EarthScope Science and Long-term Value: View from the EarthScope National Office

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Talk Outline

- http://www.earthscope.org
- EarthScope National Office
  - Encouraging scientific synthesis
  - Communication and outreach to the public
- EarthScope science and facilities
- Long-term impacts of EarthScope data

EarthScope National Office

- We are the public outreach and scientific community engagement arm of EarthScope
  - Communicate EarthScope science to the public
  - Engage with and represent scientific community
  - Foster scientific synthesis

History of ESNO

- EarthScope facilities included a coordination office in DC during facility construction phase
- 2007-2011: Oregon State University
  - Anne Trehu, PI
- 2011-2015: Arizona State University
  - Ramon Arrowsmith, PI
- 2015-2019: University of Alaska Fairbanks
  - Jeff Freymueller, PI

Synthesis and Integration

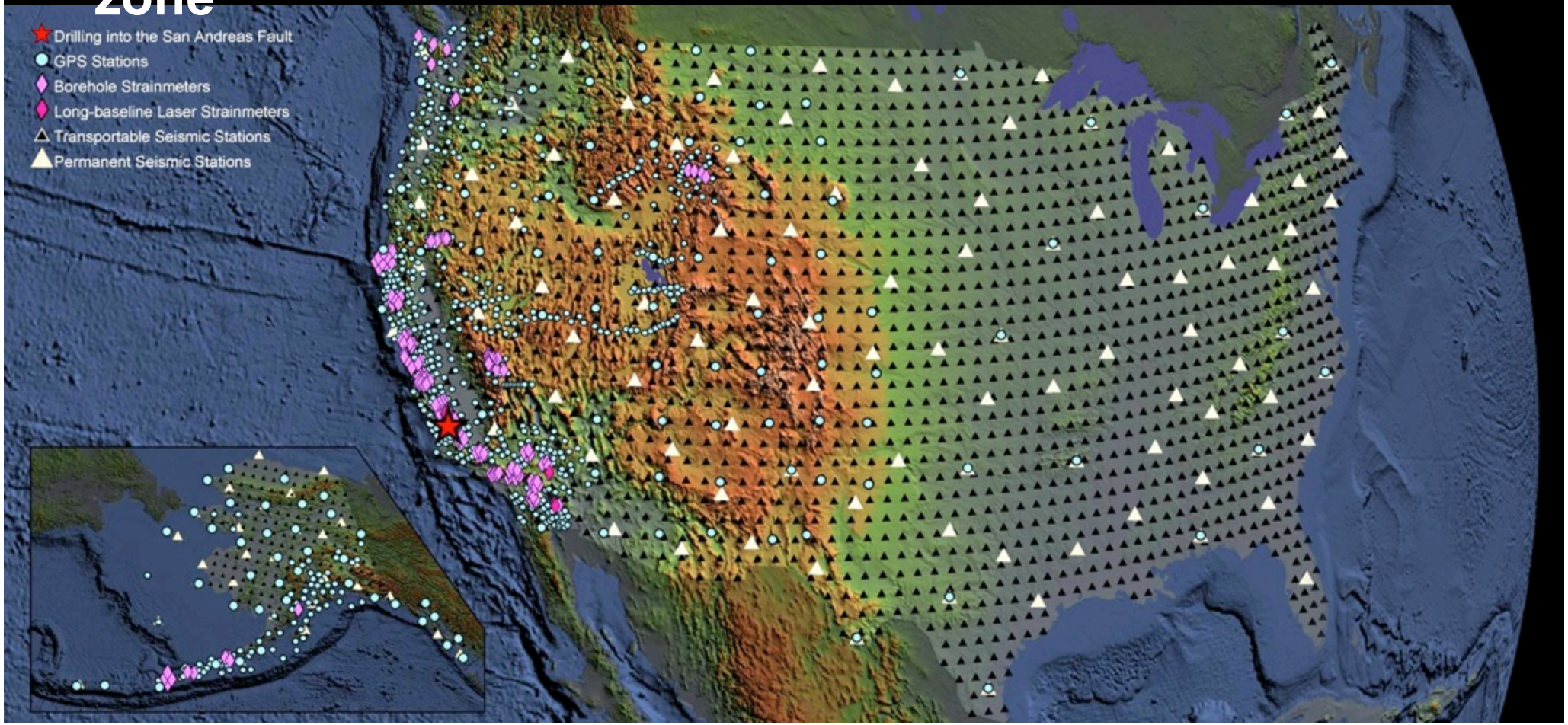
- A prime focus of the EarthScope science program and the Office
  - ESNO is convening a series of Synthesis Workshops to stimulate effective working groups
  - Science program is emphasizing synthesis and integration rather than new field data collection
- ESNO will use synthesis results to communicate EarthScope findings to the public.

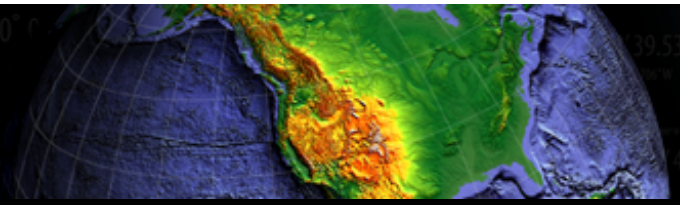
EarthScope Facilities

USArray: temporary seismic network (IRIS)

Plate Boundary Observatory (PBO): GPS (UNAVCO)

San Andreas Fault Observatory at Depth: sampling fault zone





EarthScope Science

- Making and Breaking the Continent
  - Structure of the continent
  - How continent is deforming
  - How these are related
- Complete continental coverage to enhance discovery
- All data open to everyone, heavily used
  - Over 410 peer-reviewed papers so far

