Geodesy Advancing Geosciences and EarthScope (GAGE) GPS Result Characterization

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OVERVIEW

- GAGE Processing
  - Characterization of results
- Earthquakes and postseismic motions
- Slow slip events
  - Alaska
- Anthropogenic signals in data
- Anomalous motions
- Access to information and products

Details in: Herring et al., Plate Boundary Observatory and Related Networks: GPS Data Analysis Methods and Geodetic Products, (2016) *Rev. Geophys*., 54, doi:10.1002/2016RG000529

GAGE Processing

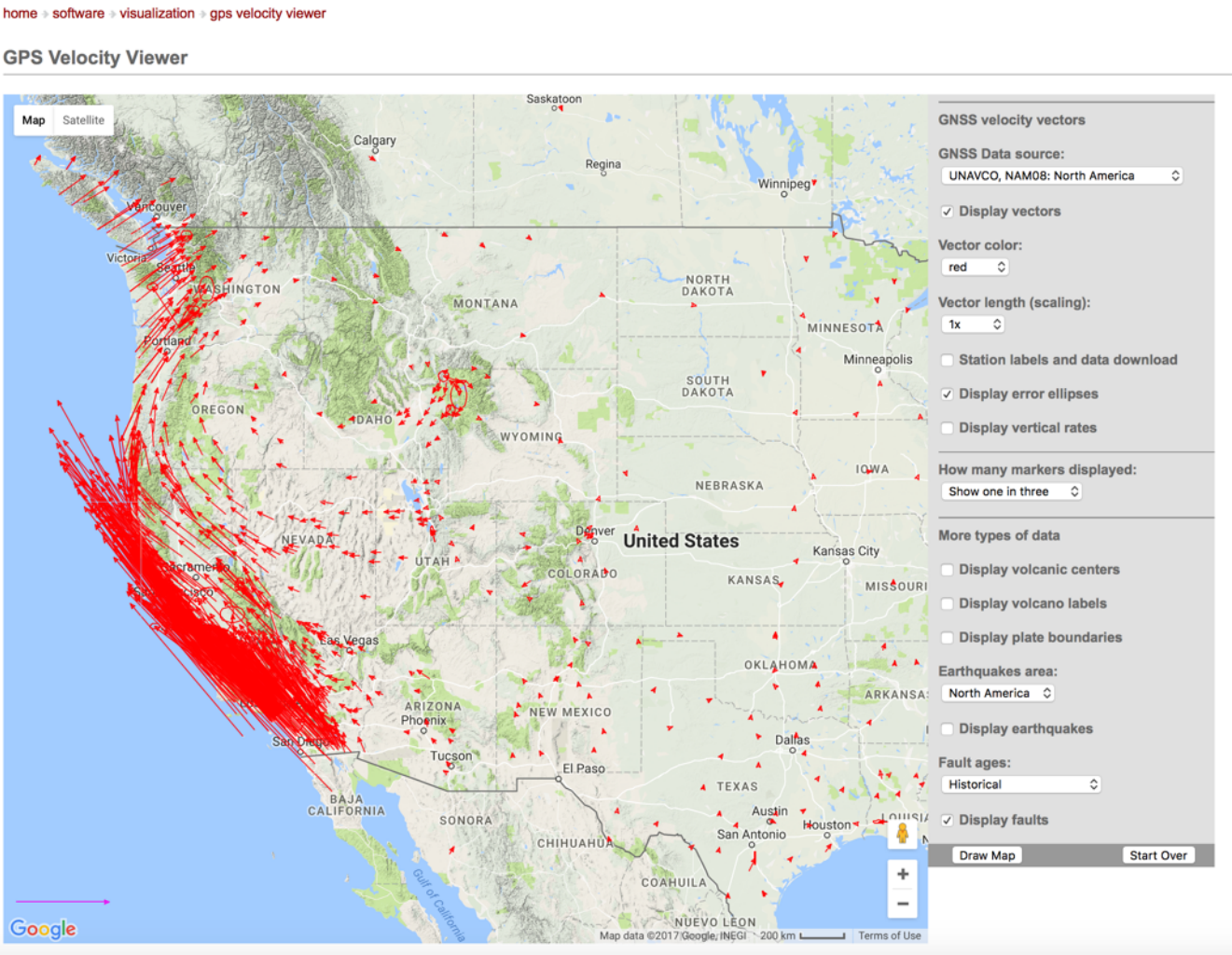
- Time tables of results:
  - Rapid solutions: latency 1 day
  - Final solutions (used IGS final orbits) 2-3 weeks
  - Supplemental runs at 12 and 24 weeks to add stations missed in finals
  - Reprocessing runs. Next will start soon for ITRF2014/IGS14
- Products: All available through UNAVCO http/ftp/php and web services (soon)
  - Time series: North America “Fixed” and IGS08
  - Secular velocity fields (released monthly based on time series analyses).
  - SINEX files: Full covariance files
  - Event files for earthquakes
  - Atmospheric delay estimates, phase RMS scatters and other quality metrics

http://www.unavco.org/software/visualization/GPS-Velocity-Viewer/GPS-Velocity-Viewer.html

Tools

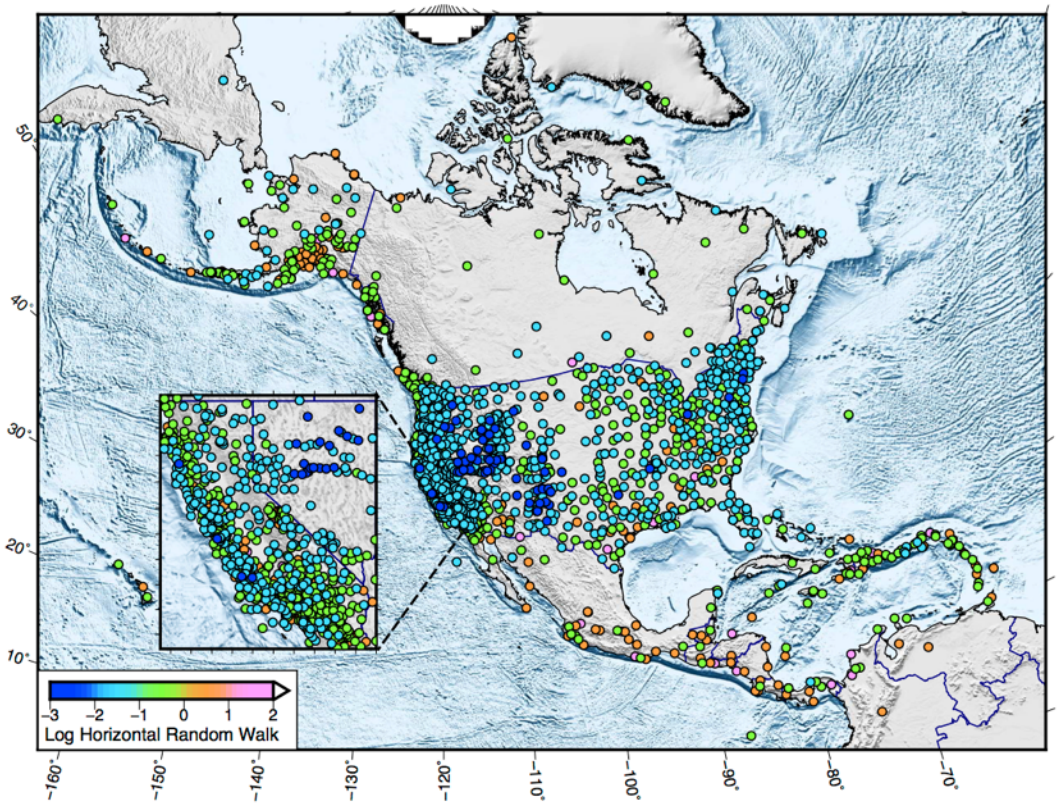
This is one of the data visualization tools available through UNAVCO.

Other tools allow time series viewing and station and data information to be accessed.



Station homepage:
http://www.unavco.org/instrumentation/networks/status/pbo/overview/<site>

Characterization of non-secular variations



One method of characterizing non-secular motions: Horizontal position variations parameterized as a random walk.

