



Getting to know EarthScope Plate Boundary Observatory & UNAVCO

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UNAVCO



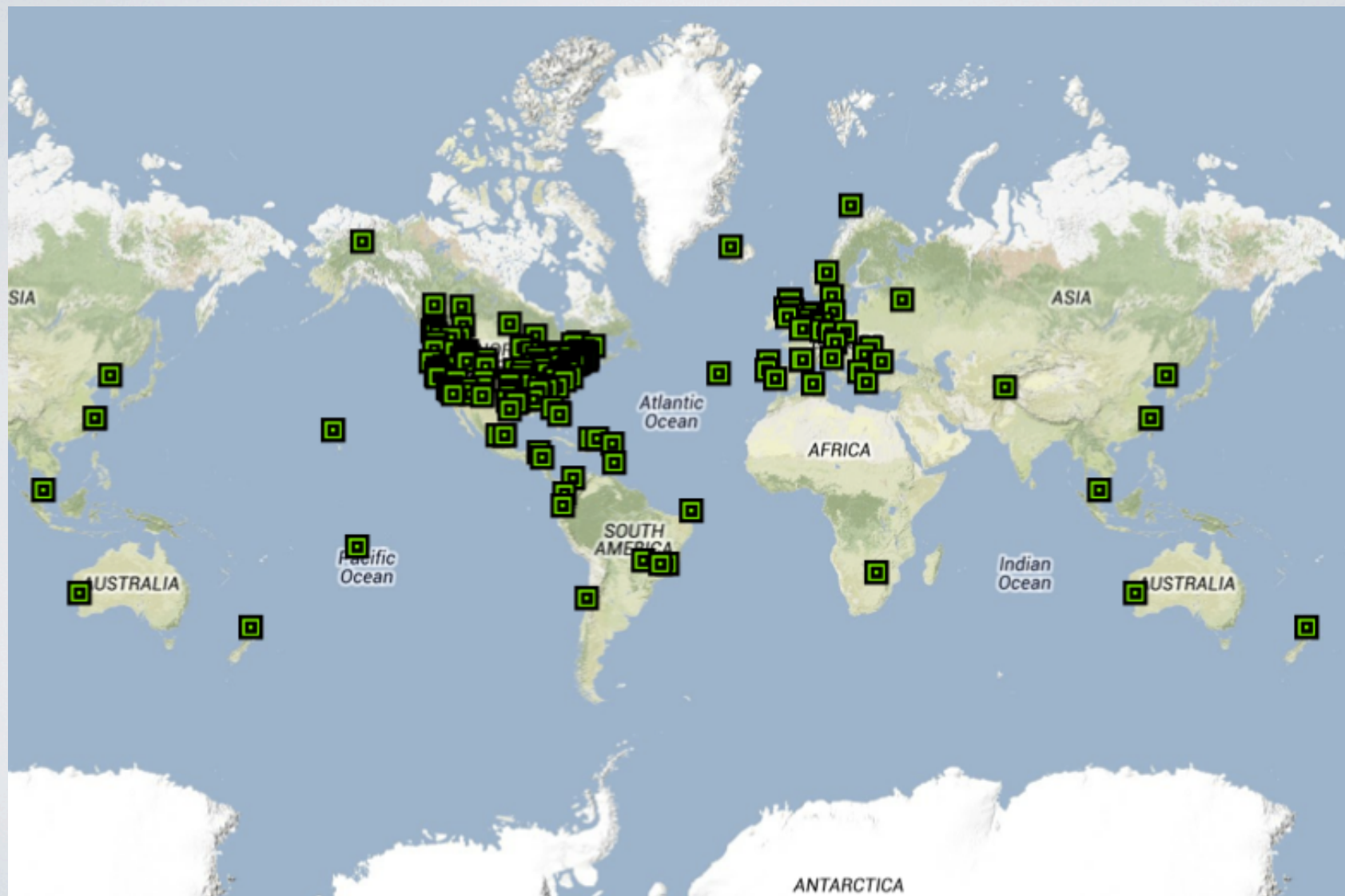
About UNAVCO

- NSF and NASA funded
- Non-profit
- Consortium
- Membership-governed
- **Facilitates geoscience research and education using geodesy**
- Operates the Nation's geodesy facility, including the Plate boundary Observatory on behalf of NSF



Broaden the use of UNAVCO data and products by a wide audience of educational and research users

UNAVCO Consortium Members



Meet the Plate Boundary Observatory

Geodesy Advancing
Geosciences &
EarthScope (GAGE)

Continent-scale
network

- GPS
- Borehole strainmeters
- Laser strainmeters
- LiDAR

Focus:

- Extended plate boundary

Operated by UNAVCO

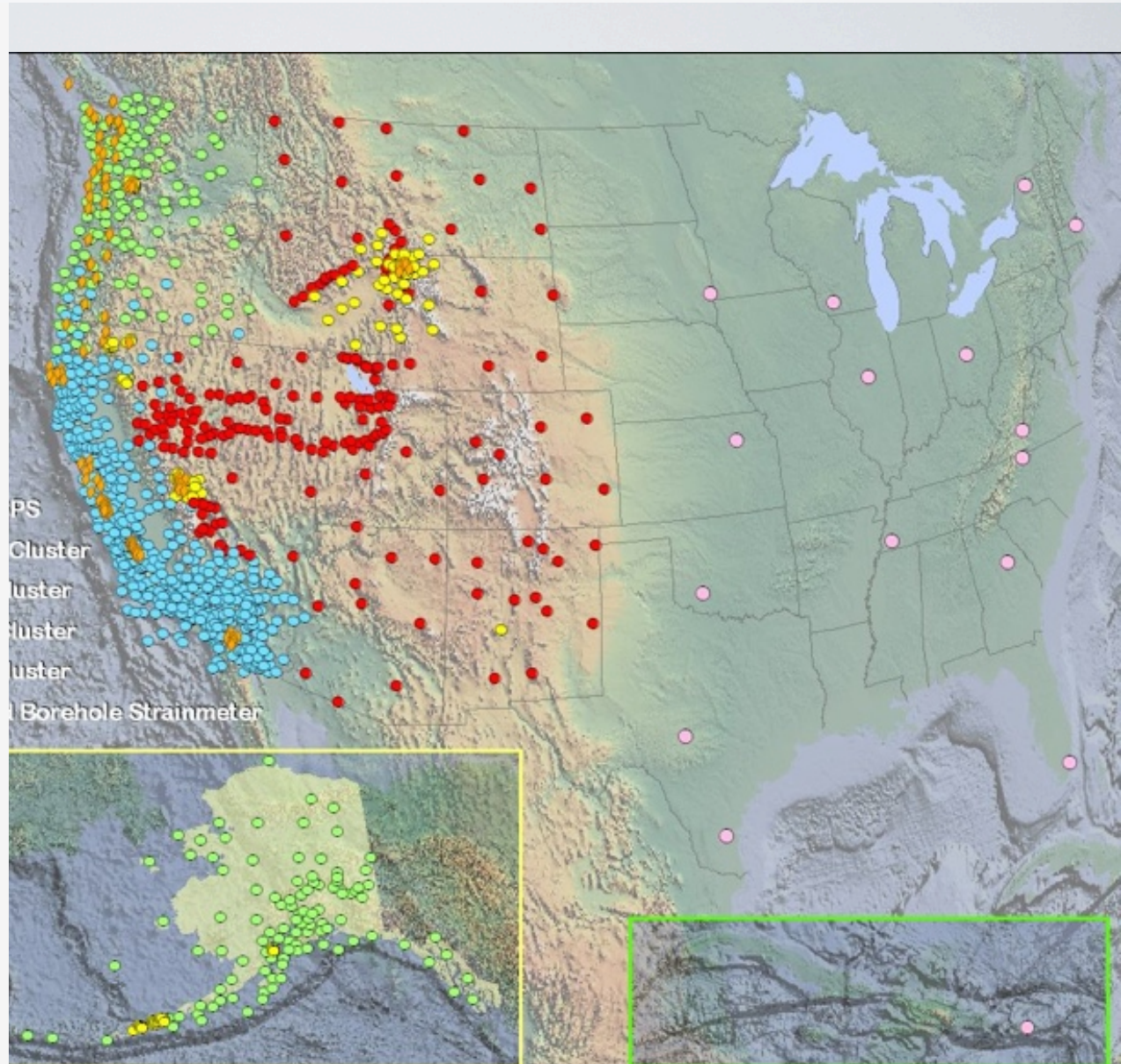




Plate Boundary Observatory Instruments

GPS: 1100 Continuous



5 Laser Strainmeters



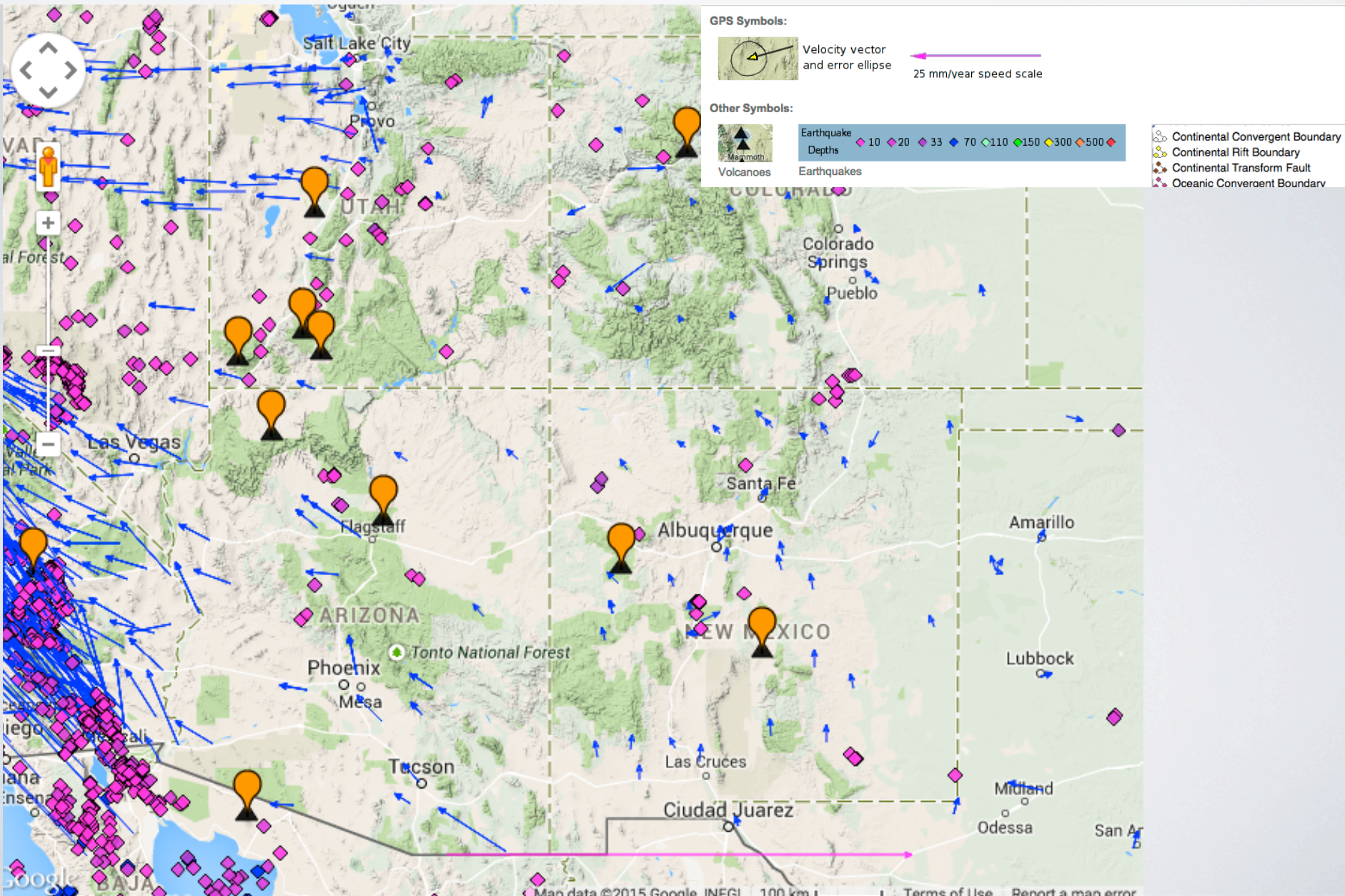
74 Borehole Strainmeters
and 78 Borehole Seismometers