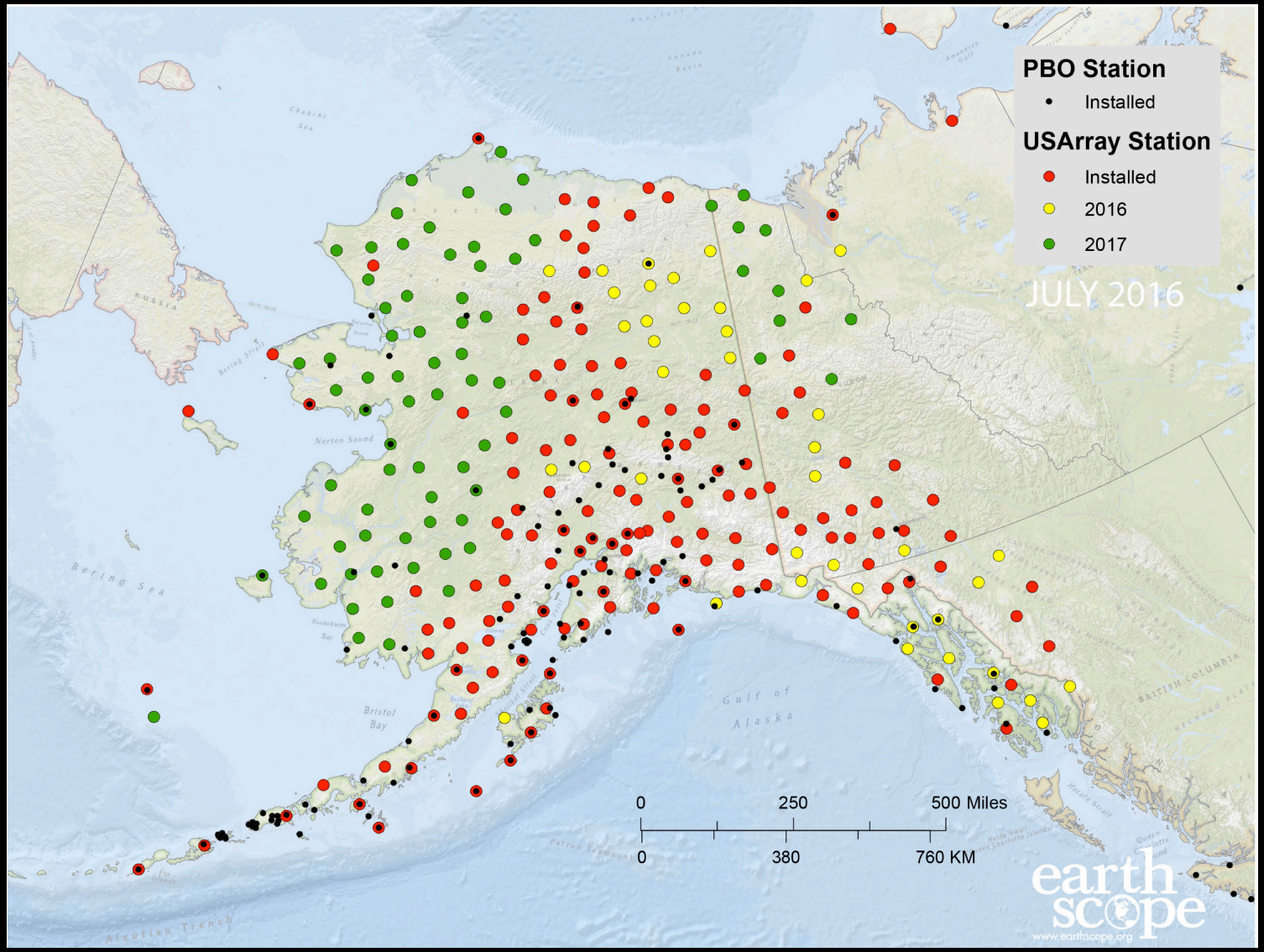
Making the Continent

- Structure and tectonic evolution
- Lithospheric and mantle properties
- Evidence for past tectonic construction of North America
- USArray emphasis on ***imaging***

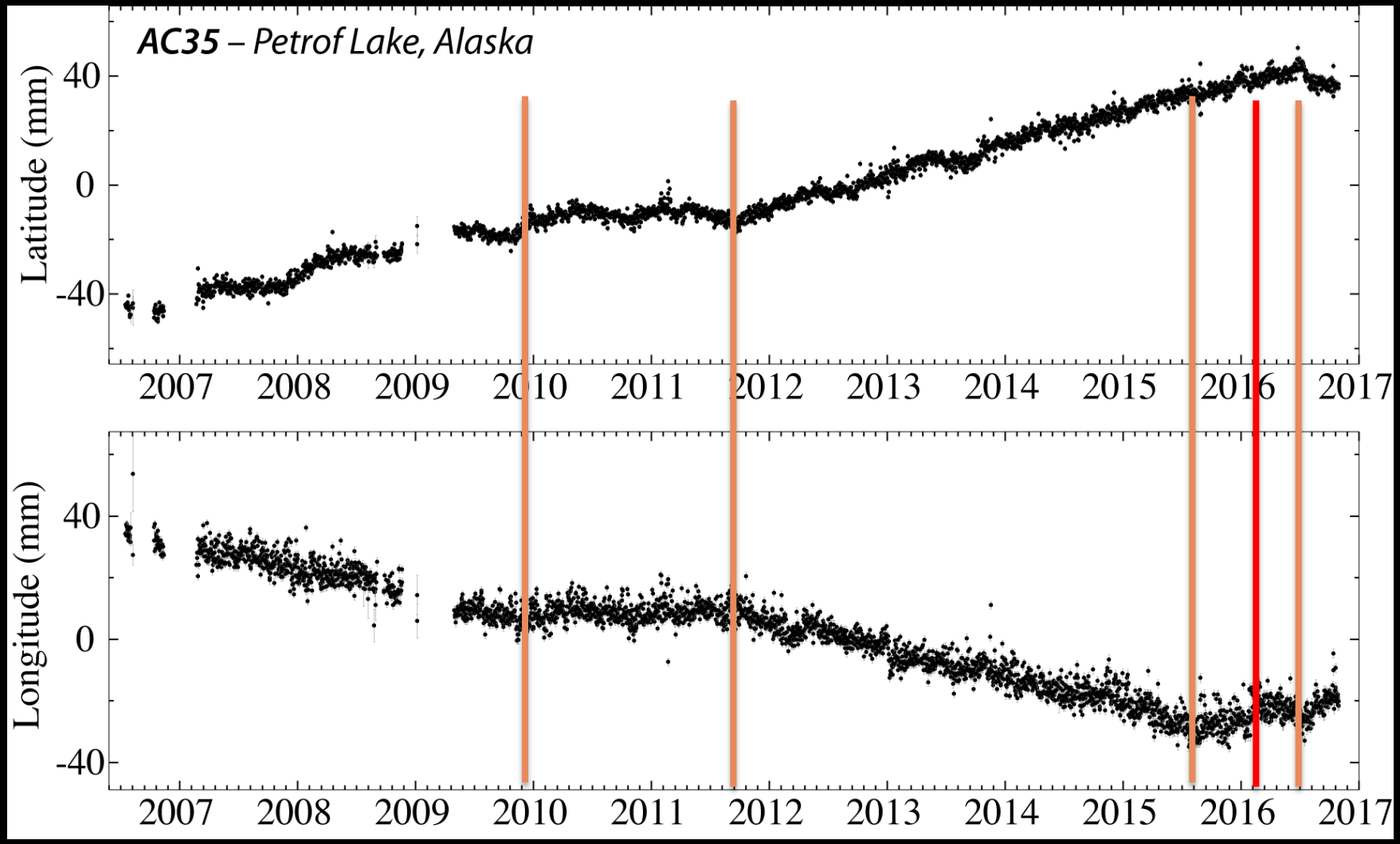
Breaking the Continent

- Steady and **transient** deformation
  - Tectonics
  - Earthquakes
  - Volcanism
- Probe mechanical properties of fault zones, crust and mantle
- Active deformation to understand the past

EarthScope Network in Alaska



What is Transient?