Plot of log of value in mm^2/yr
Standard deviation over a decade:
Dark blues: 0.3 mm
Light greens: 3 mm
Browns: 4.5 mm
Pinks: 30 mm

Each sites needs careful examination to assess nature of signal

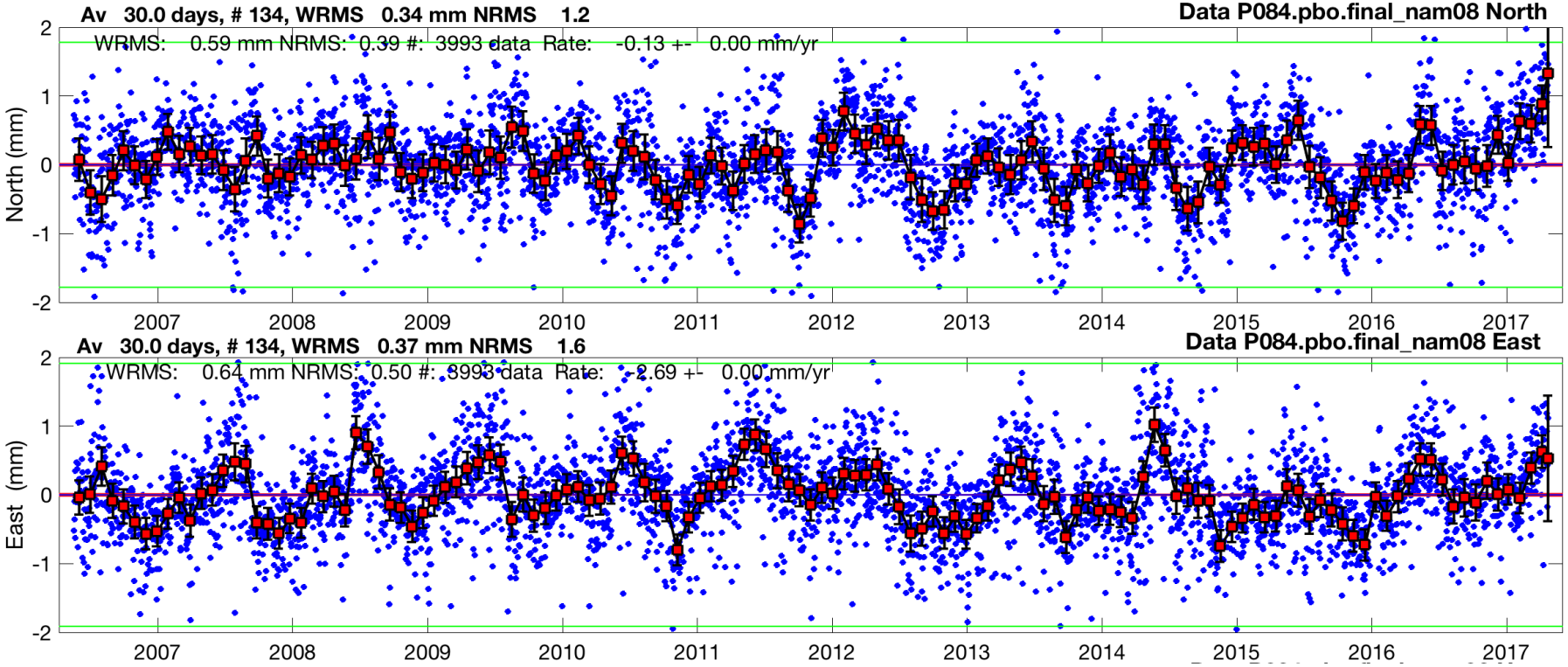
Statistics computed with annual and in some cases post-seismic log terms estimated

From Herring at al., Reviews of Geophysics

Low Level of systematic noise

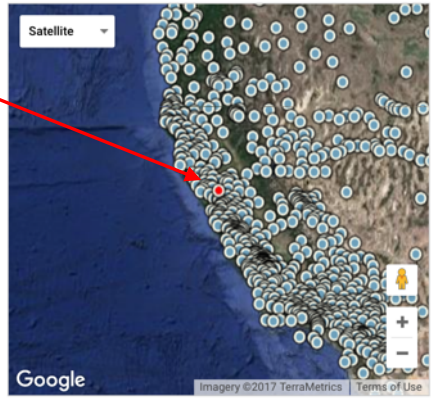
P084

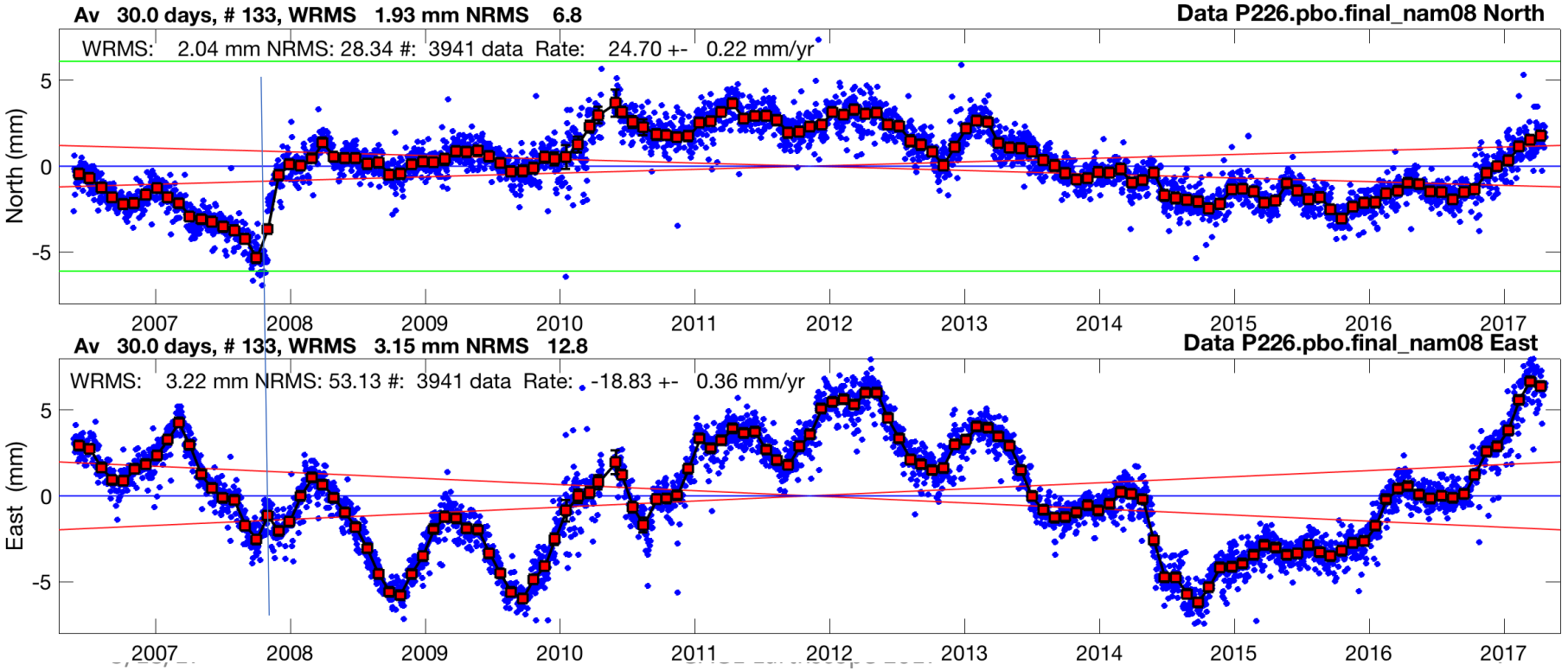
Red squares are 30-day averages. RMS <0.4 mm; daily RMS <0.7 mm
Even the lowest noise sites are not white noise.



