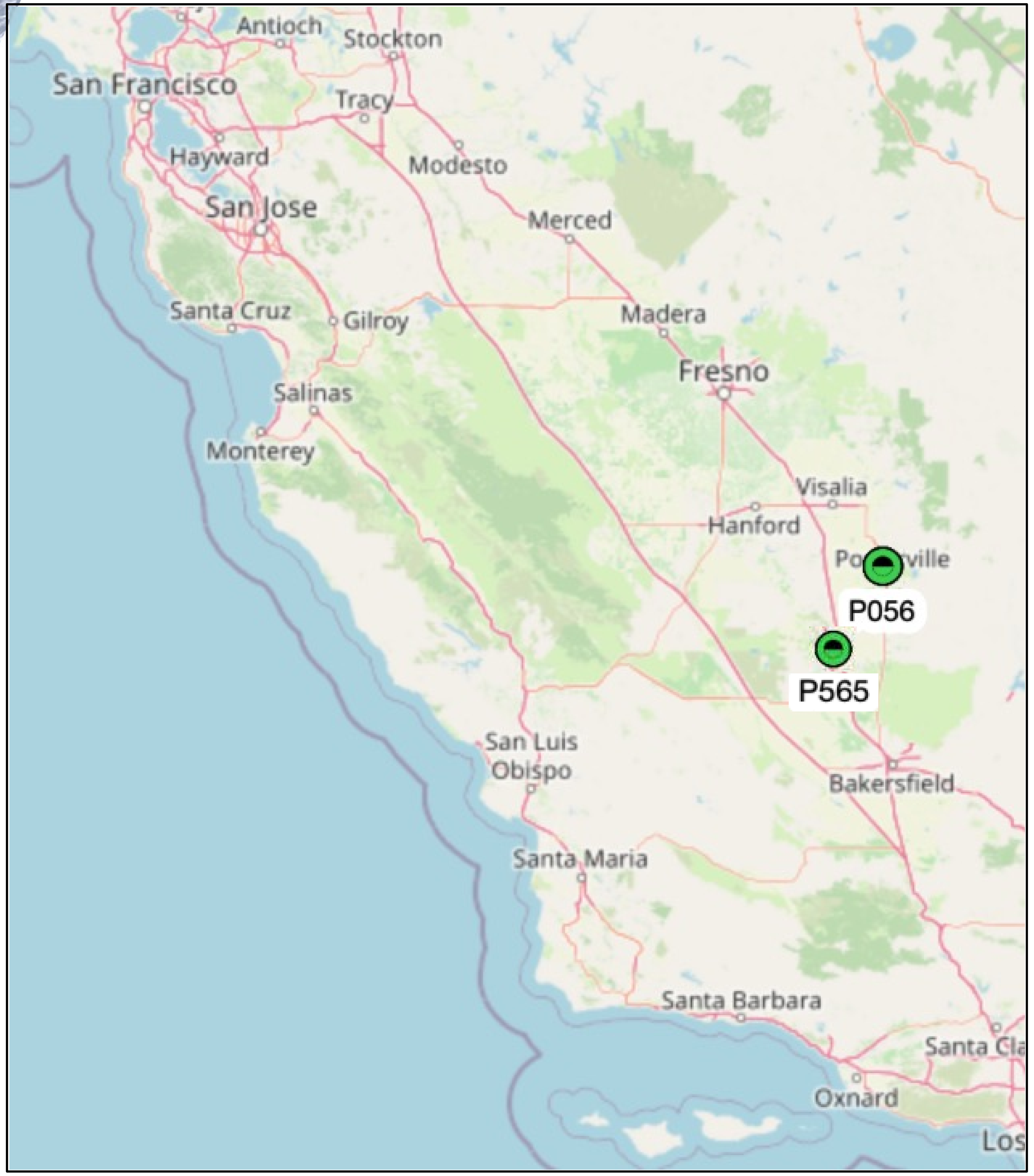
2	Position solution time series	ASCII, CSV	Daily	MIT
	Velocity solutions	ASCII, CSV	Monthly	MIT
	Position offsets (e.g. coseismic)	ASCII	Varies	MIT
	Tropospheric parameter estimates	ASCII	Daily	CWU
	Position solution QA parameters	ASCII	Daily, varies	UNR
	Position solutions (loose)	SINEX	Daily	CWU
	Position solutions (constrained)	SINEX	Daily	MIT