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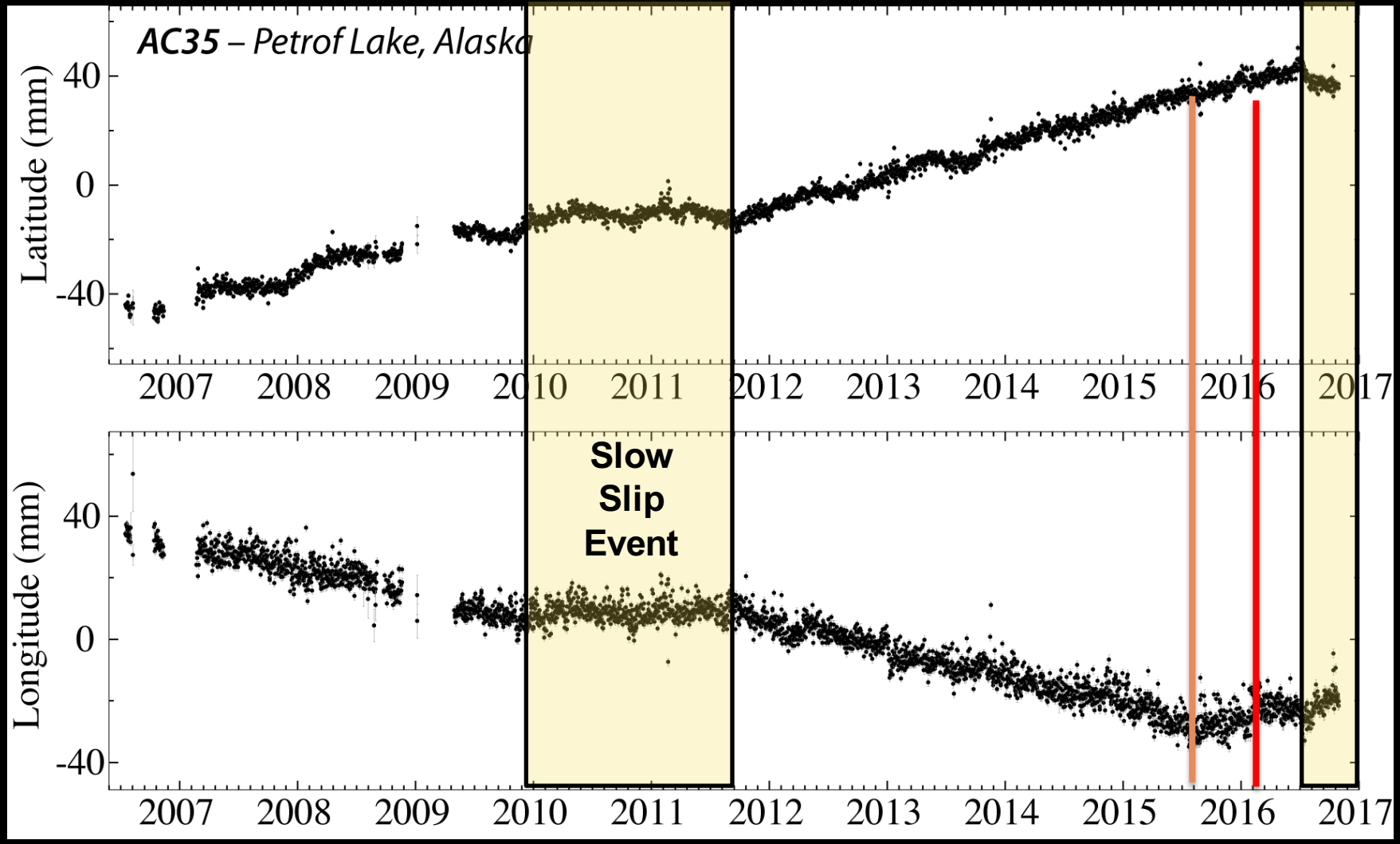
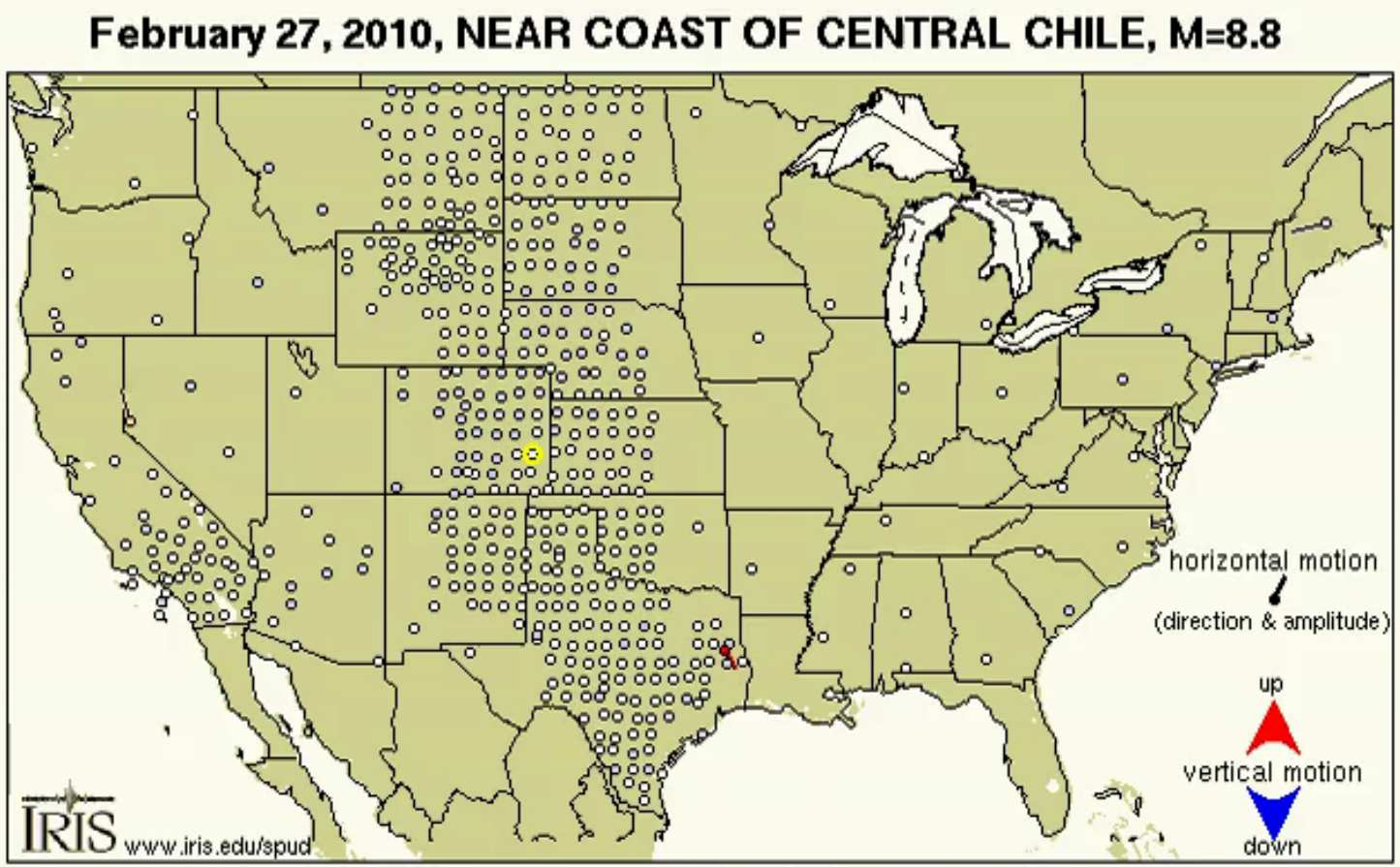
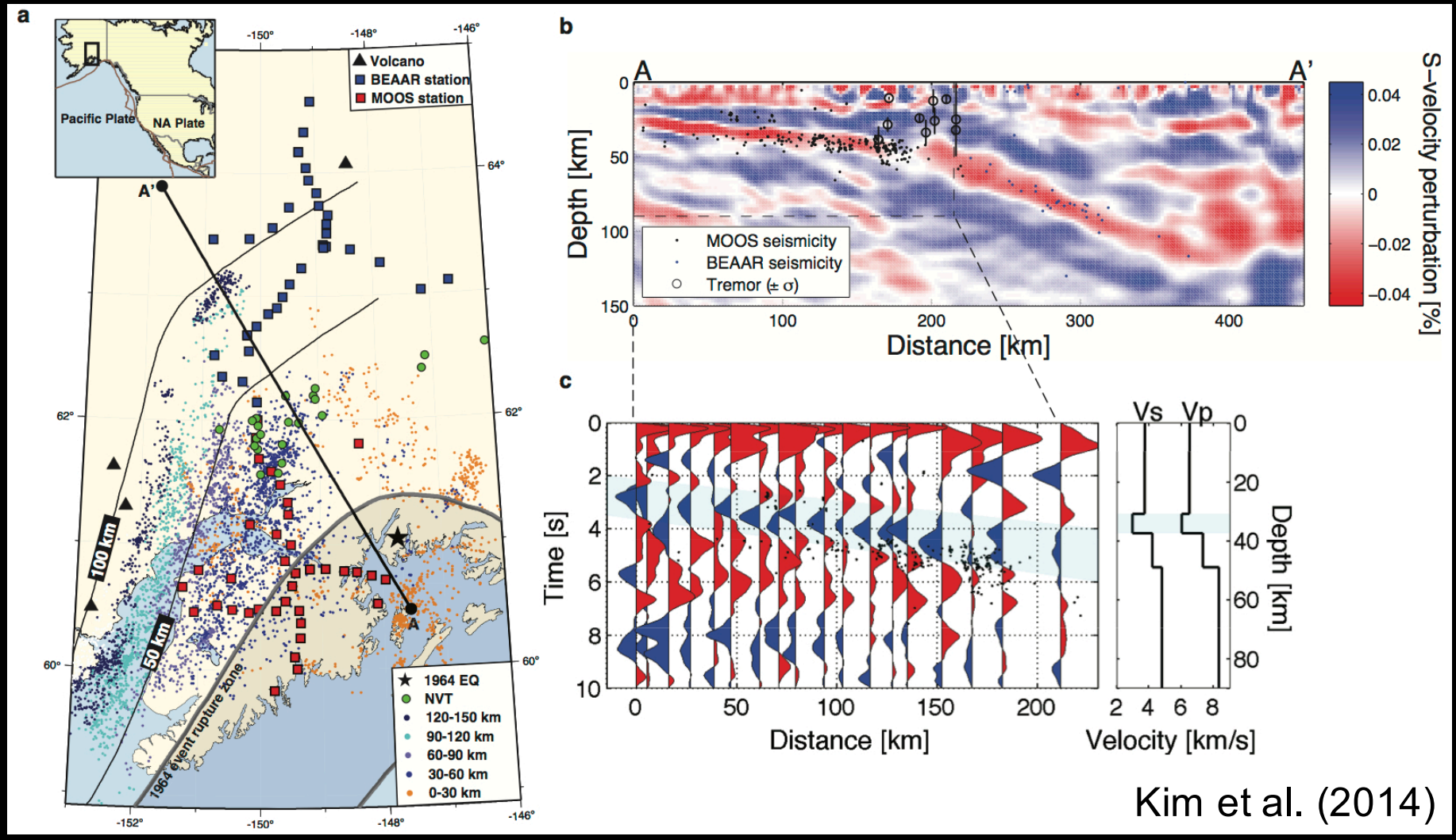