High level of systematics

RMS scatters are now 2-4 mm. (Earthquake offset 2007 10 31 Mw 5.6, Event 12)

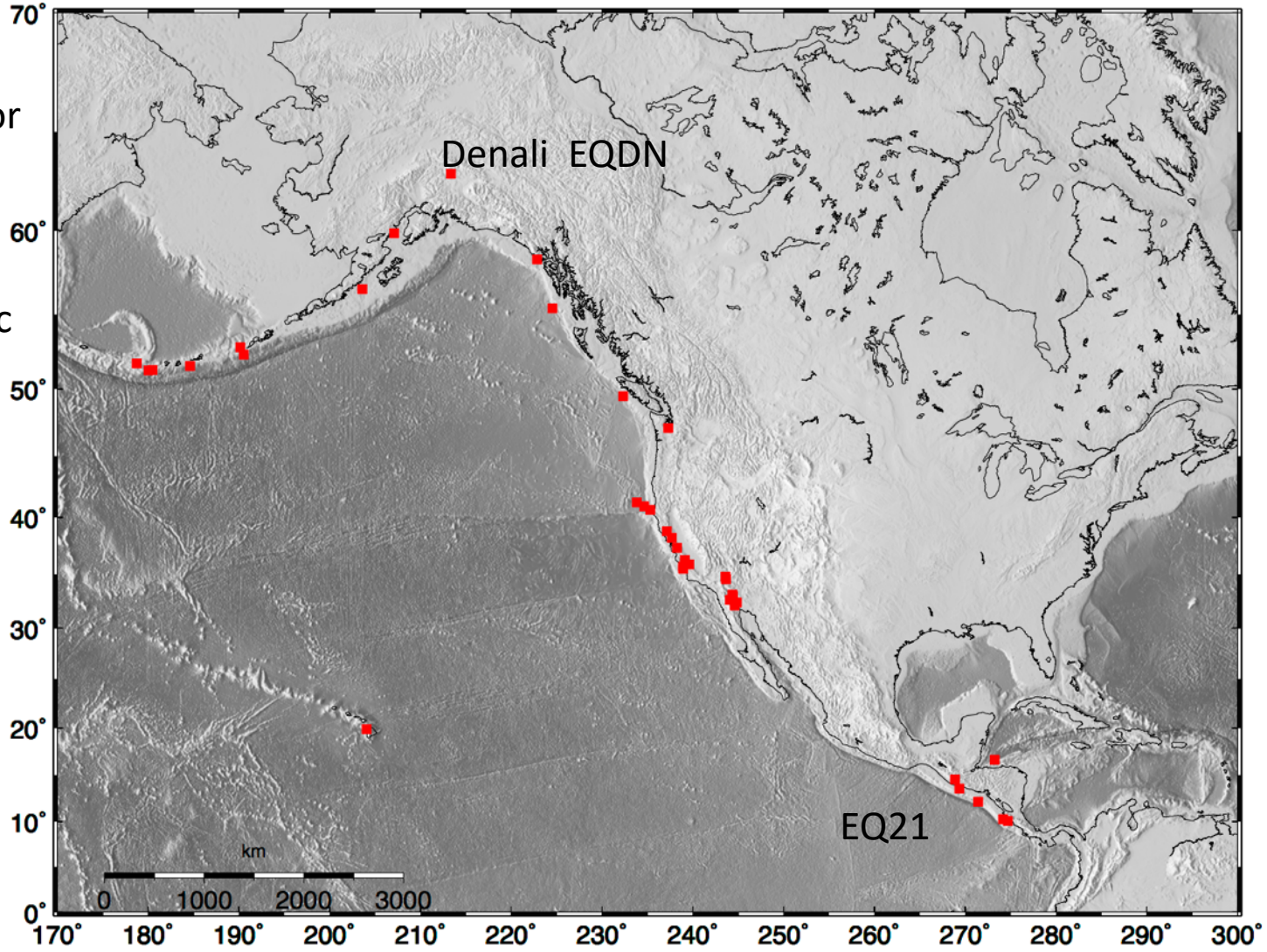




Earthquakes included in processing

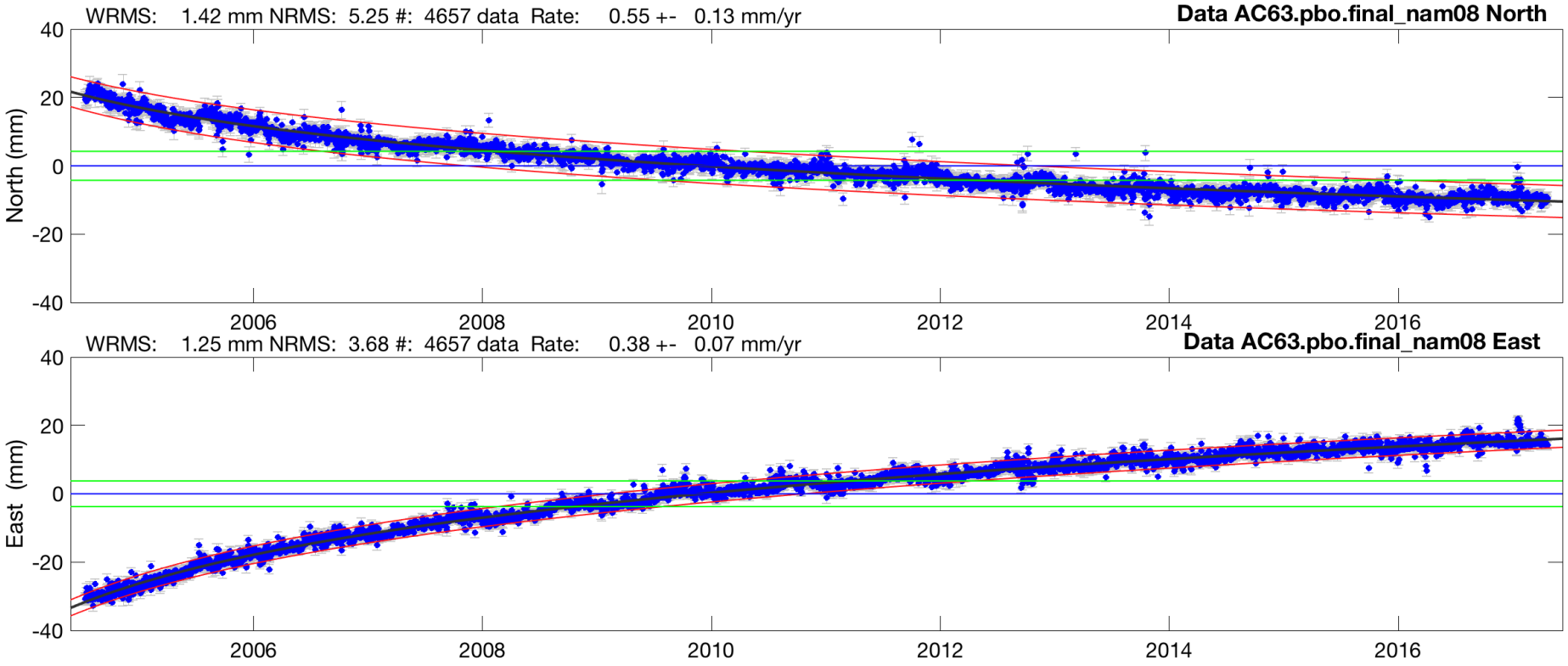
Between 1996 and now, we account for
38 Earthquakes
18 Fault plane solutions
10 with postseismic signals

Most earthquakes are given a 2-digit numerical code. In some cases letter codes are used for well known events



Denali Postseismic

Mw 7.9 Date 2002 11 3
Data below starts over 2 years after the earthquake.
We estimate site would have been displaced 410 mm N, 140 mm E