26 Shallow Borehole
Tiltmeters



EarthScope in Arizona and New Mexico



LiDAR – looking below the trees

Open Topography: <http://www.opentopography.org/>

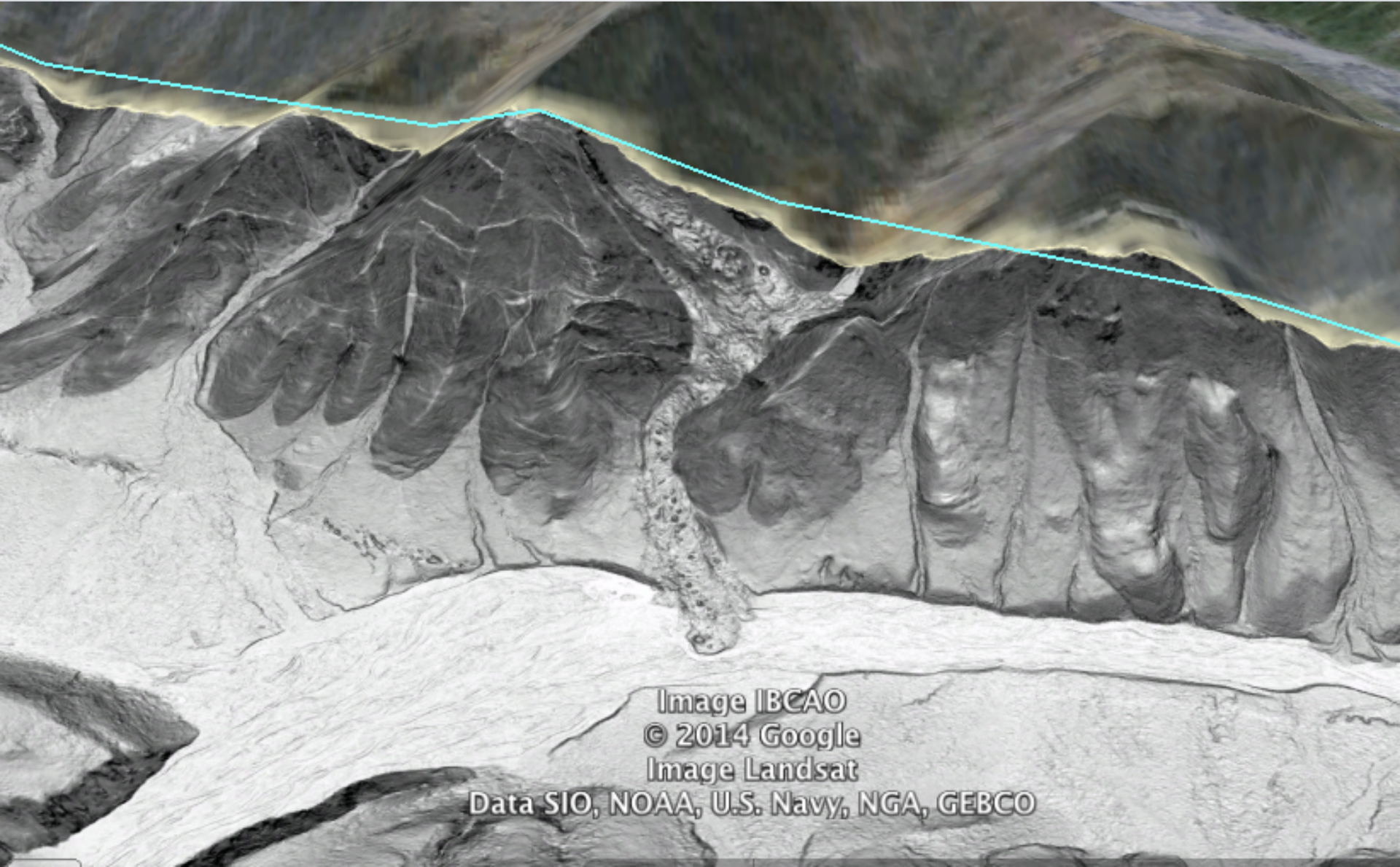
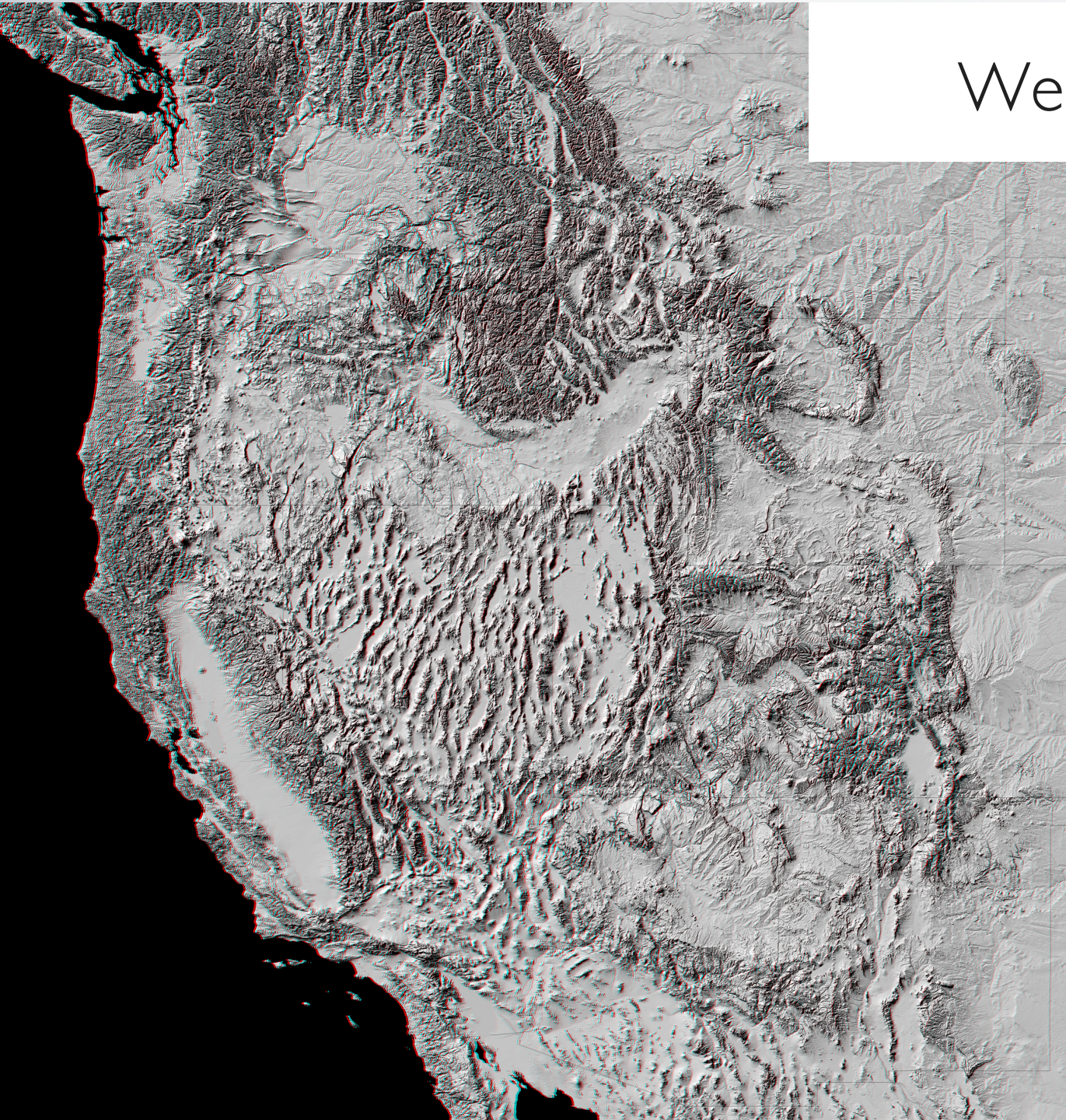


Image IBCAO
© 2014 Google
Image Landsat
Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Western US in 3D



WESTERN UNITED STATES



Courtesy: Parul Morin, National Center for Earth-surface Dynamics
Data Repository
http://www.nced.umn.edu/Data_Repository.html
[retrieved on 08 March 2015]



Education & Community Engagement

Training

Education Materials

Communications

Workforce Development

• Training

Technical short courses, educational workshops, evaluation, new delivery methods

• Education Materials

Curriculum development (Strain module, GETSI project [NSF-TUES], existing learning materials

• Communications

Website, outreach materials, social media, conferences

• Workforce Development

RESESS, RESESS Alumni network, Science Workshop mentoring

- Tutorials & How to's
- Lessons
- Student worksheets
- Animations
- How to download data

Based on time series inversion algorithm (2001) and Berardinelli

Computer Instructions

Visualizing Relationships between Earthquakes, Volcanoes, and Plate Boundaries in the Western U.S. Using the EarthScope Jr. Data Tool

Part I
Starting at www.unavco.org
➤ Click on maptools under the Education and Outreach section

➤ Click on **EarthScope Voyager Jr.** -The direct link is: <http://jules.unavco.org/VoyagerJr/EarthScope> A map of North America will load in several seconds.

➤ Next, click on the map two times to obtain a zoom view of the western United States.

Click on map to zoom in

Worksheet

Visualizing Relationships between Earthquakes, Volcanoes, and Plate Boundaries

Part I: Comparing earthquake and volcano locations

What you will need:

- Internet access (Mac and PC-compatible) or the map packet
- Dry erase pens and transparency paper with map of Western U.S. OR color pencils

Instructions

Work in teams of two. In your teams, designate one person to study the Earthquake map and one person to study the Volcano map. Separately study your designated map and answer the questions below.

Read the computer instructions on how to use EarthScope Voyager Jr. or study the map showing Earthquakes and Volcanoes of the Western United States provided from the map packet.

Earthquake Map Questions: Study where earthquakes are and are not located. Mark the approximate locations of several earthquake "clusters" using a dry erase pen on the map of the western United States printed on a transparency or from the last page of the worksheet.

How are earthquakes distributed? If there is a pattern, how would you describe it? Are there any earthquakes? Are they located near the edges of the continents, mid-continent, in the ocean?

At what depth do the earthquakes occur?

Volcano Map Questions Study where volcanoes are and are not located. Mark the approximate locations of several volcanoes using a dry erase pen on the map of the western United States printed on a transparency or from the last page of the worksheet.

How are volcanoes distributed? Where are there no volcanoes? Are they located near the edges of the continents, mid-continent, in the ocean?