Earthquakes as Imaging Sources



Seismic Imaging

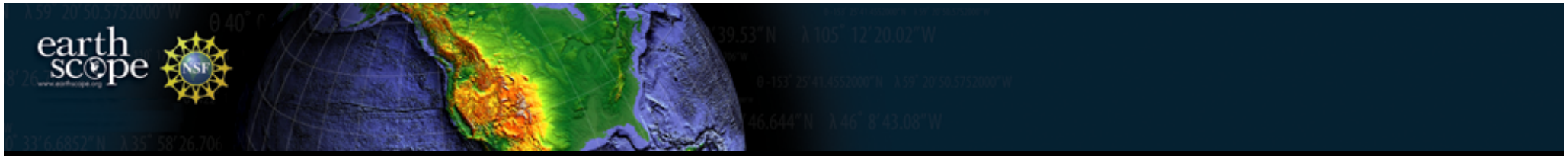
Receiver Functions



Kim et al. (2014)

Many Seismic Sources

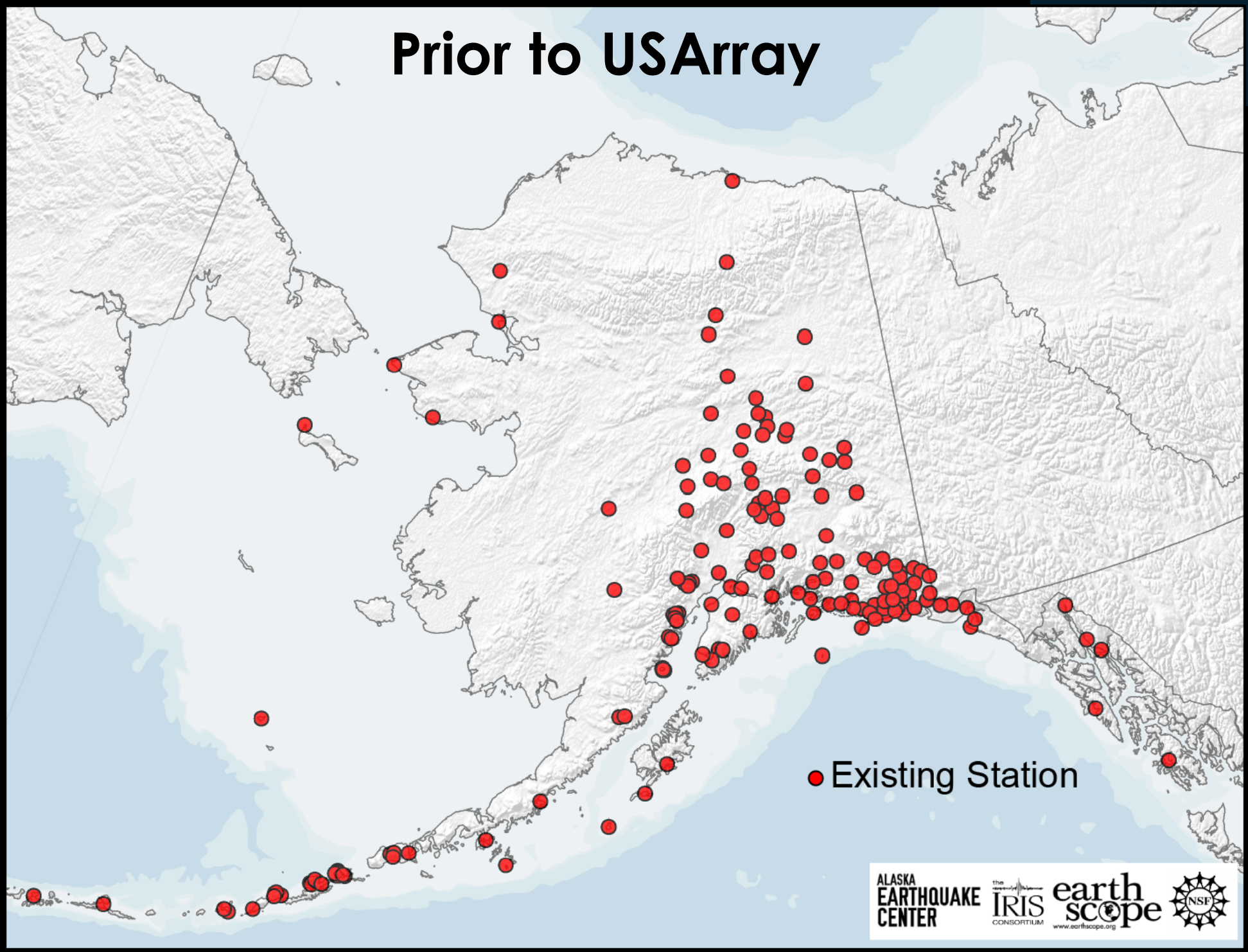
- The primary seismic imaging goals of USArray could be met by ~2 years of high quality data
  - Although more is better!
- Comprehensive coverage and greater spatial density were higher priorities than longer measurements at fewer sites
- But earthquake monitoring and hazard assessment have different requirements than imaging (***long term observations***)