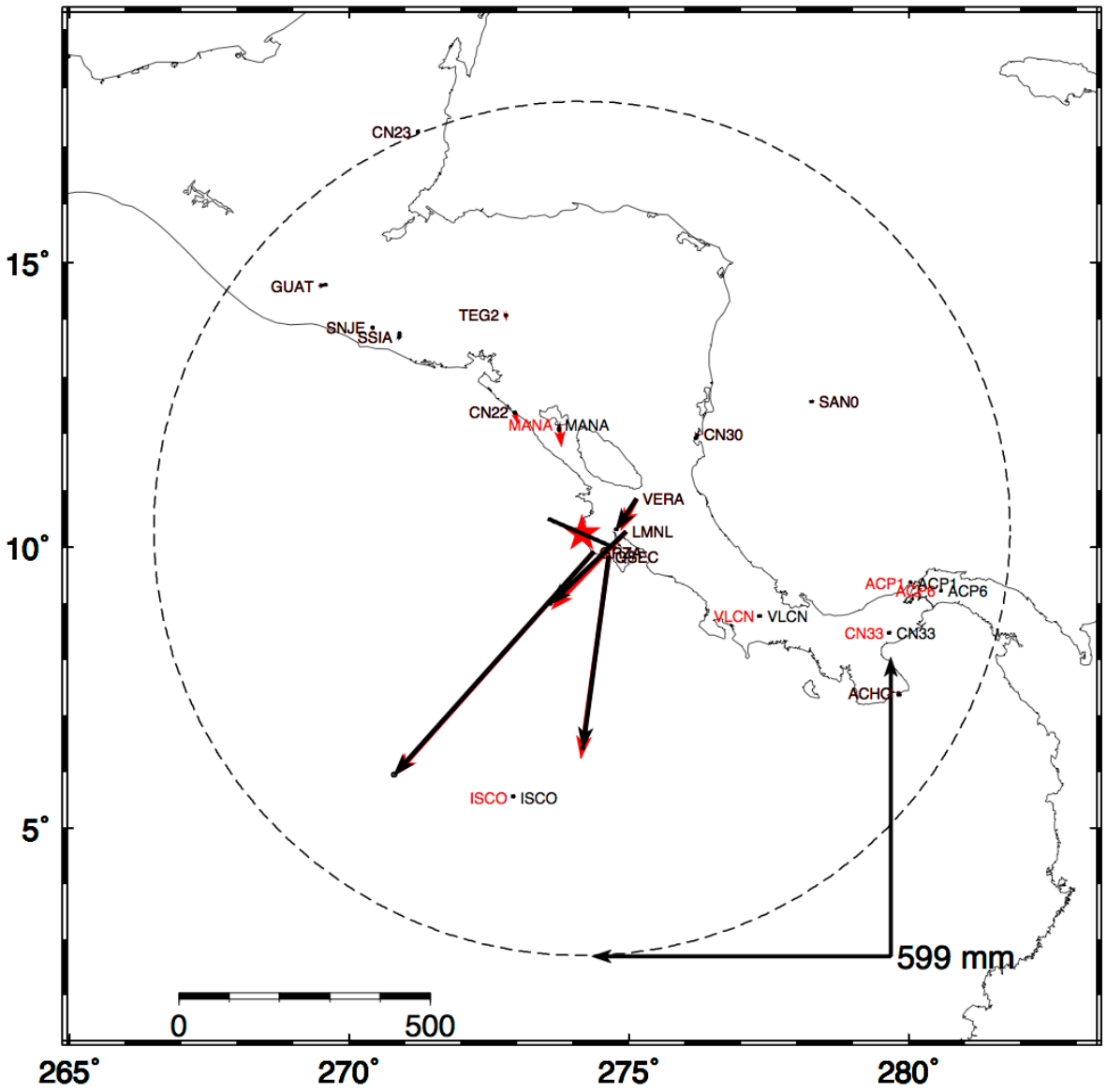
Central America Postseismic

EVENT EQ21:
Mw 7.6
Location 10.1N 85.310W
Date 2012 9 5 UTC 14 42

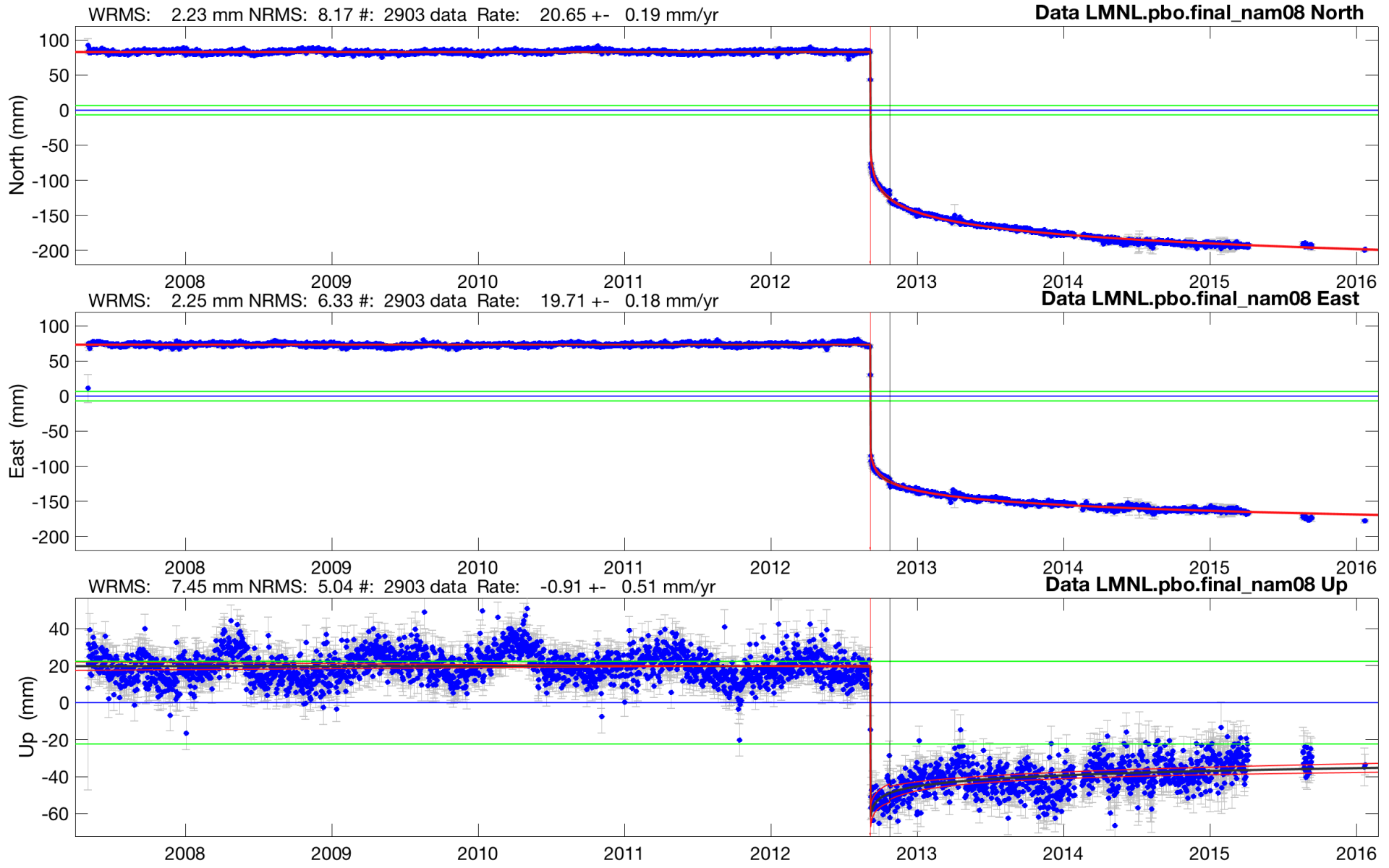
Event file generated initially generated from rapid solutions 3-4 days after event.

Circle is estimated region where coseismic displacements up to 1 mm may occur.

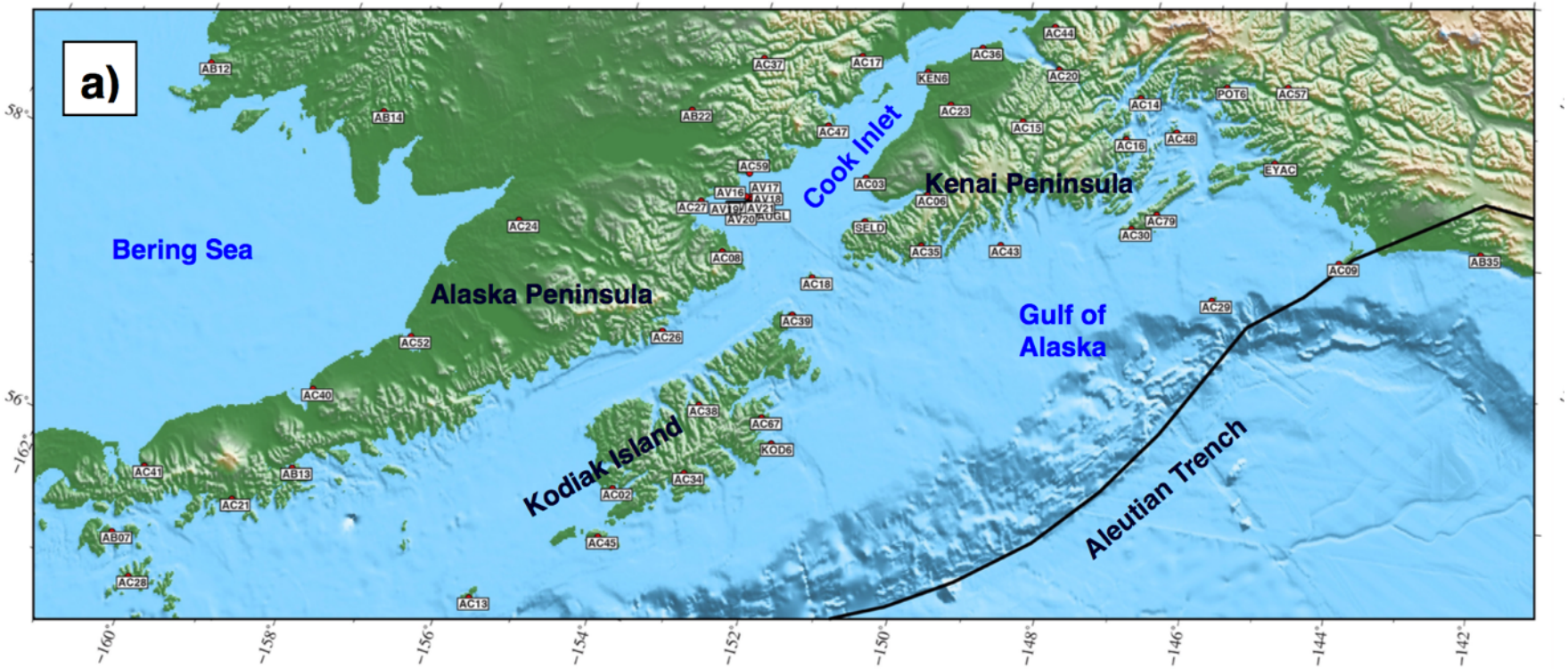
Postseismic assessment happens months after event based on time series behavior and time constant determination.