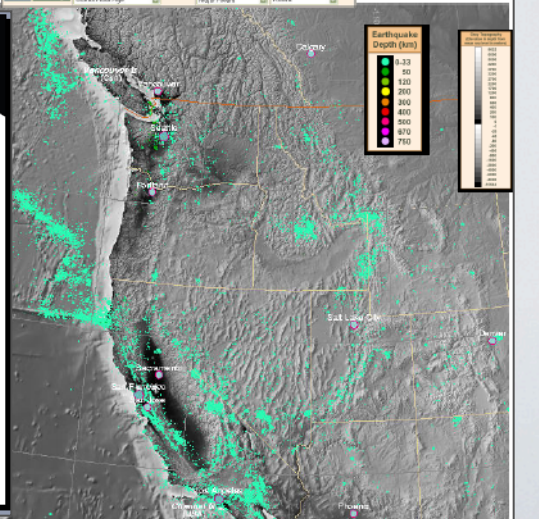
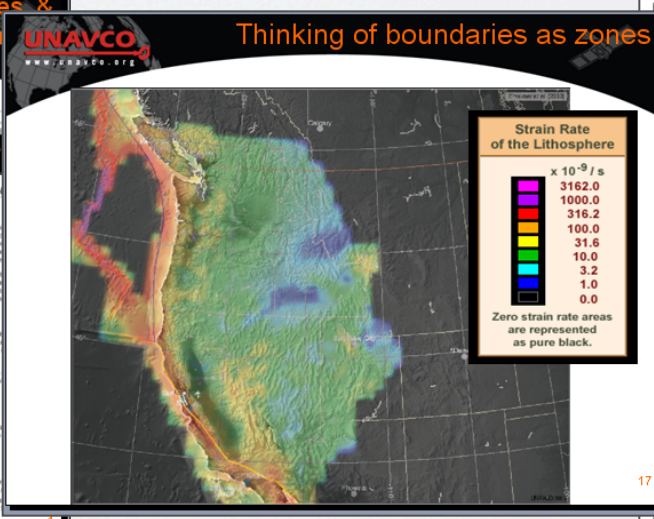
If there is a pattern, how would you describe it?

Part I: Comparing Locations of Earthquakes & Volcanoes

Go to: <http://www.unavco.org/>

Map Tools

- EarthScope Voyager Jr.
- EarthScope Voyager Jr. Data Tool
- EarthScope Voyager Jr. Data Tool
- EarthScope Voyager Jr. Data Tool



UNAVCO Highlights, and Snapshots reading literacy with science

unavco.org

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Community Services Data Instrumentation Software Science Learning

2014 SCIENCE WORKSHOP

celebrating 30 YEARS of INNOVATION for SCIENCE

UNAVCO, A NON-PROFIT UNIVERSITY-GOVERNED CONSORTIUM, FACILITATES GEOSCIENCE RESEARCH AND EDUCATION USING GEODESY.

We challenge ourselves to transform human understanding of the changing Earth by enabling the integration of innovative technologies, open geodetic observations, and research, from pole to pole.

WHAT'S HOT

[view all »](#)

New Video: UNAVCO (Explained in 3 Minutes).

Notice to UNAVCO GPS Data Product Users: File Format Update on March 25th 2013.

HIGHLIGHTS

[view all »](#)





Event Response:
Mw 8.2 Earthquake 95km NW of Iquique, Chile
April 3, 2014

A magnitude Mw 8.2 earthquake ruptured the subduction zone off the coast of northern Chile at 11:46:46 p.m. GMT on April 1, 2014. The event occurred in the "Iquique seismic gap", a...

SCIENCE SNAPSHOTS

[view all »](#)

M9 Tohoku Earthquake, March 11 2011



UNAVCO's Strainmeters Record the Arrival of Tsunamis on the west coast of North America
August 15, 2012

UNAVCO's Plate Boundary Observatory includes 75 borehole strainmeters installed predominantly throughout the west coast of North America. Strainmeters work by detecting changes in the size of the borehole, and are...

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Solid Earth

Cryosphere

Environmental & Hydrogeodesy

Ocean

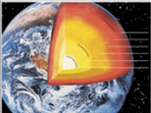
Atmosphere

Human Dimensions

Technology


Science

UNAVCO is a university-governed consortium uniquely positioned to advance and support the geodesy community's science goals. Over the last decade, UNAVCO's scope has expanded significantly with many **Collaborations** to serve new science communities and including those who focus on the deformation of ice, the Earth's response to ground water, sea level, and other aspects of the hydrosphere, and renewed interest in imaging the structure of the atmosphere. **Community Science** showcases the UNAVCO community's applications of space geodesy and science products, and highlights their science.




Solid Earth

Earth and the tools we use to study it are constantly changing. The tectonic plates are continuously in motion, though so slowly that even with our highest precision instruments we need months or years of observations to measure it. Over the last several decades, the advent of space-based geodetic techniques have improved our ability to measure tectonic plate motion by several orders of magnitude in spatial and temporal resolution



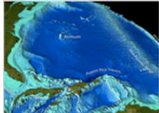
Cryosphere

Ice covers approximately 10% of Earth's land surface at the present, with most of the ice mass being contained in the Greenland and Antarctica continental ice sheets. Designing and undertaking geodetic experiments that enable researchers to improve our understanding of ice



Environmental & Hydrogeodesy

Through its sensitivity to mass redistribution and accurate distance measurements, geodesy is uniquely posed to answer fundamental questions about issues relating to water and the environment. Geodetic observations are enabling us, for the first time, to follow the motion of water within Earth's system at global




Ocean

Seventy five percent of Earth's crust is unobservable using solely electromagnetic energy-based geodetic techniques. Seafloor geodesy can now expand geodetic positioning to off-shore

environments. Researchers can see the effects of changes in Earth's crust far beyond what we can measure with instruments placed solely on dry land.

[Ocean Science Snapshots »](#)




Atmosphere

Space geodesy utilizes electromagnetic signals propagating through the atmosphere of Earth, providing information on tropospheric temperature and water vapor and on ionospheric

electron density. Thus, in the early twenty-first century, the goal of geodesy has evolved to include study of the kinematics and dynamics of both Earth's atmosphere and the solid Earth.

[Atmosphere Science Snapshots »](#)

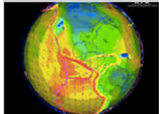


Human Dimensions

Natural hazard mitigation, the effects of climate change, and optimum use of water resources are major areas of concern for humankind today. Geodetic research associated with earthquakes and volcanoes have far-reaching goals of providing early warnings and mitigating future

hazard events on a global scale. As the population density increases and more people live in proximity to seismically active faults, understanding the nature of earthquakes remains a vital goal of the Earth sciences.

[Human Dimensions Science Snapshots »](#)



Technology

The incorporation and calibration of new technologies as an extension of geodetic research is a burgeoning opportunity that is being avidly embraced by the scientific community. High-resolution images and 3D/4D topography maps both inspire and facilitate field-based tests of a

new generation of quantitative models of mass transport mechanisms. Open access to data, tools and facilities for processing, analysis, and visualization, and new algorithms and workflows are transforming the landscape of geodetic scientific collaboration.

[Technology Science Snapshots »](#)



Social Media

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UNAVCO
5.0 ★★★★★


(5 ratings)

959 likes · 100 talking
about this · 52 were
here

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 Like

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 Save

Message



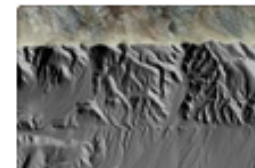
Non-Profit Organization

UNAVCO, a non-profit university-governed consortium, facilitates geoscience research and education using geodesy.