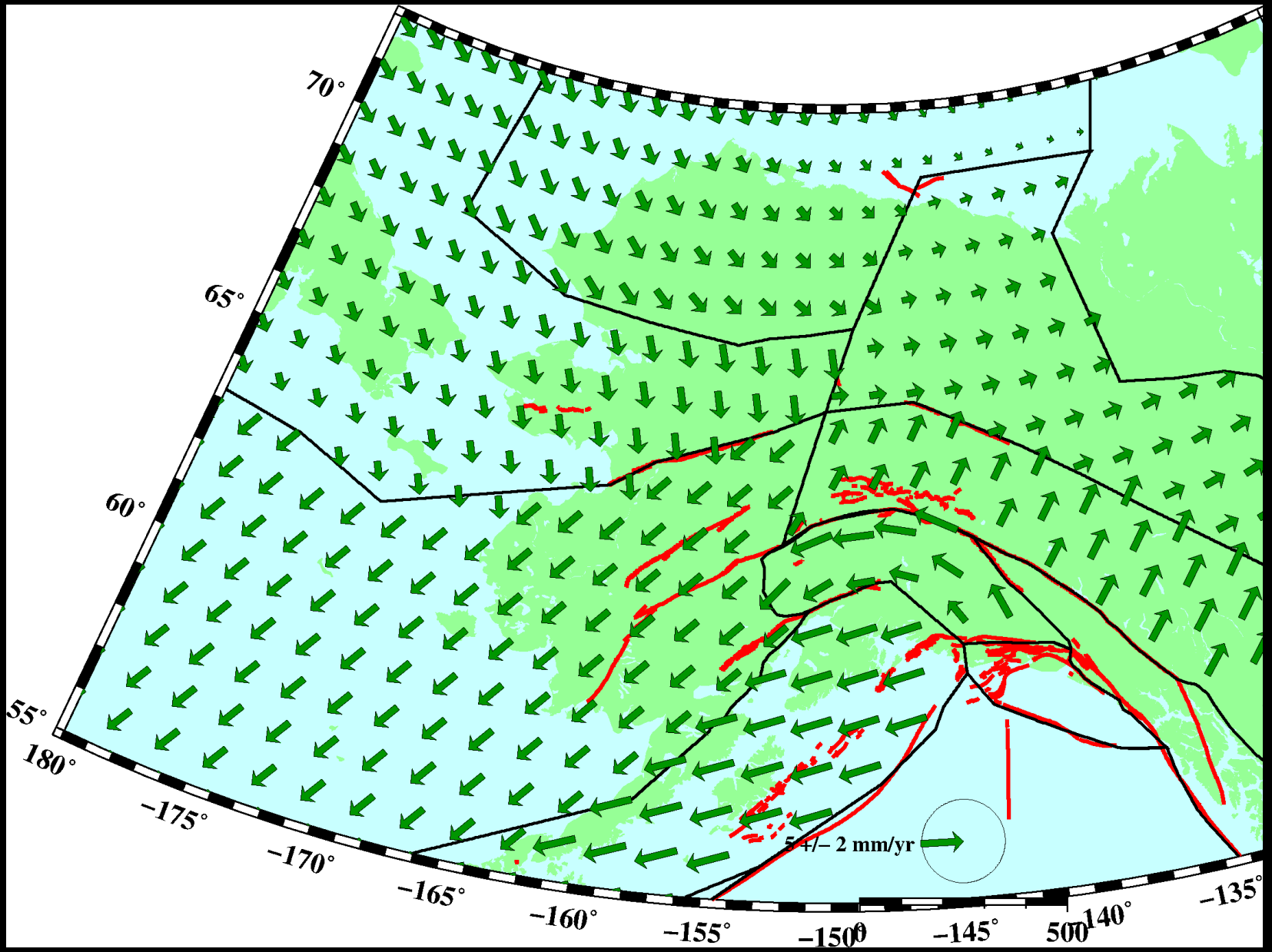
Earthquake Characterization

- Earthquake detection and location
- Delineation of active structure (microseismicity)
- Source Characterization
  - What fault was this on?
  - Rupture extent
  - ***Requires accurate locations/depths and focal mechanism/moment tensor***
  - ***Should integrate information from GPS***