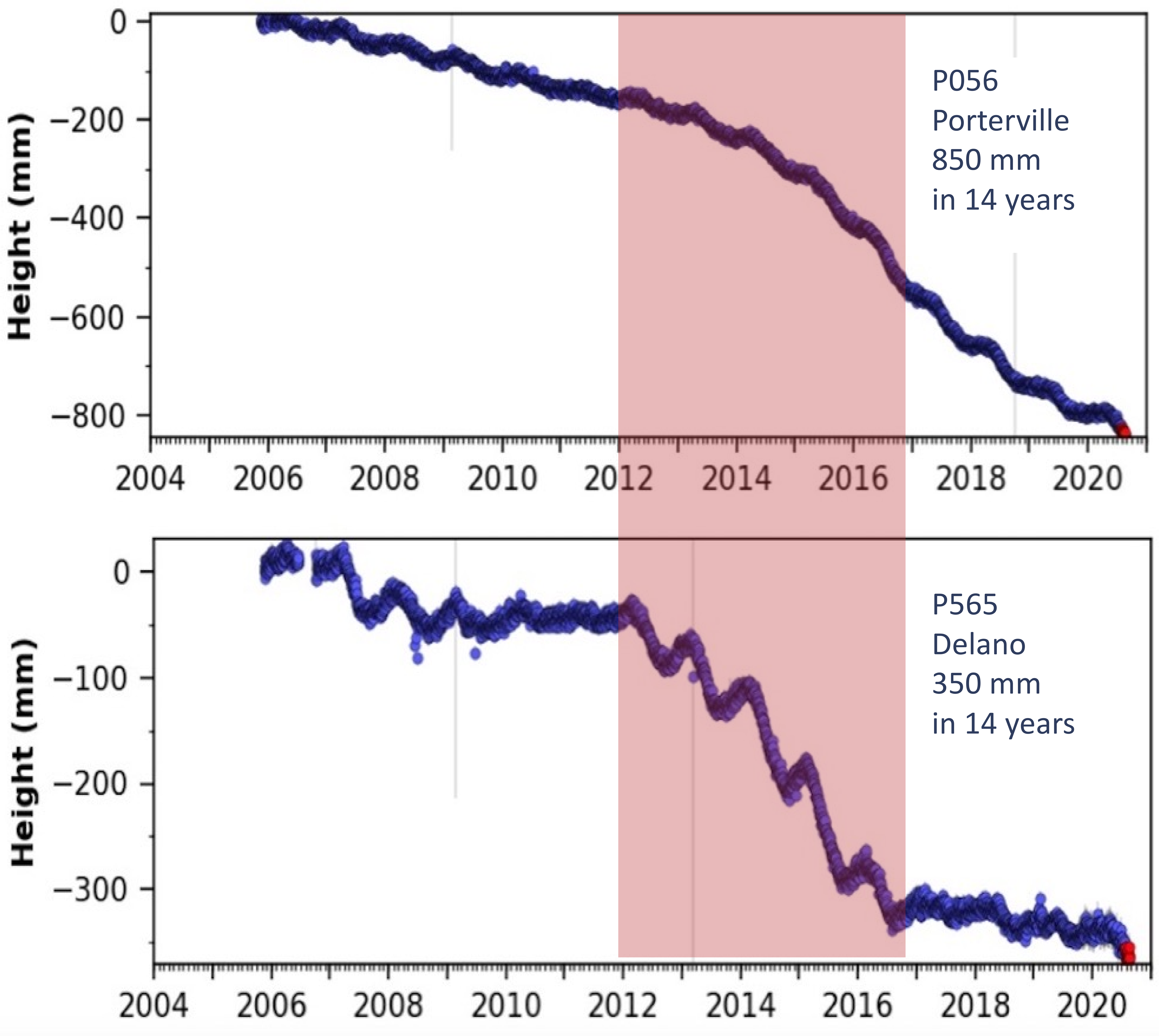
Position Time Series: Earthquakes





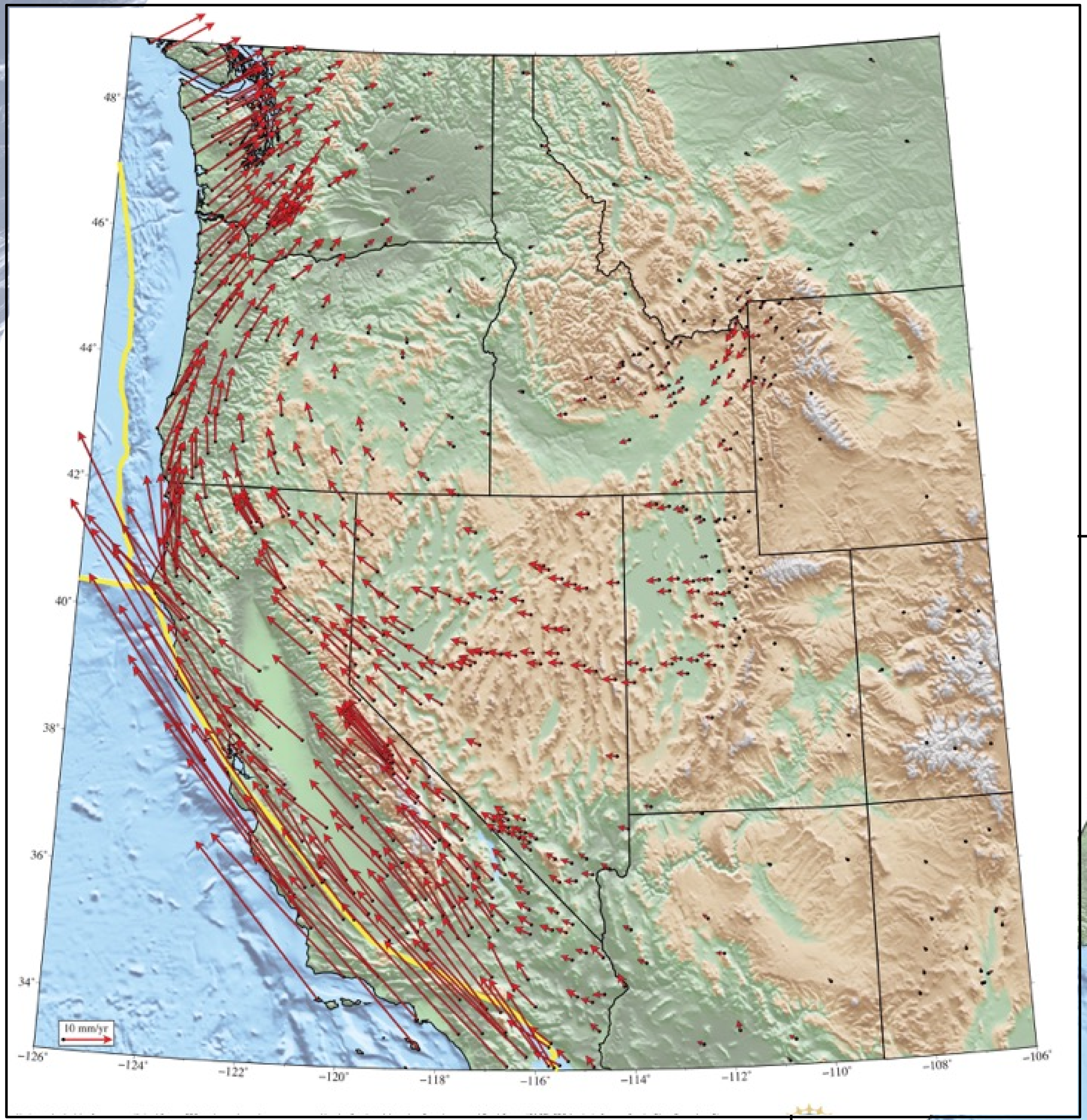