About



Photos



Events

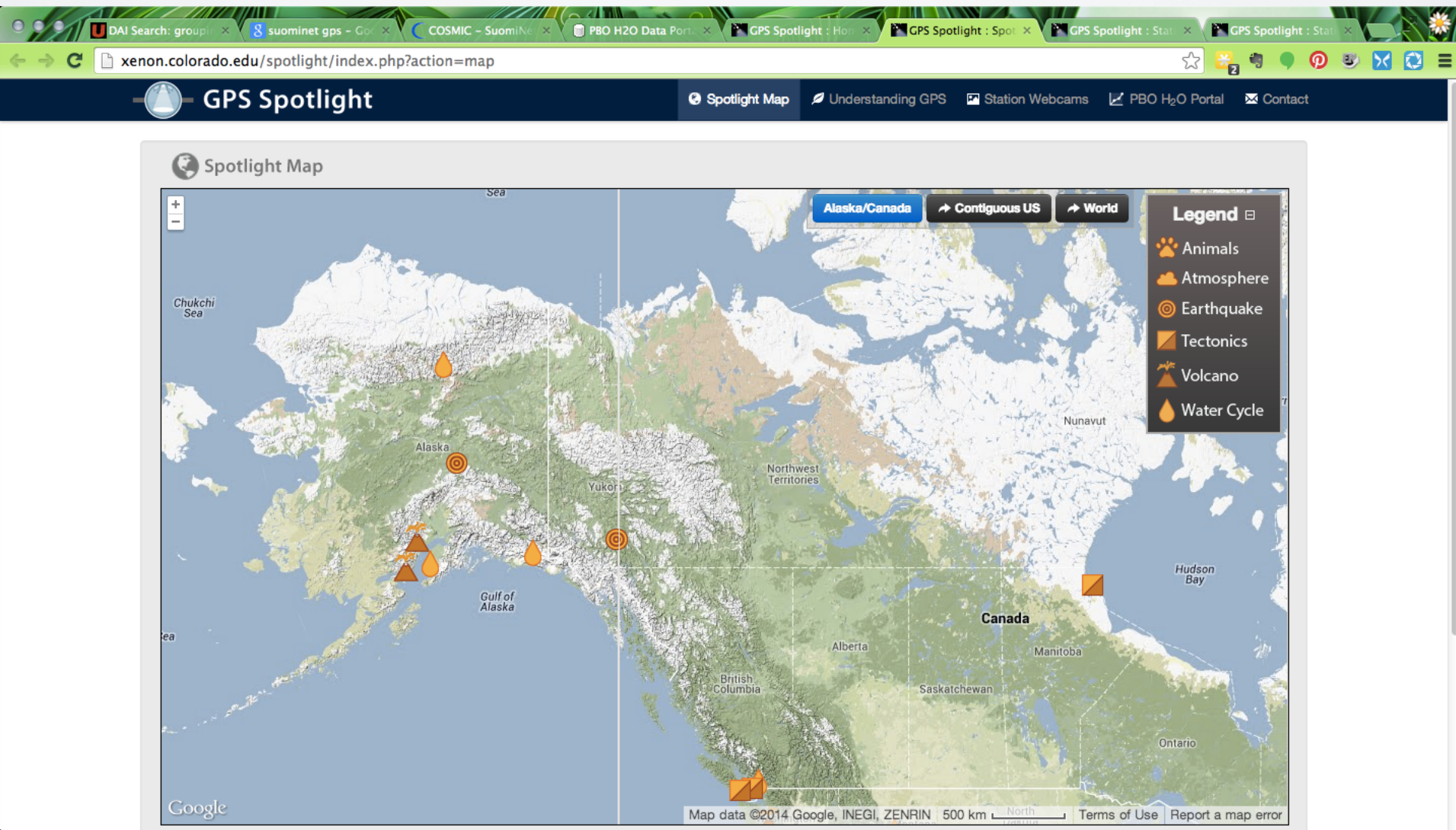
 959

Likes

Exhibits



GPS Spotlights



<http://xenon.colorado.edu/spotlight/index.php?action=map>

- Visual display of station locations

- Interesting data

- Full data plot

- Quick data preview

- Excel readable formats

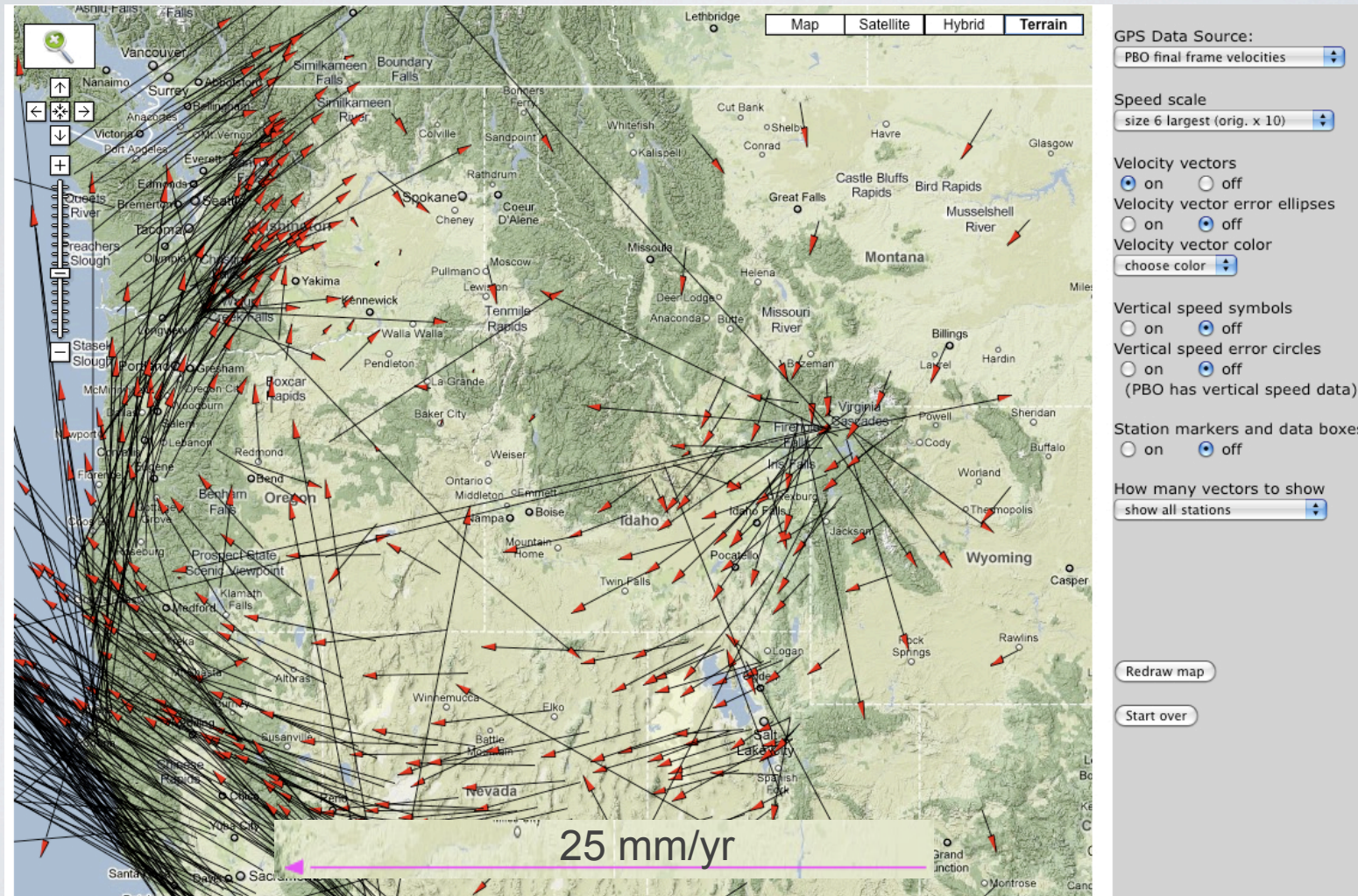
- Associated learning activities

[Download Time Series Data](#)
Excel-compatible format - [CSV]

- [Using GPS Data to Visualize the Influence of a Subducting Plate in the Pacific Northwest](#)
- [Visualizing Relationships between Earthquakes, Volcanoes, and Plate Boundaries in the Western United States](#)
- Episodic Tremor and Slip: The Case of the Mystery Earthquakes