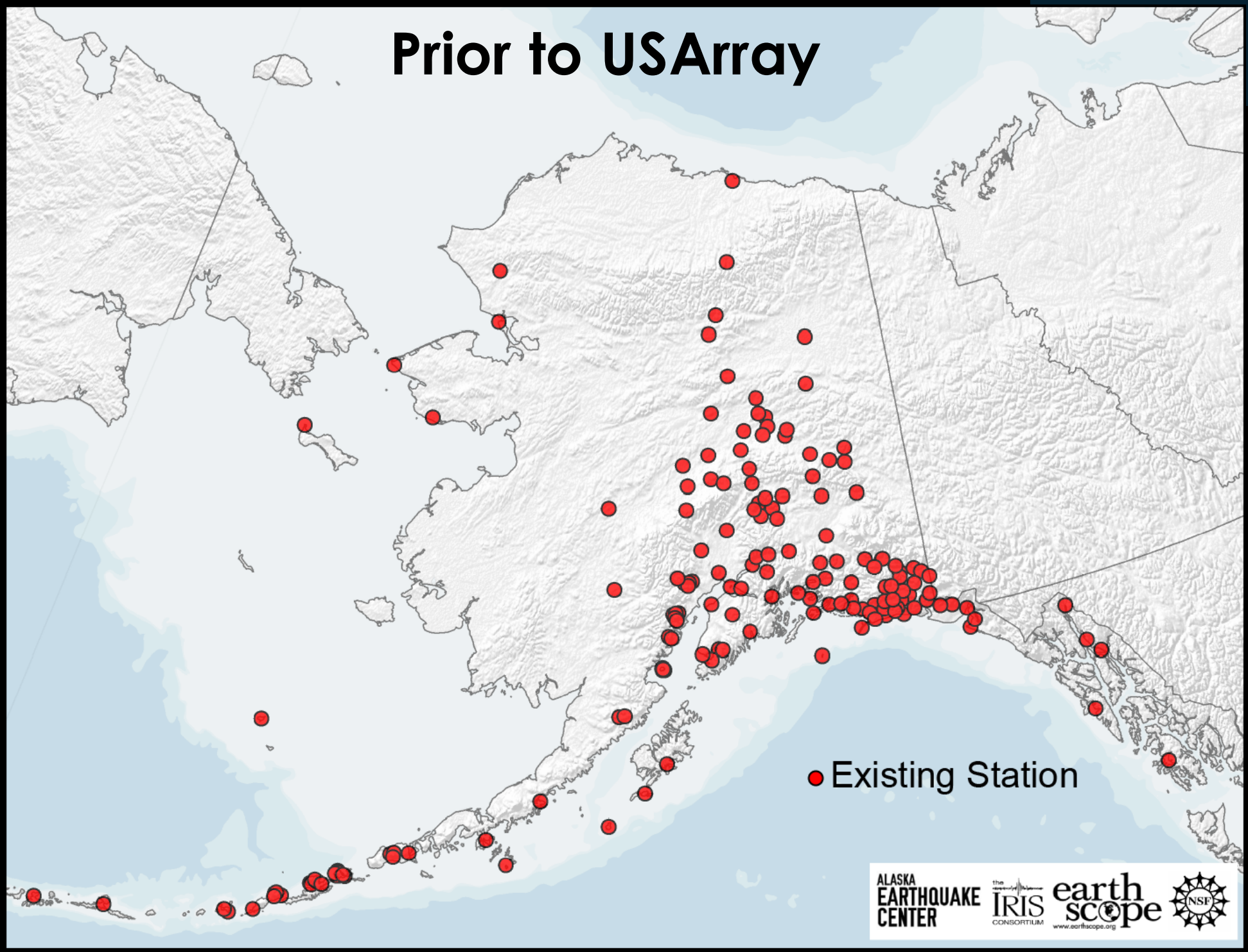
Prior to USArray



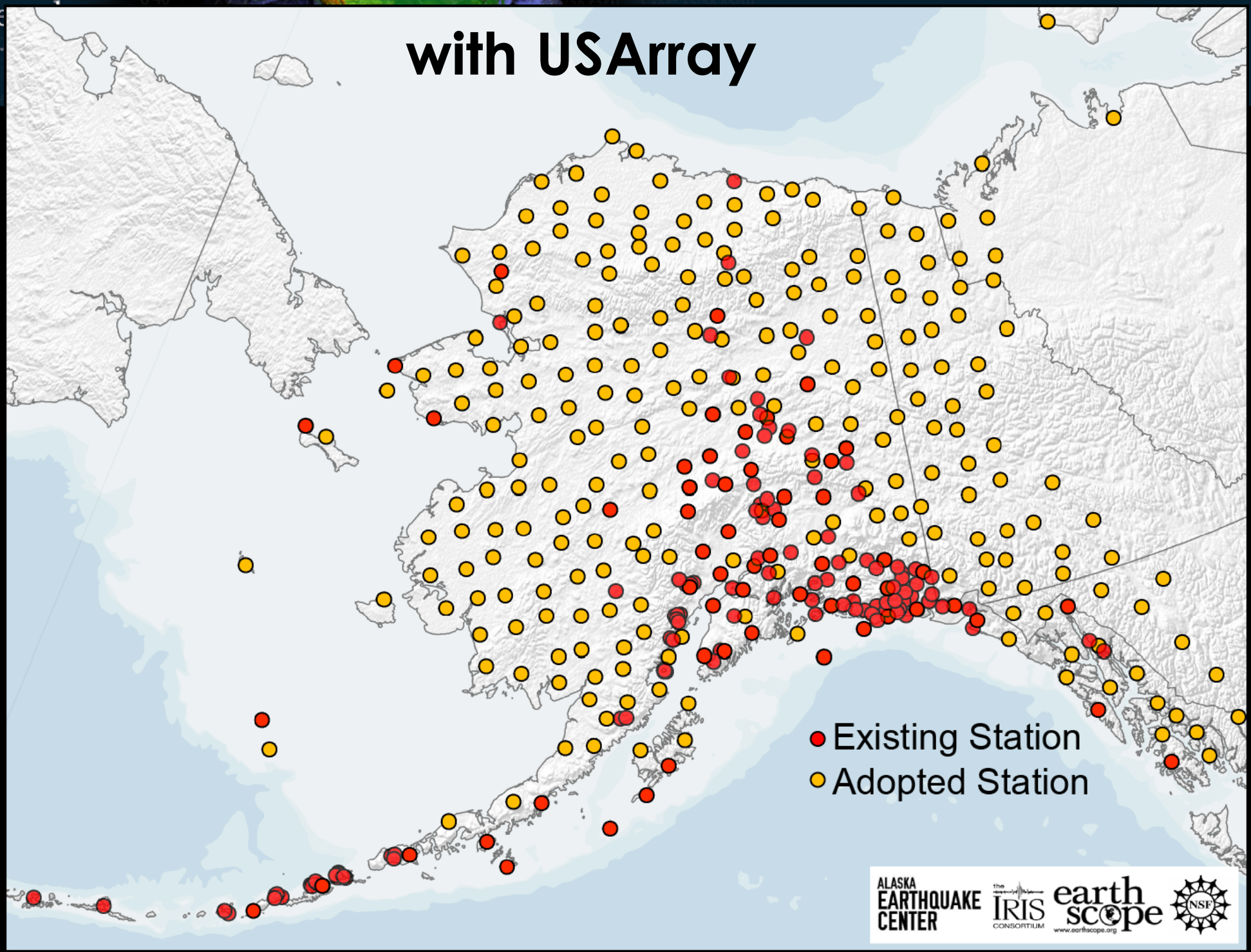
Block Motions



Prior to USArray



with USArray

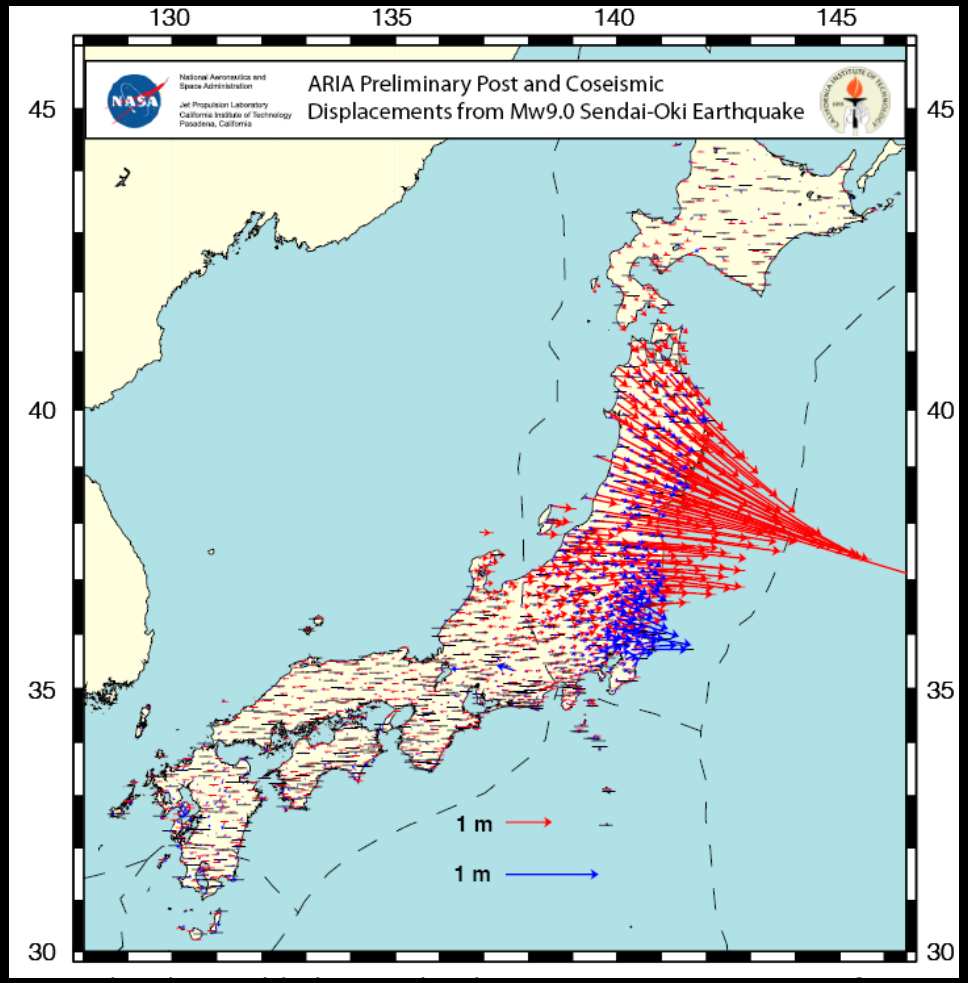


EarthScope data for the public interest

- USArray: Seismometers
  - Enhanced earthquake and volcano monitoring
  - Needed as part of earthquake early warning
- Plate Boundary Observatory: GPS
  - Earthquake and volcano hazards
  - Real-time for earthquake early warning and tsunami warning
  - Atmospheric water vapor, snow depth, space weather, use by land surveyors, …
- Both: Platform for multidisciplinary observations