Position Time Series: Hydrogeodesy





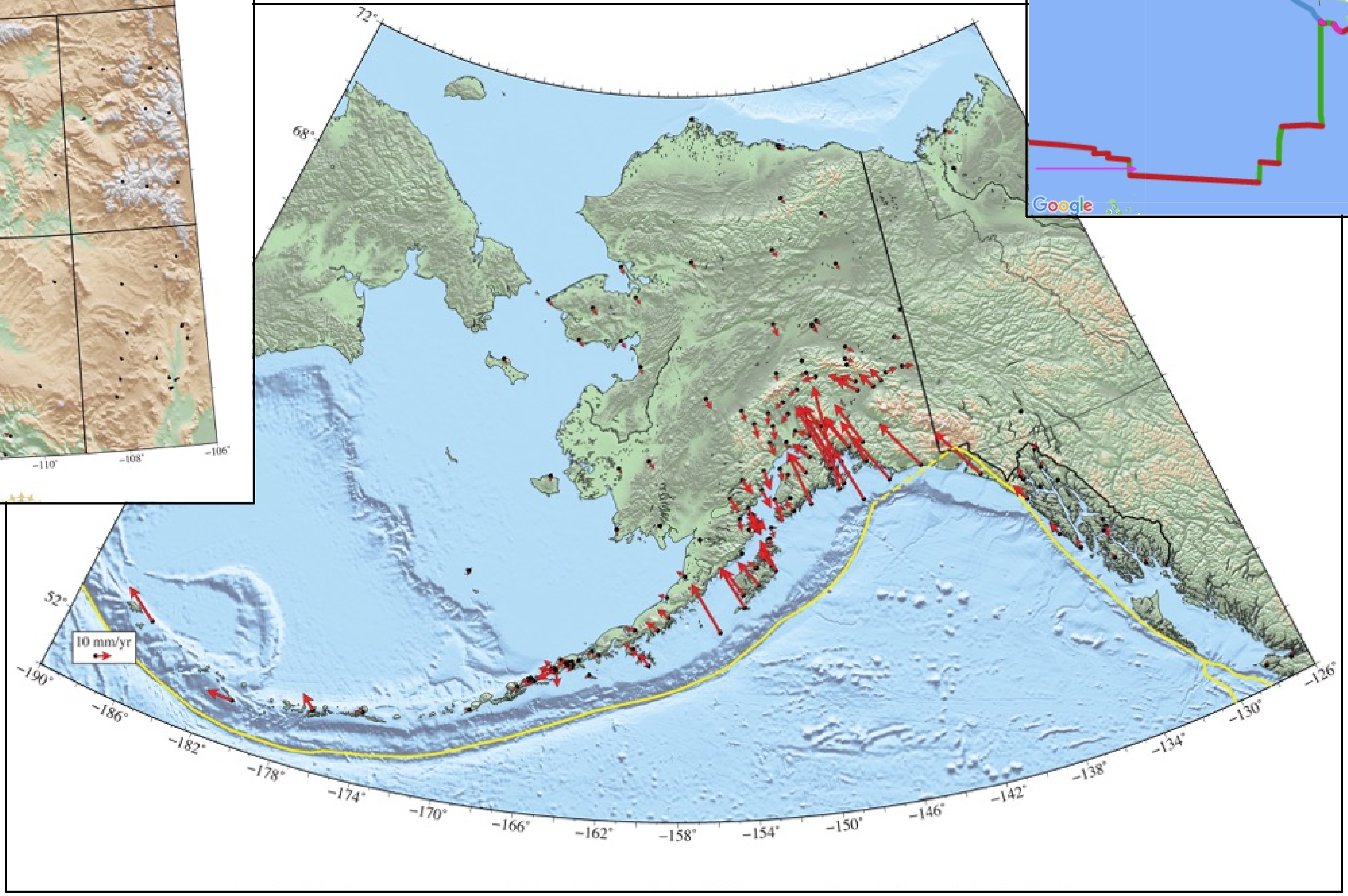
NOTA Velocity Field – Regional Tectonics