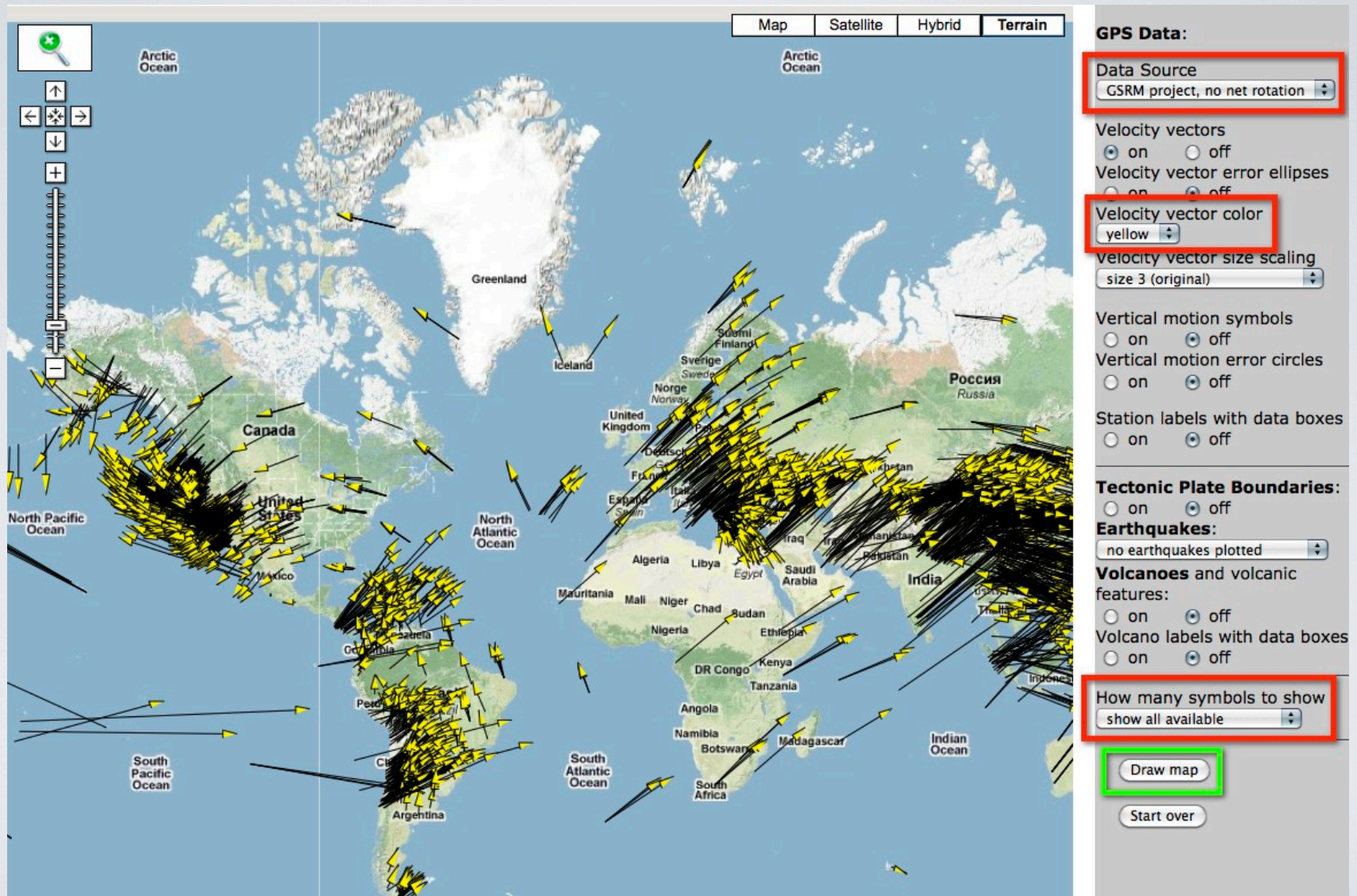
http://www.unavco.org/edu_outreach/data.html

Use Data Tools



Data Source: UNAVCO Plate Boundary Observatory: North American Reference Frame
UNAVCO GPS Velocity Viewer