Time series example

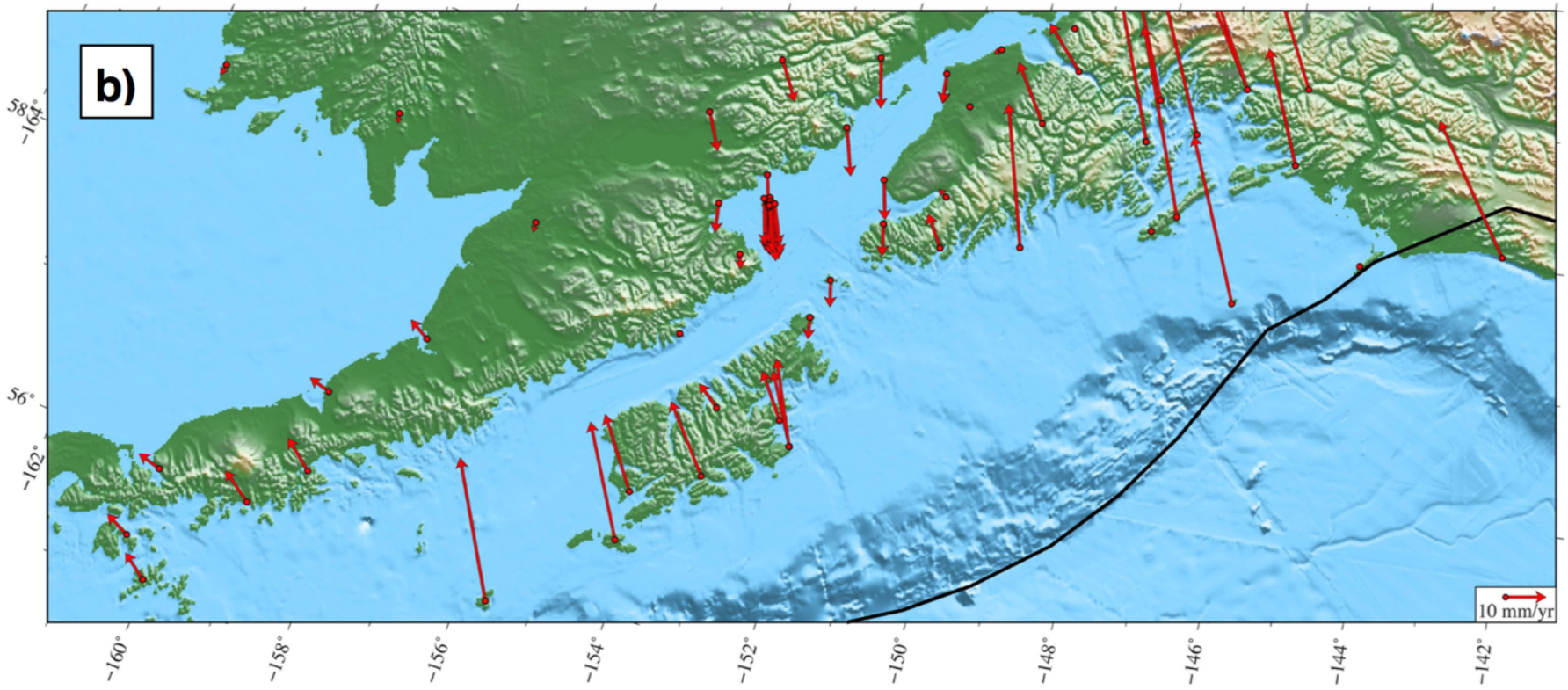


Transient Events: Alaska



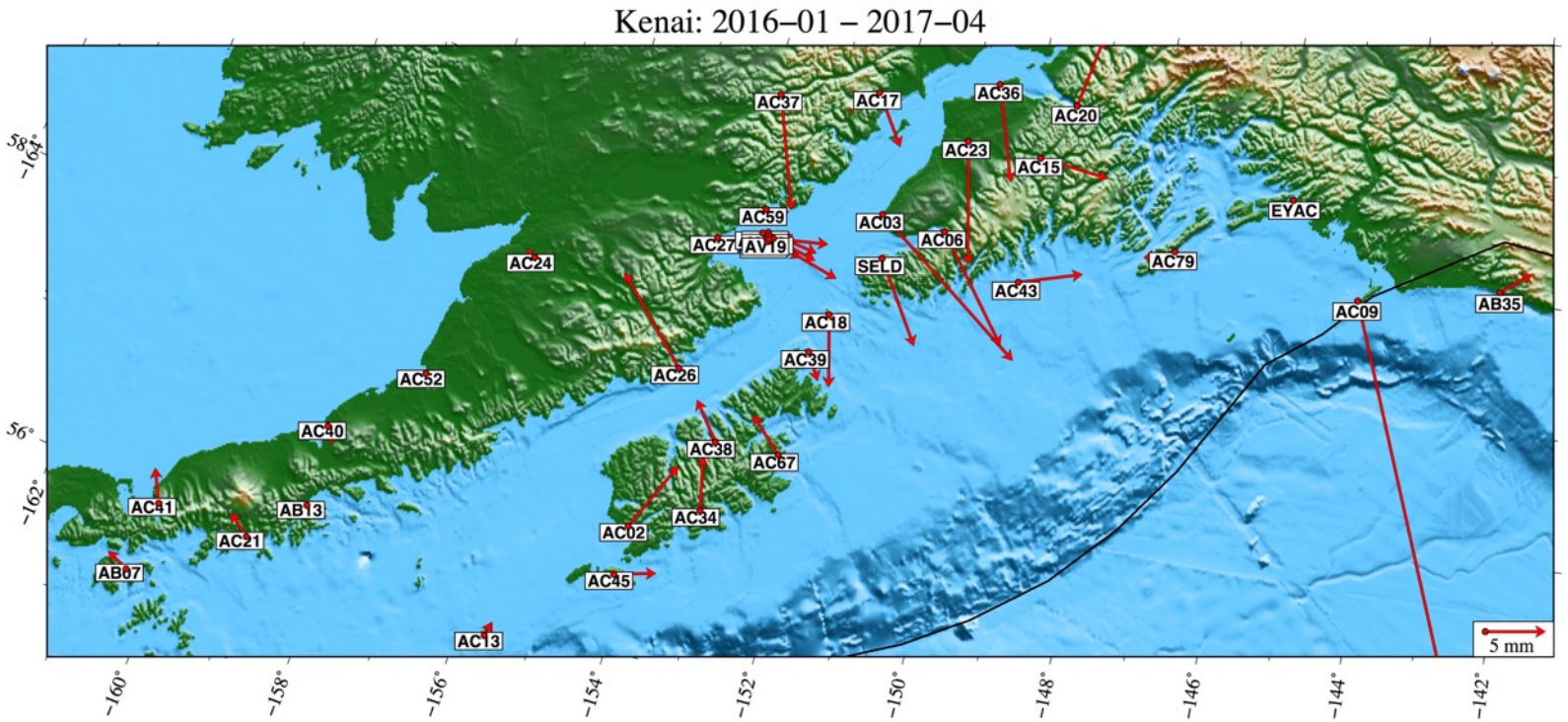
Site names: We will look at sites on the Kenai Peninsula