Rapid Assessment of Earthquakes

- GPS complements seismology for rapid magnitude estimates for the biggest earthquakes.
  - Both should be part of rapid warning systems.
- GPS constrains rupture length, source model.
- No breakthroughs are required, only a commitment to do the job.

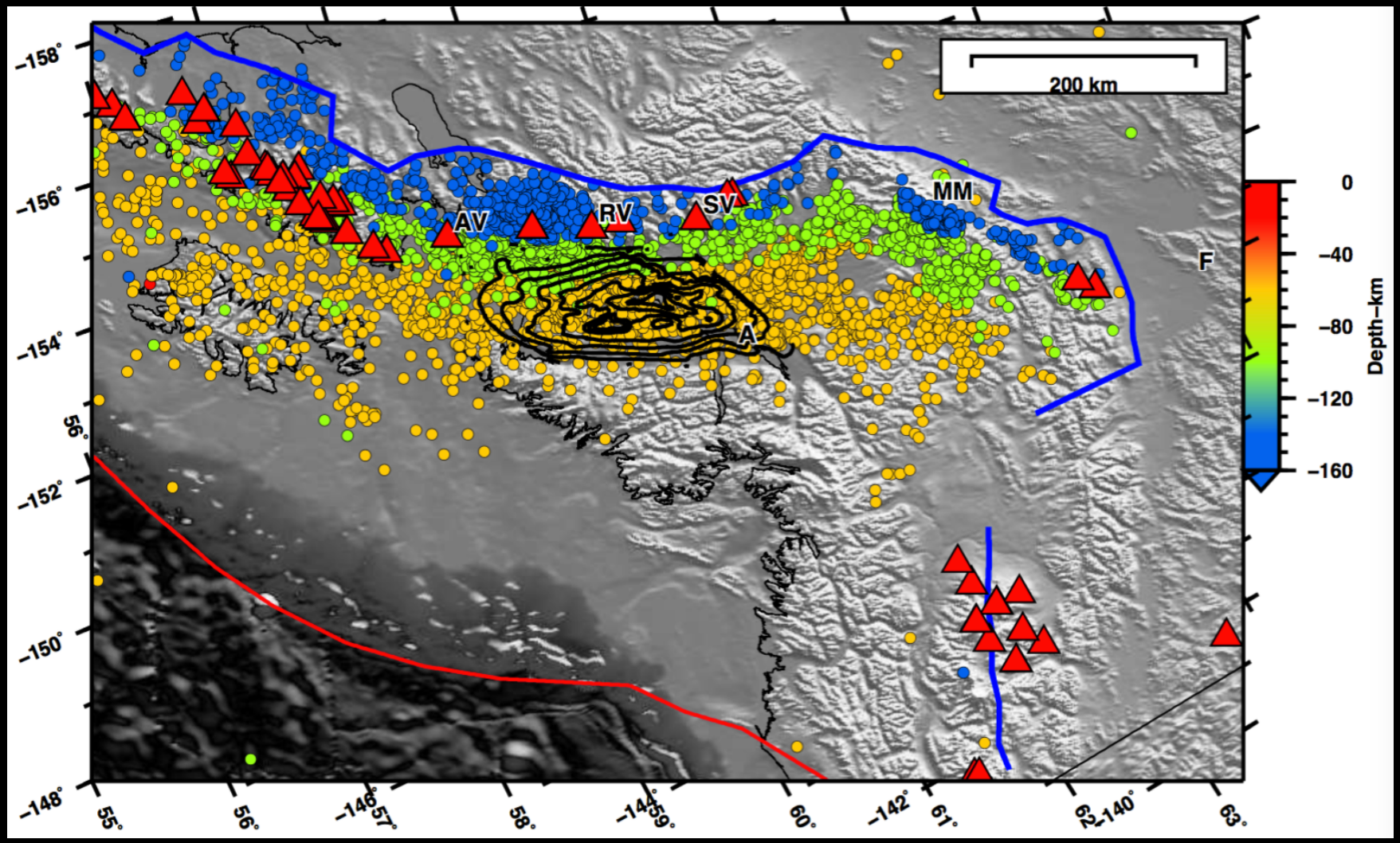


Opportunities for Enhanced Earthquake Hazard Mitigation

- Improved seismic monitoring
  - Already realized for central and eastern US
- Implement Earthquake Early Warning
  - West Coast EEW plan builds on all current instrumentation and activities
- Alaska?
- Integrate real-time GPS to EEW and tsunami warning