Tectonic Motion of the Western U.S.

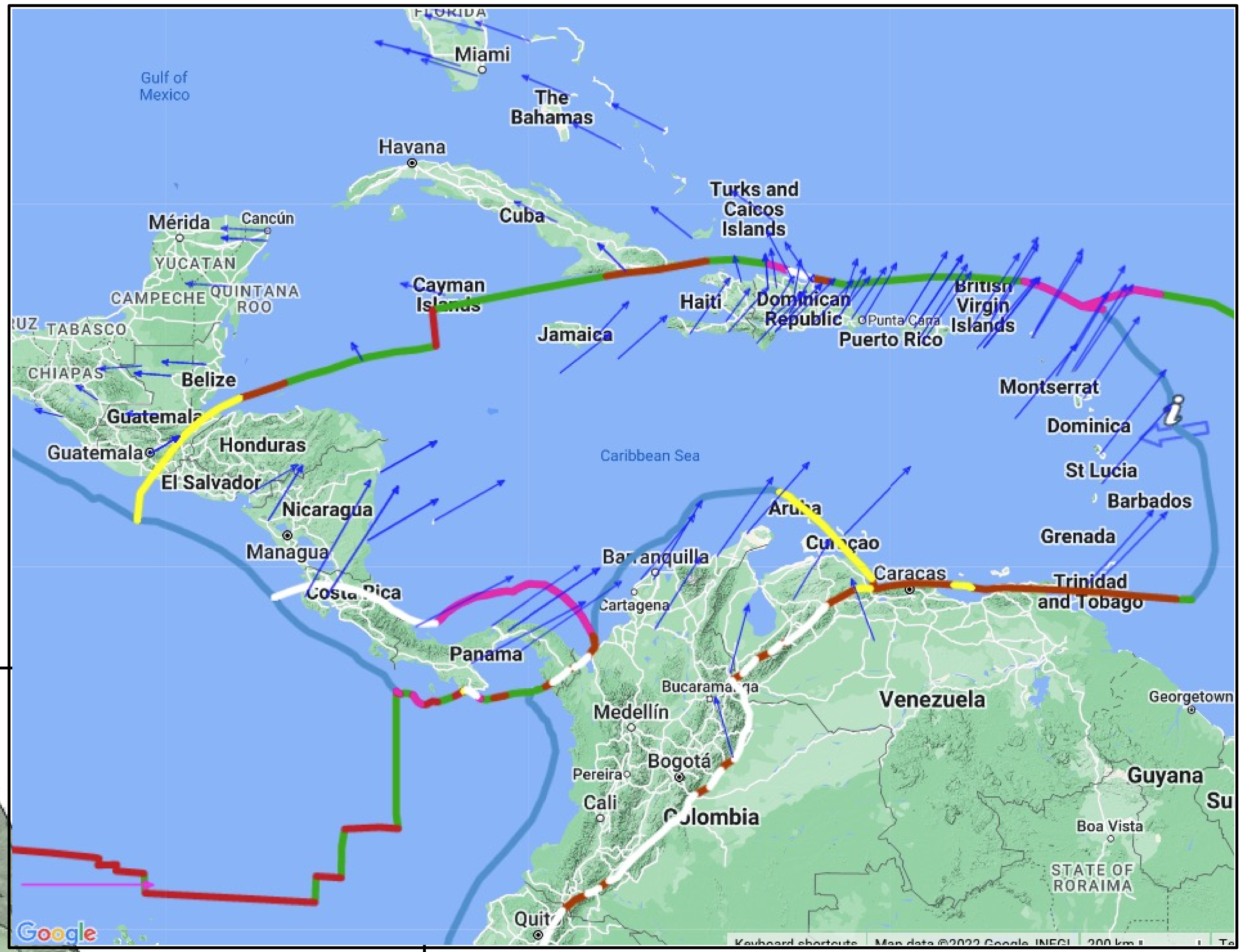


Based on combination of JPL and IGS Orbit and Clock Products

Tectonic Motion of Alaska



Tectonic Motion of the Caribbean