Secular Velocities: North America ”fixed”



Kenai Peninsula: De-trended and 30 day average

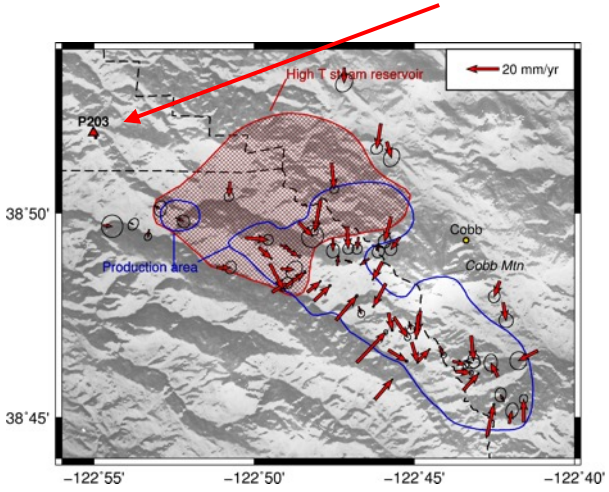
One event pattern: Deviation from secular trend

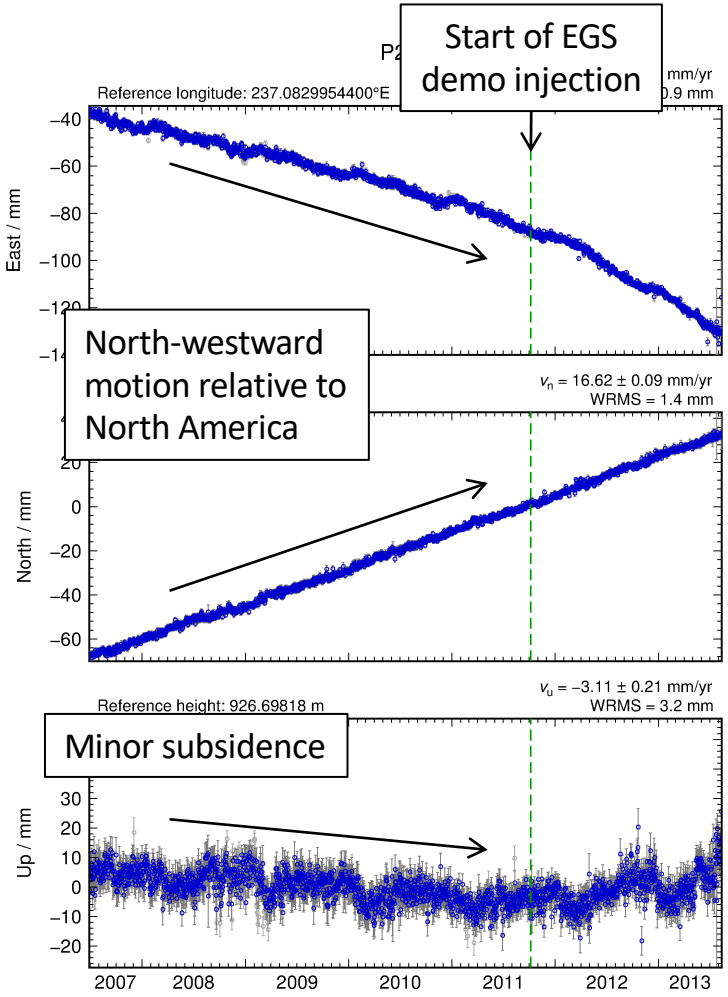


Rich pattern on transient signals in this region

Example of human induced changes in The Geysers, California, Geothermal injection.

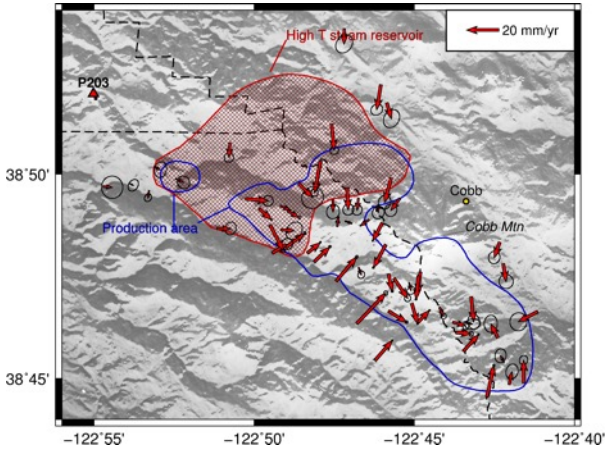
Plate Boundary Observatory (PBO) continuous GPS site P203