Seismic Imaging

Many Seismic Sources



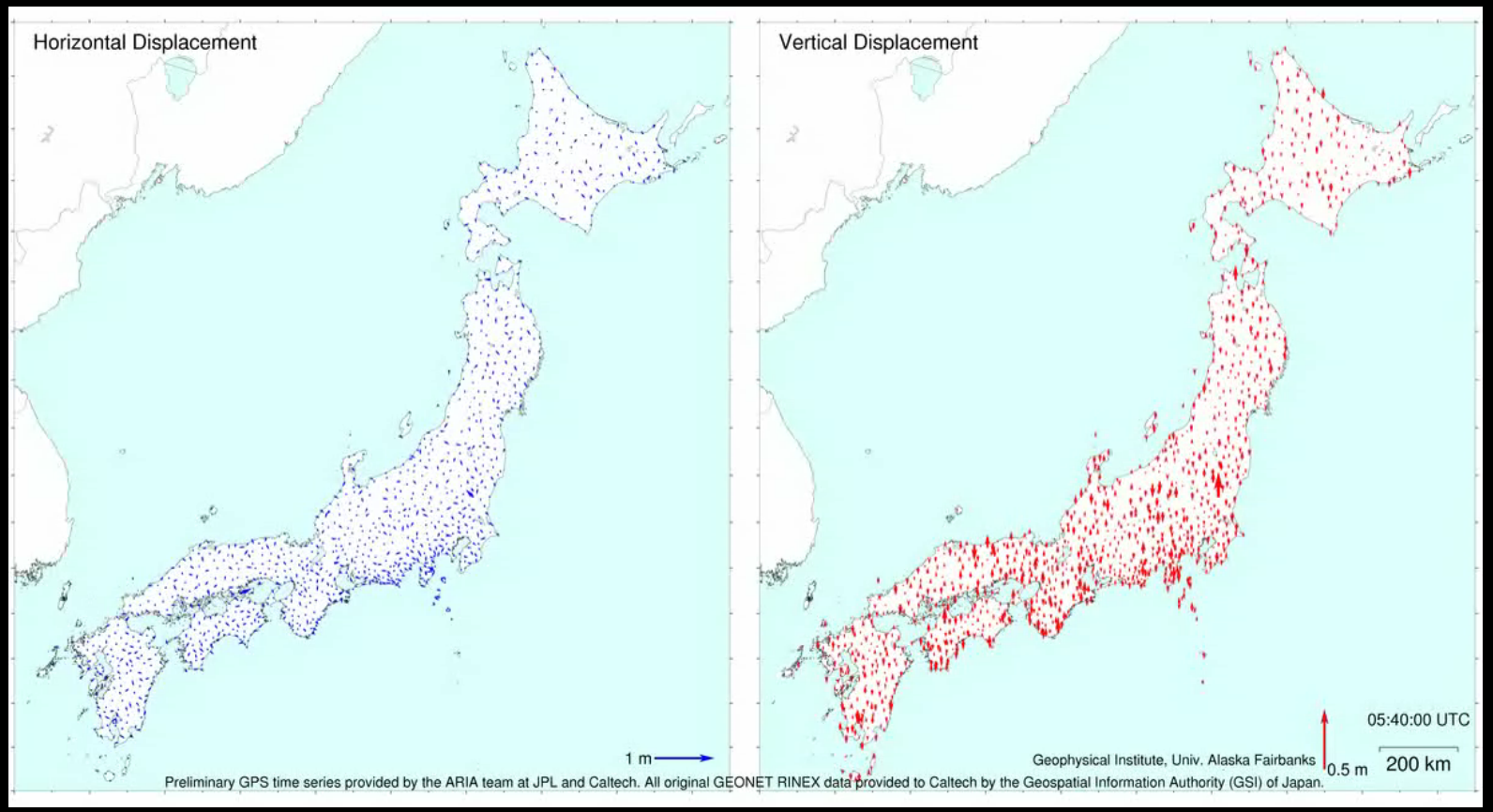
What is Earthquake Early Warning?

KTLA St Patricks Day Earthquake 3/17/2014

https://www.youtube.com/watch?v=KiB7ny52-xw

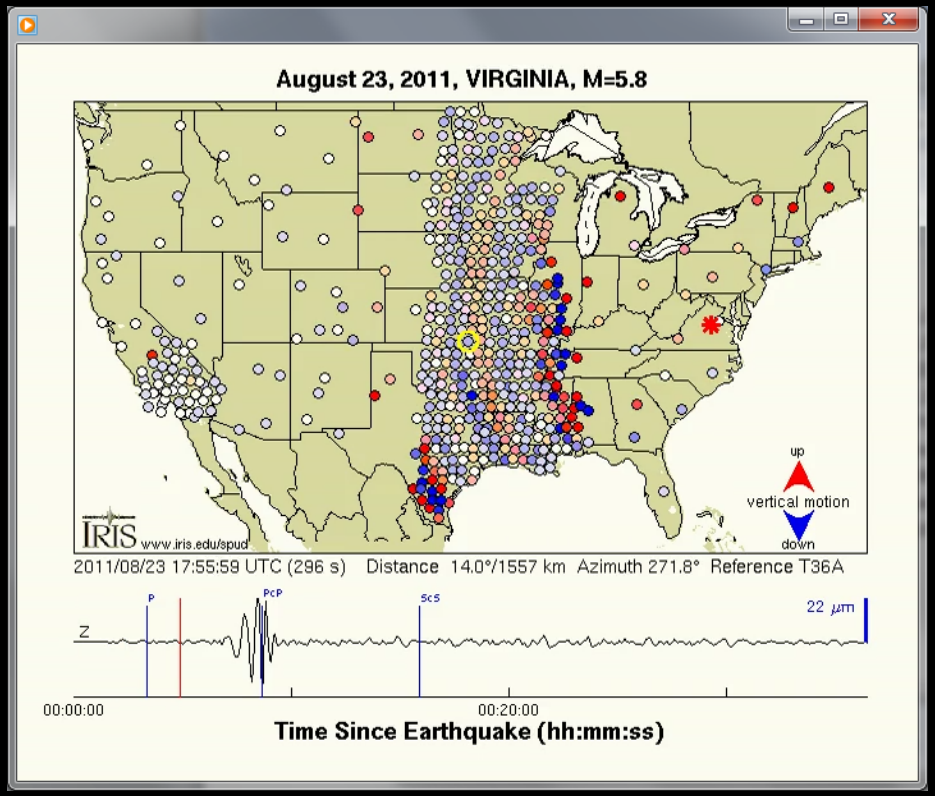
Ronni Grapenthin
University of Alaska Fairbanks

Movie of an Earthquake



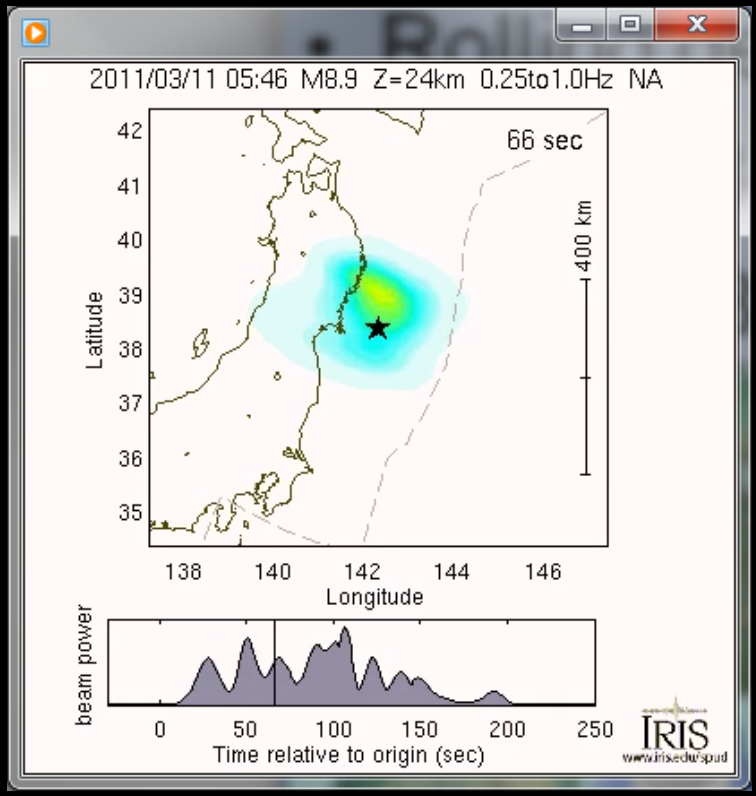
Seismic Imaging

Structure



Dots show the up/down motion of the ground surface from distant earthquakes. The distortion of the wave front, gives a measure of structure beneath. The typical seismogram is displayed along bottom from one station-circled in yellow.

Source



These Back Projection movies show a view of the earthquake source-mapping where the rupture is occurring over a period of time.

Typical Earthquake

Seismic Body Waves for making a "CAT scan"