Taken from UNAVCO online velocity viewer

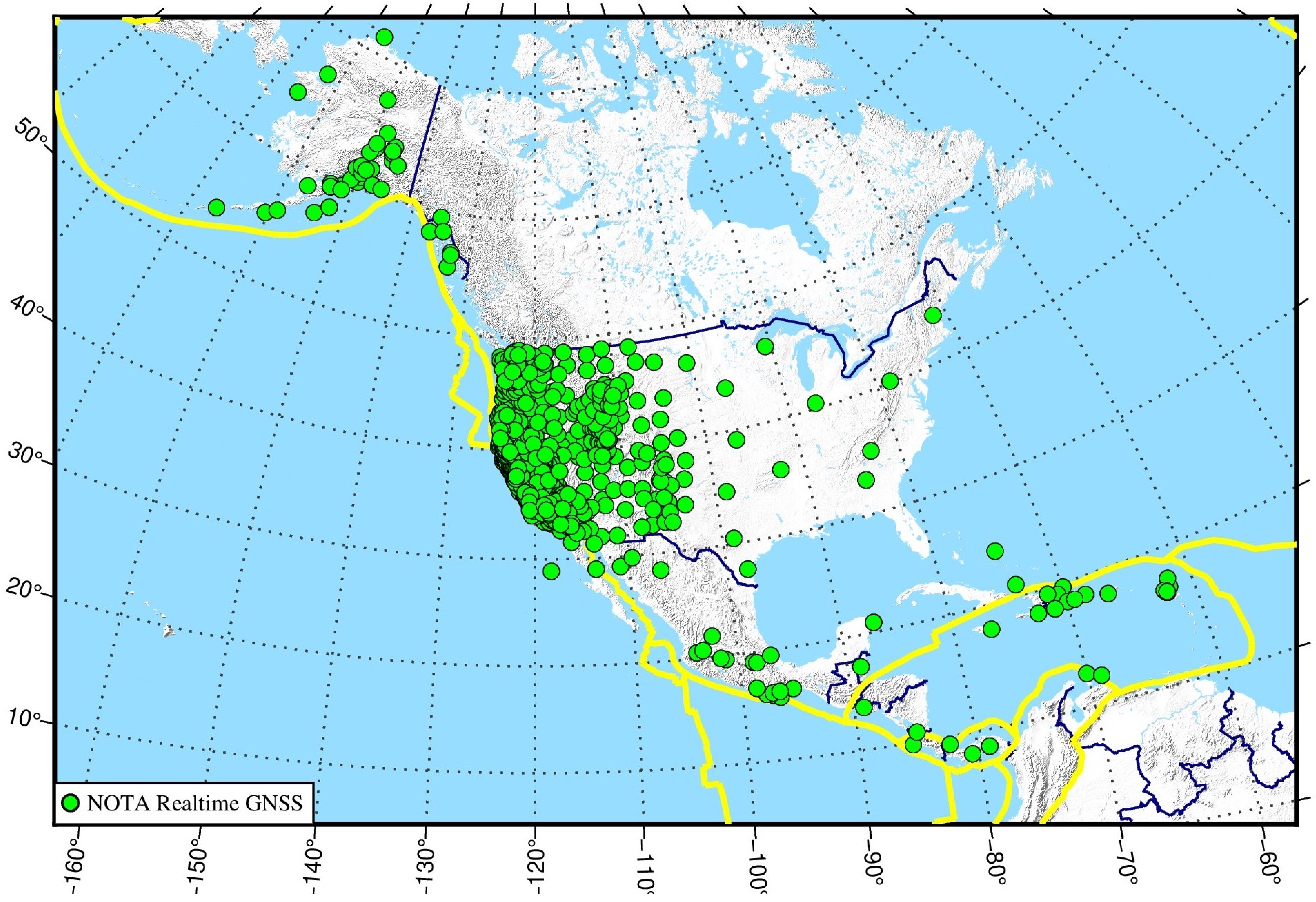
NOTA Real Time Streams

985 STATIONS, 1-SPS STREAMS:

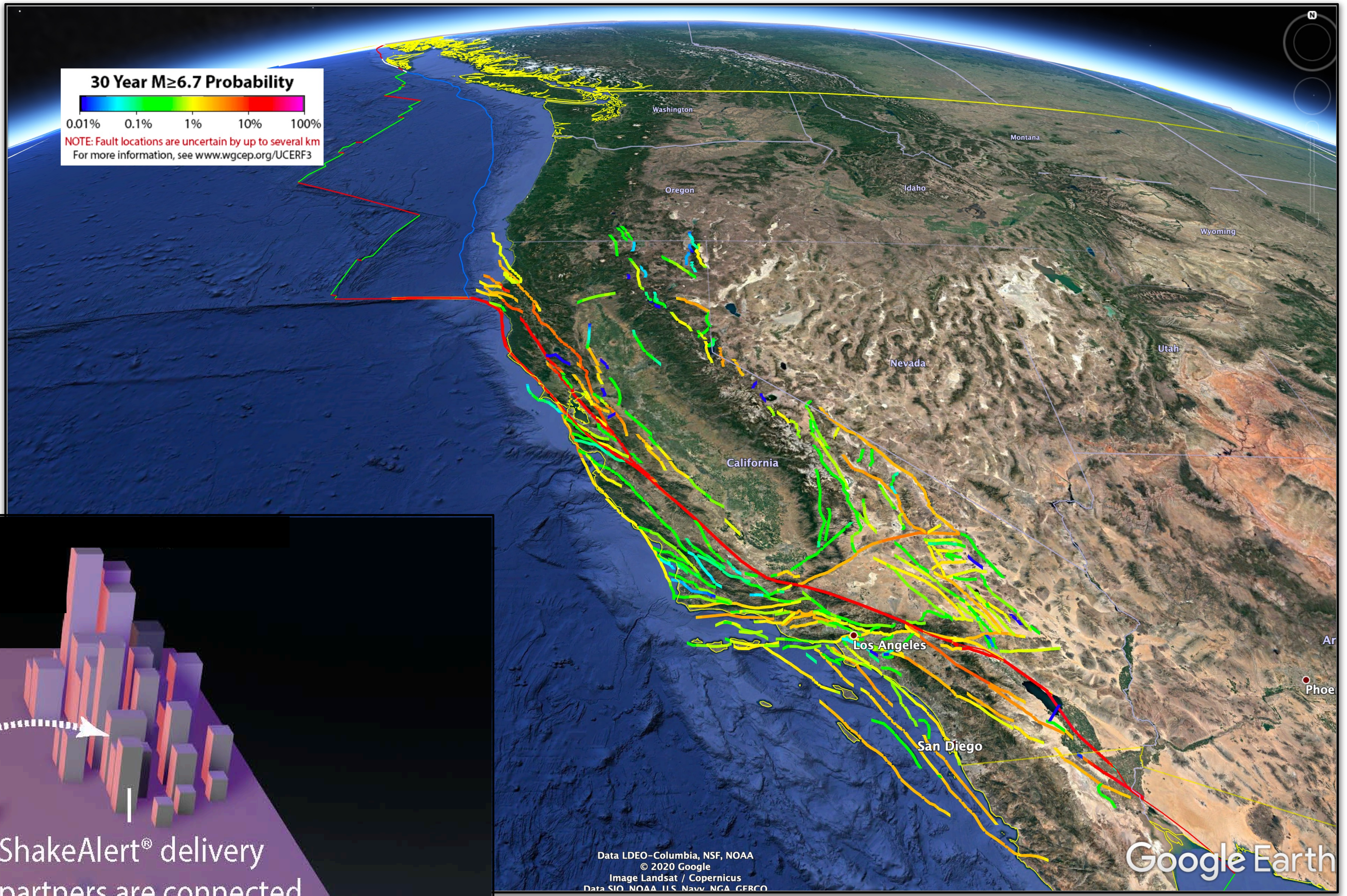