GPS Velocity Viewer

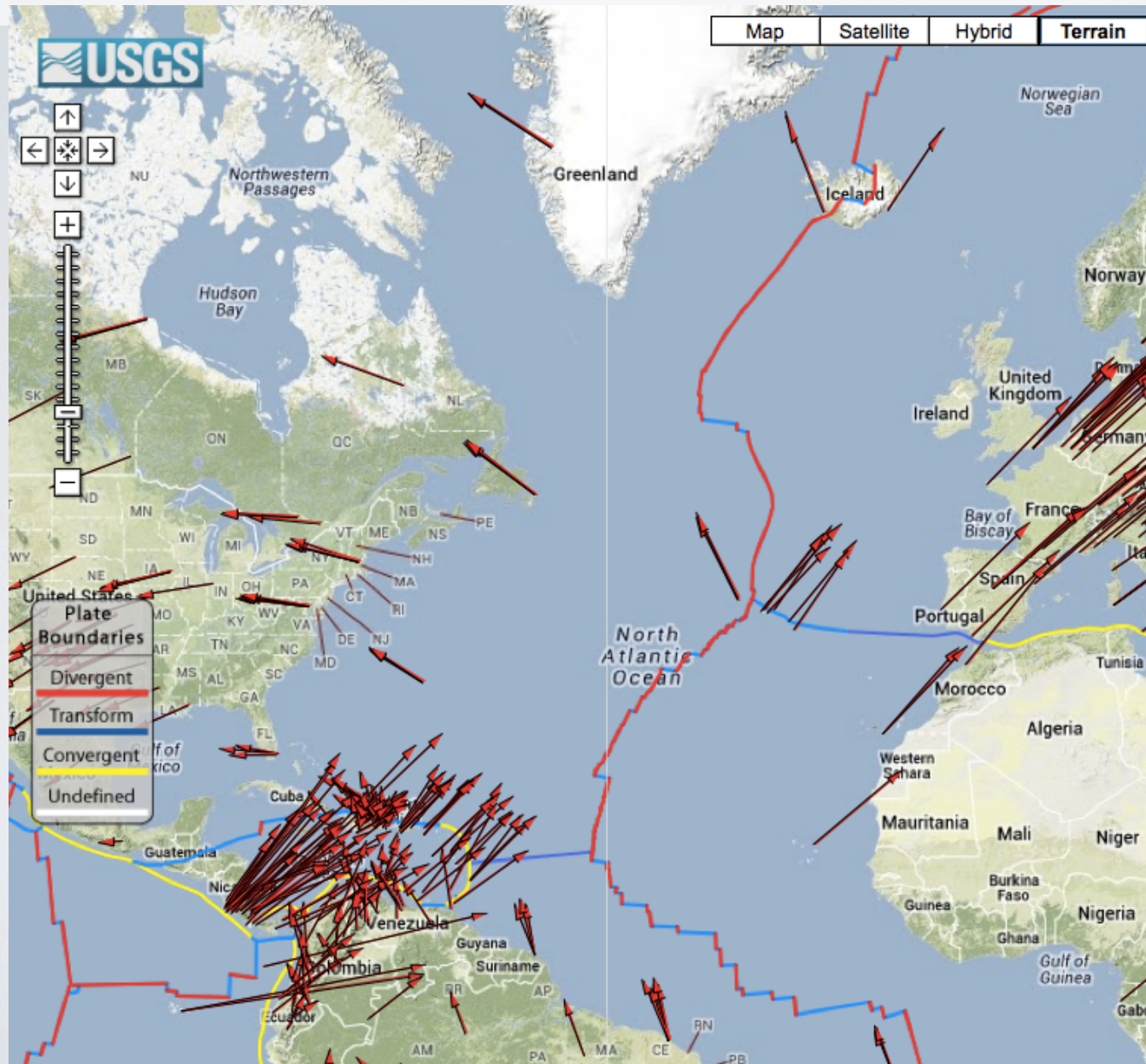


Data source: Global Strain Rate Map Project ; Reference Frame: No Net Rotation

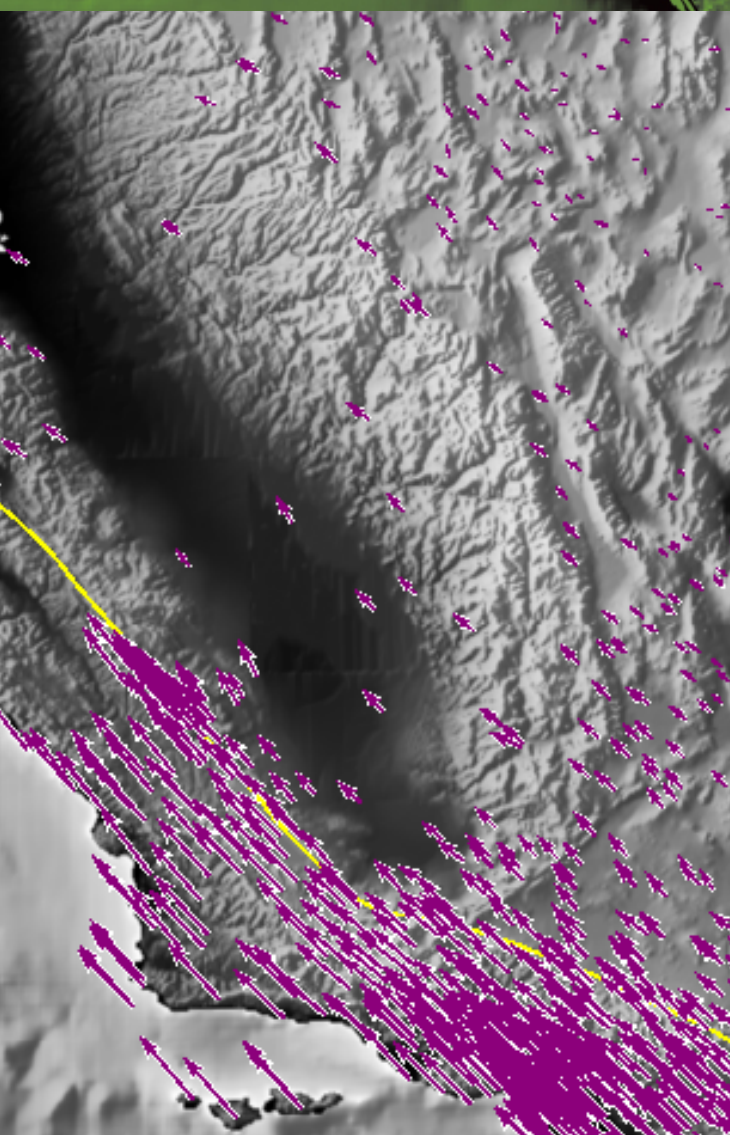
UNAVCO GPS Velocity Viewer:

<http://facility.unavco.org/data/maps/GPSVelocityViewer/GPSVelocityViewer.html>

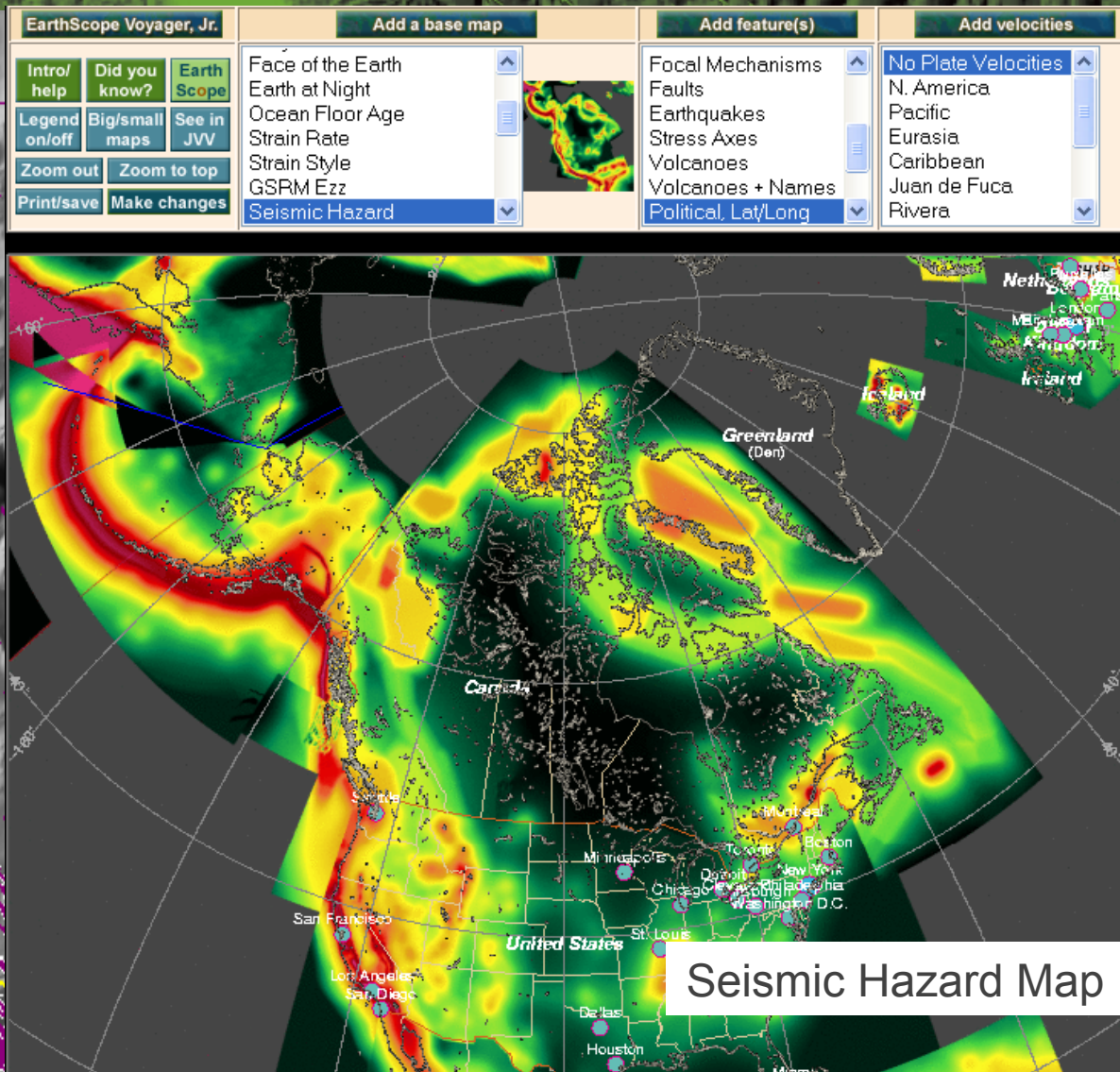
Comparing Plate Movement



Jules Verne & EarthScope Voyager Jr.