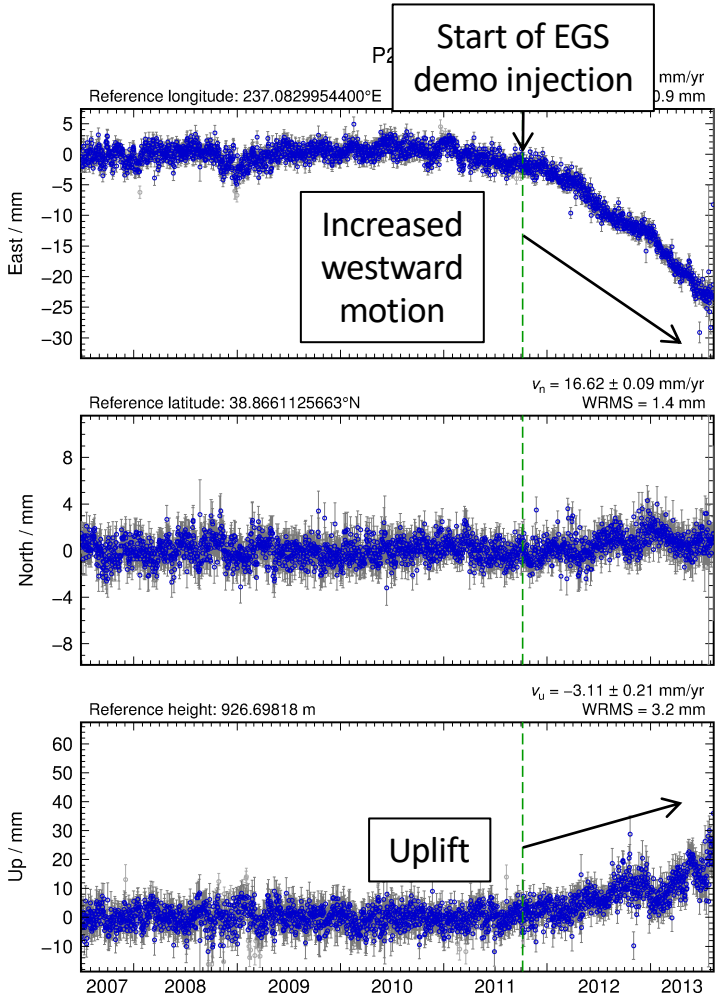




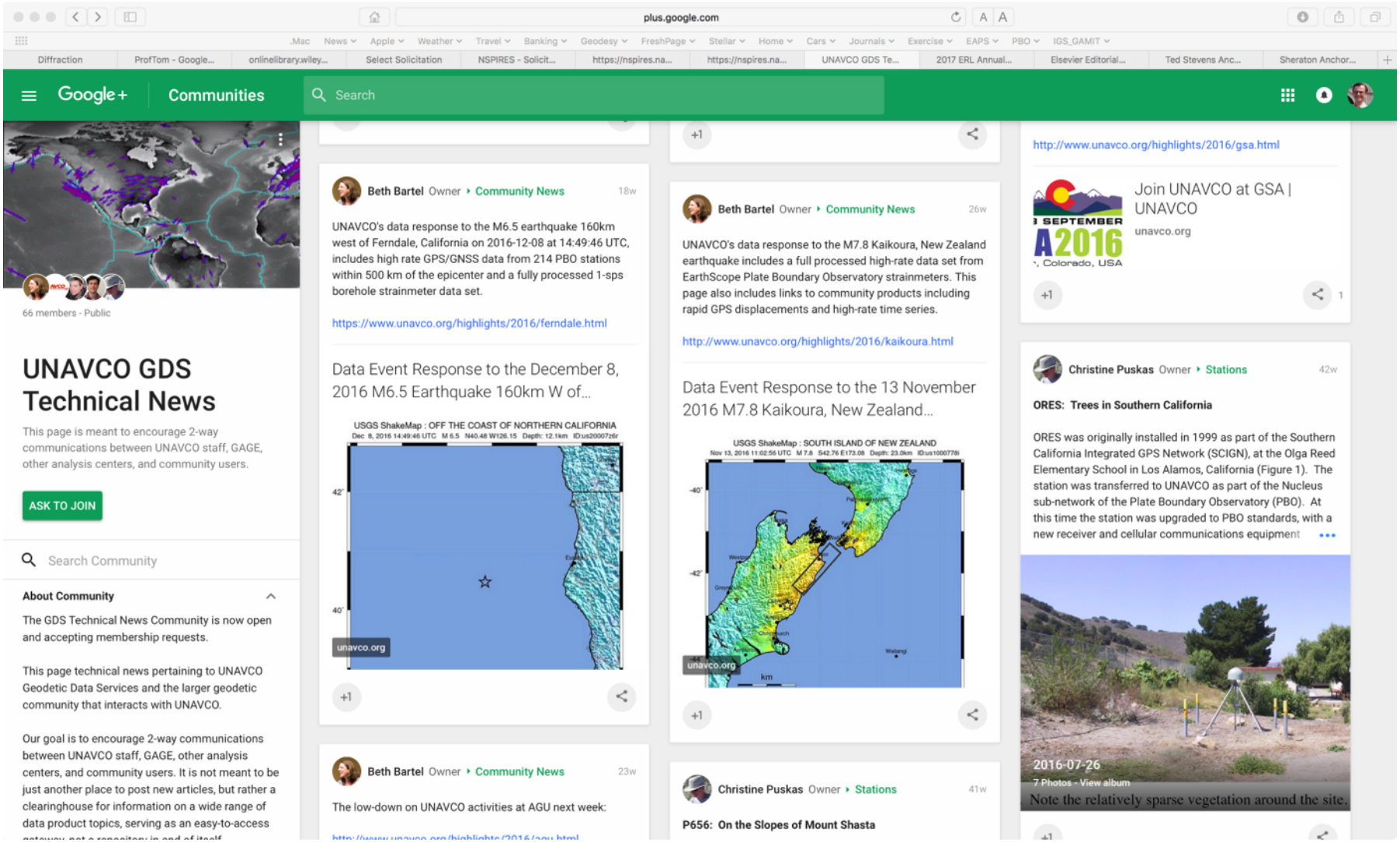
In collaboration with Gareth Funning, UC Riverside

Plate Boundary Observatory (PBO)
continuous GPS site P203



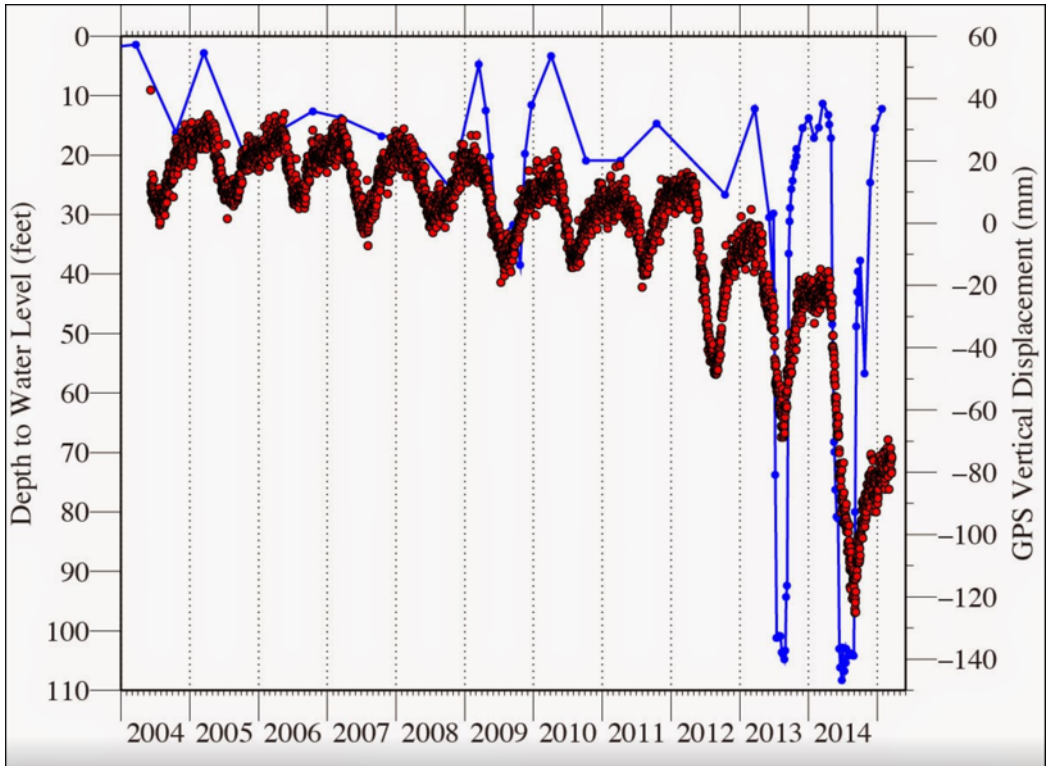


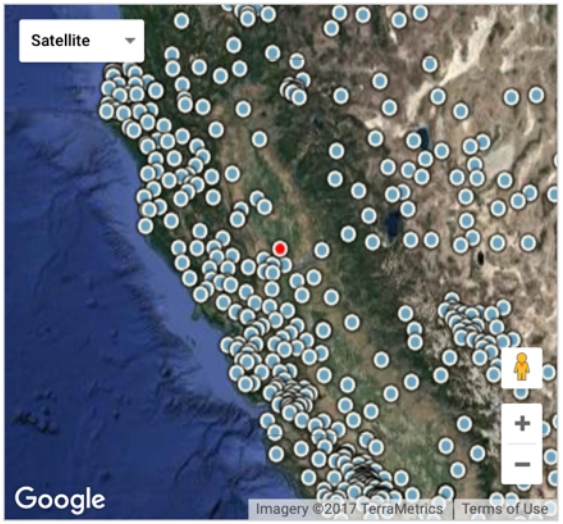
UNAVCO GDS Technical News: Google Plus



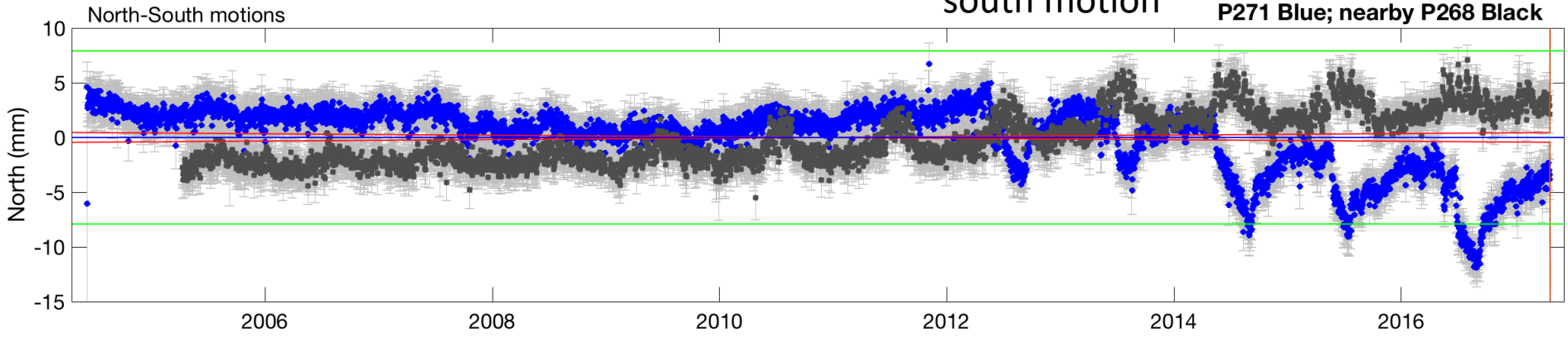
Find on UNAVCO page or Google search “UNAVCO GDS Technical News”