- **BINEX**: Primarily used by Academia, USGS
- **RTCM**: Used by commercial entities
- **PPP:** Precise Point Positioning (NMEA string)

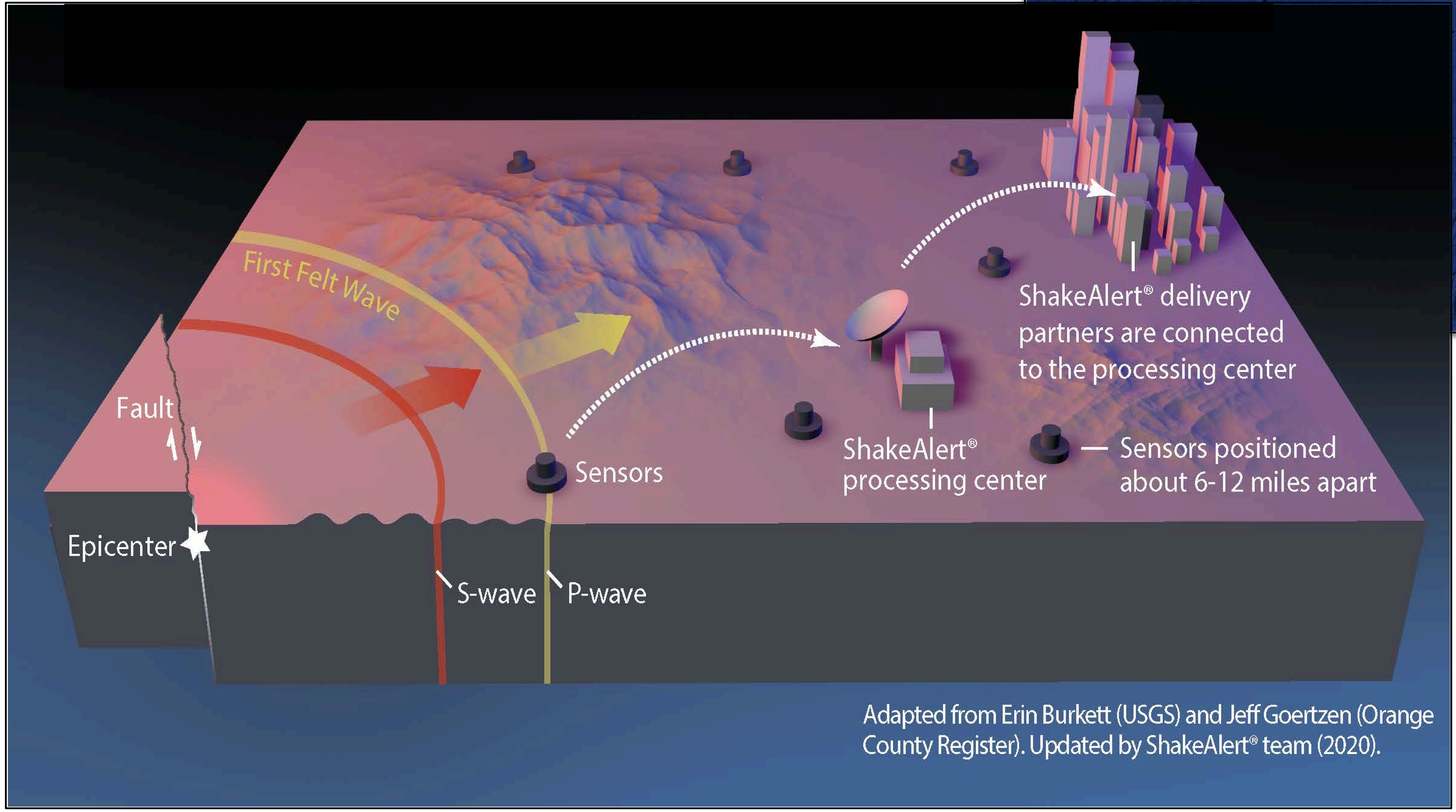
STREAMS ACCESSED BY ALL SECTORS OF SOCIETY:

- **Government agencies**: USGS, NOAA, state level transportation departments
- **Commercial entities**: Surveyors, Construction
- **Academia**: Universities, Schools, Research Groups
- ~4,000 active connections at any given time



Shake Alert: An Earthquake Early Warning System for the West Coast of the United States





Adapted from Erin Burkett (USGS) and Jeff Goertzen (Orange County Register). Updated by ShakeAlert® team (2020).

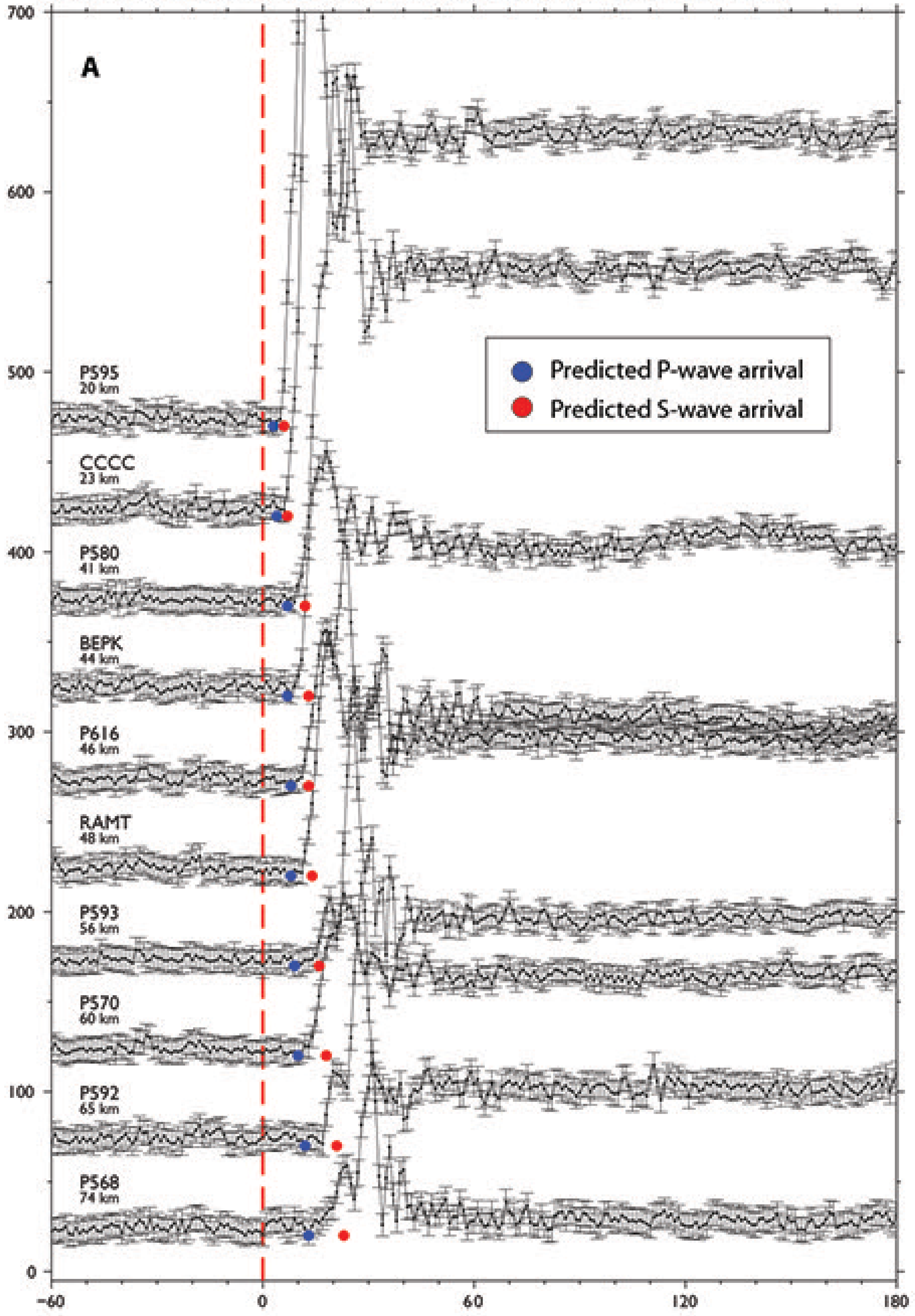
USGS science for a changing world

ShakeAlert™

https://www.shakealert.org (9/12/22)

GNSS For Earthquake Early Warning

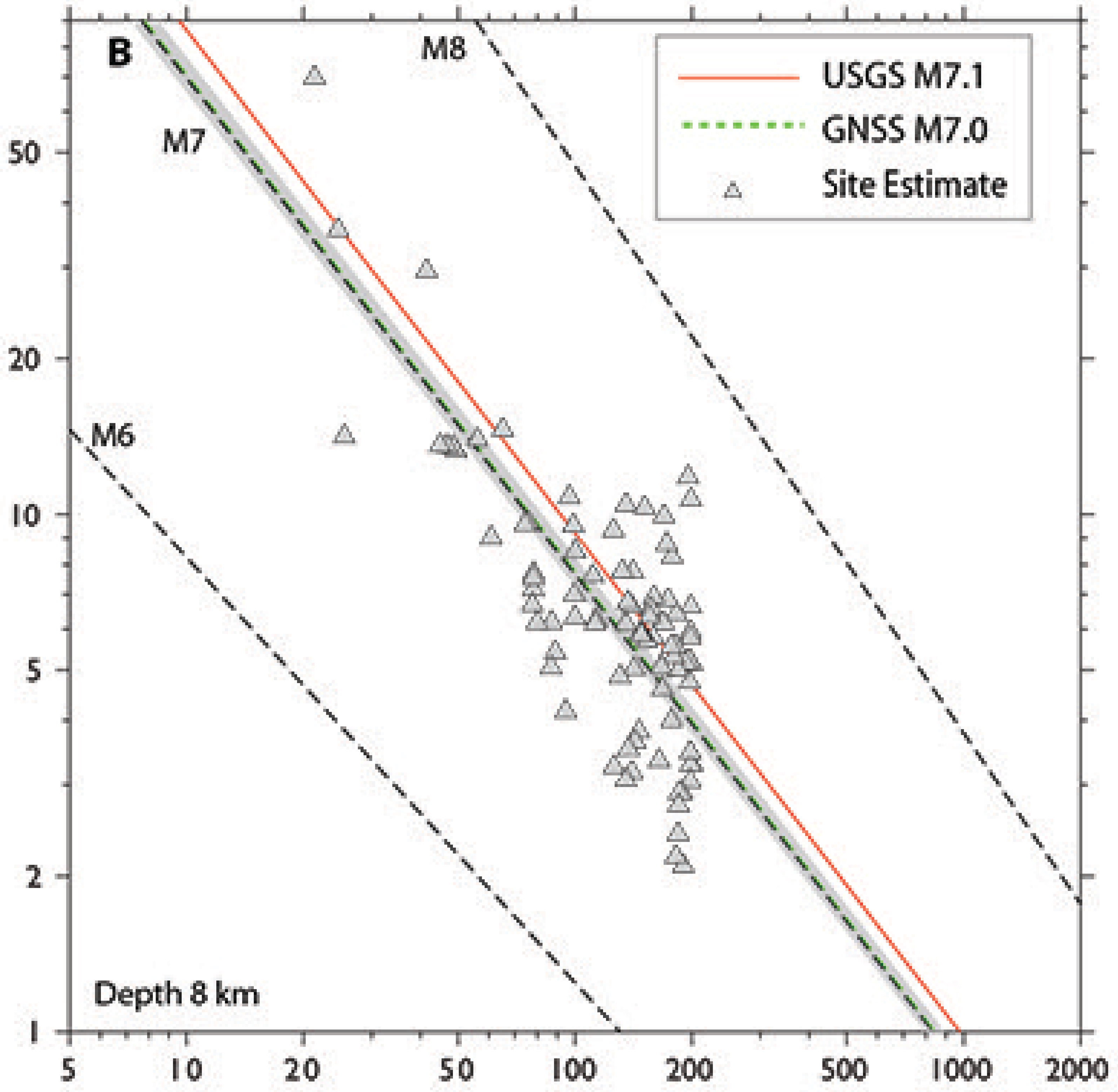
Horizontal Displacements from UNAVCO's
RT Position Solutions



Displacements (mm)

Seconds After Origin Time

Predicted Magnitude vs GNSS Derived Magnitude



PGD (cm)

Hypocentral Distance (km)

M 7.1, 17 Km NNE of Ridgecrest, CA, 2019-07-06

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Many Other Science Applications

NSF NASA USGS science for a changing world

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