Ground water: Poroelastic P271

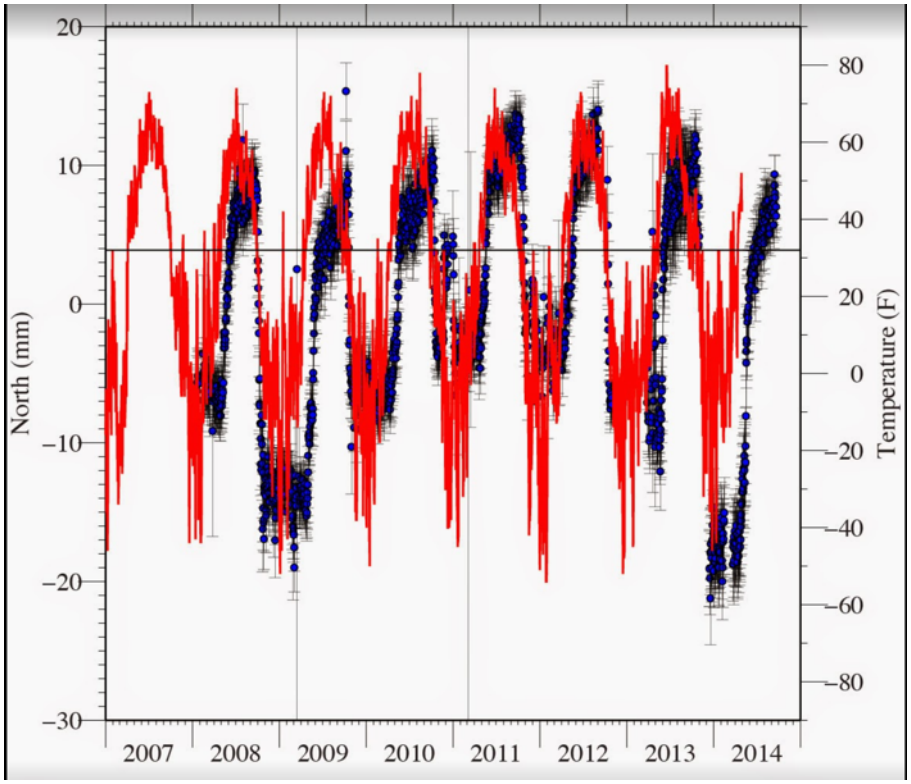




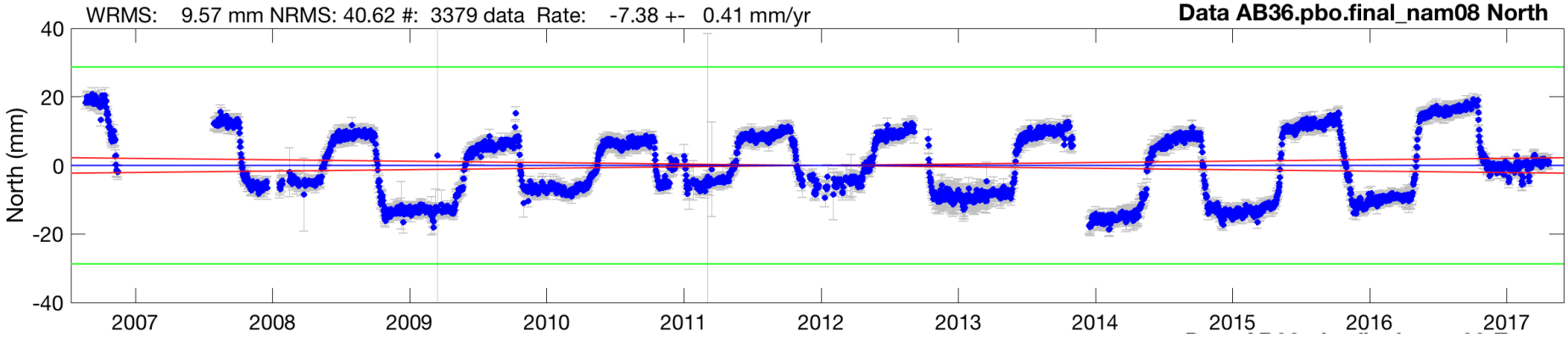
Nearby P268 shows little vertical motion but anti-correlated north-south motion



AB36



Red line is temperature at Manly Hot Springs Airport. Plot below shows “square wave” structure possibly related to freeze-thaw cycles.



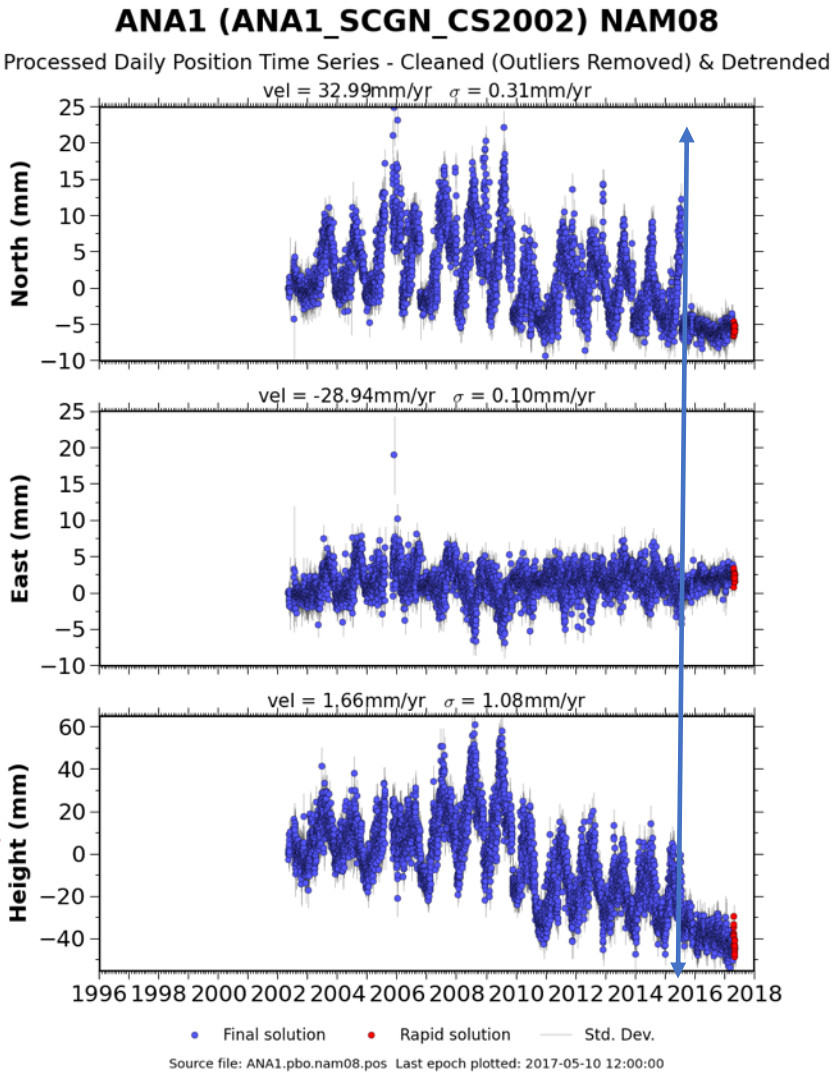
Transition seems to coincide with temperatures above and below freezing

ANA1: Alfred Hitchcock's Birds

Late 2015: Thin mess over the site to stop bird's landing on monument.
Article and video on UNAVO GDS Technical news page.

Vertical line marks time of update

We can tell the preferred direction for sitting on the radome **– New application for GPS. Bear aggression can also be studied in Alaska (See GDS notes)**



Summary

- All of the GAGE processing results are available on-line and suggestions for updates are welcome.
- Access is through www.unavco.org under Instrumentation and Data tabs. FTP access is through ftp://data-out.unavco.org/pub/products/
- There are a wide variety of signals and noise in the GAGE analysis products with new insights being gained all the time.
- Methods have been fully discussed in Herring et al., Plate Boundary Observatory and Related Networks: GPS Data Analysis Methods and Geodetic Products, (2016) *Rev. Geophys*., 54, doi:10.1002/2016RG000529