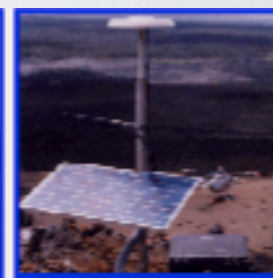
Velocity Vector





UNAVCO & PBO supported science

- Plate movement
- Earthquakes
- Volcanoes
- Glacial movements and isostatic adjustment
- Hydrologic changes
- Atmospheric – water vapor





Study & Apply Geodesy & Measuring Gravity

Geodesy is the science of ...
measuring Earth's

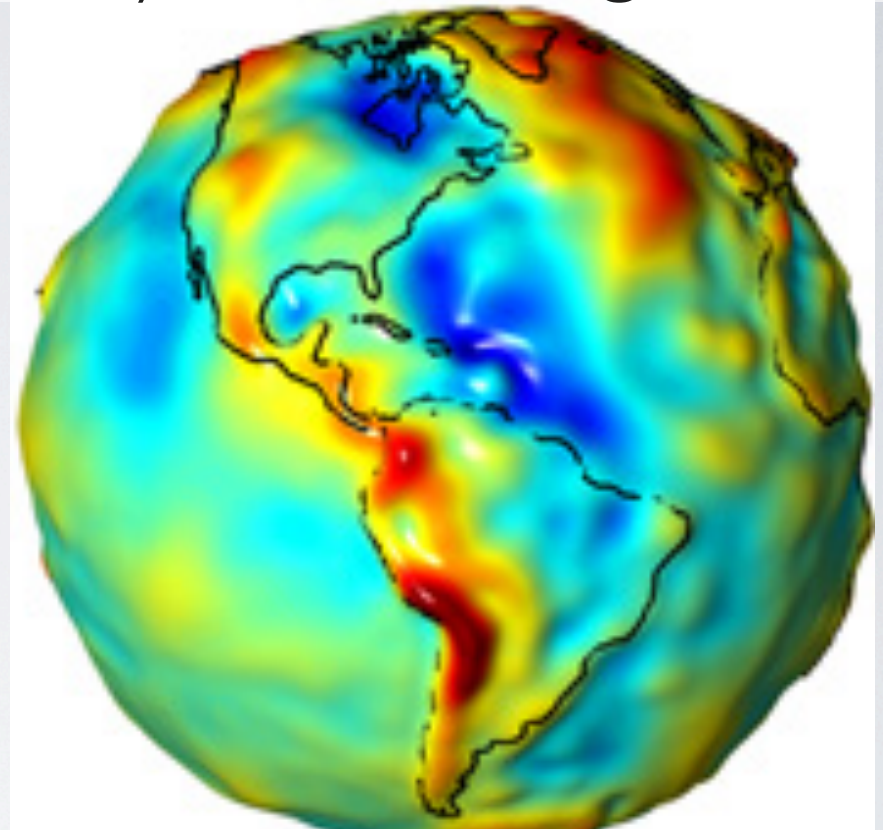
size, shape

orientation,

Gravitational *Field*

And

variations of these
with time



NASA GRACE

Map showing variations in the strength of
the gravitational force over the surface of
the Earth

Blue = less gravity
Red = more gravity

Anatomy of a High-precision Permanent GPS Station



GPS antenna inside of dome

Monument solidly attached into the ground with braces.

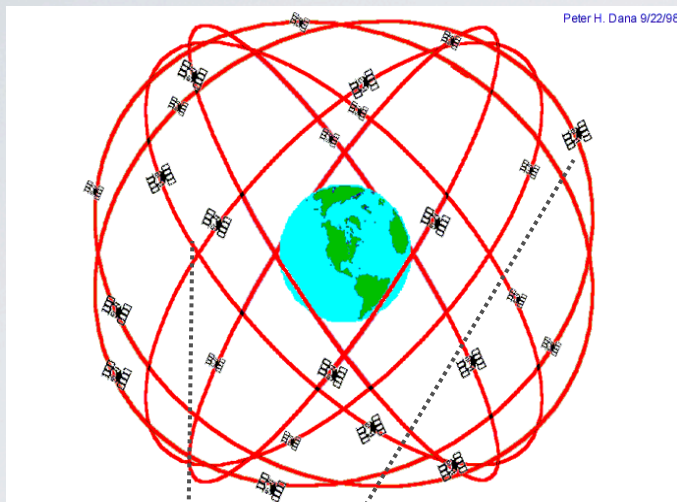
If the ground moves, the station moves.

Solar panel for power

Equipment enclosure

- GPS receiver
- Power/batteries
- Communications/ radio/ modem
- Data storage/ memory

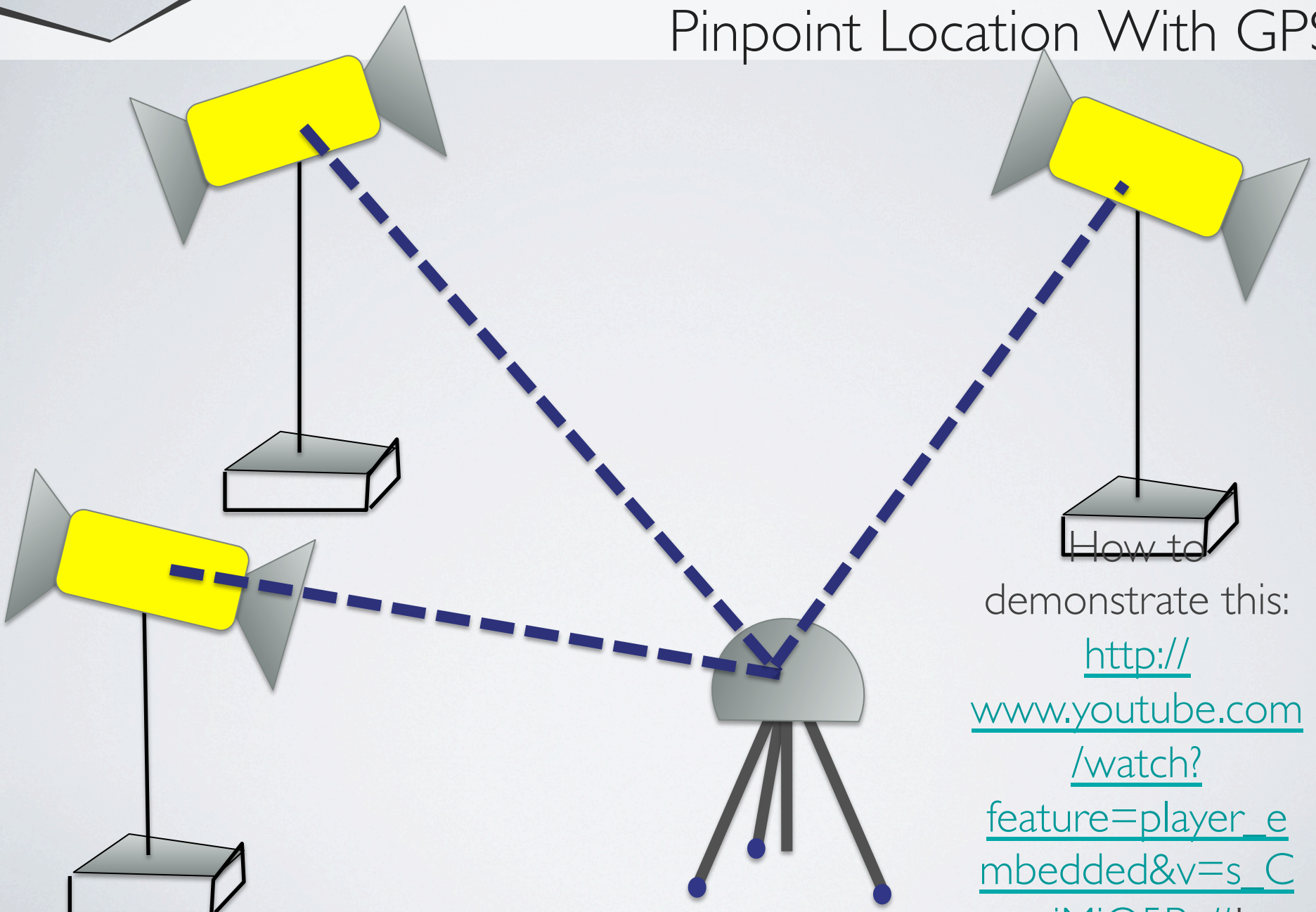
Introduction: GPS Basics



- Four satellite signals are needed to locate the receiver in 3D space.
- The fourth satellite is also used for time accuracy.
- Position can be calculated within to a millimeter.
- Needs ground control and time quality



Demonstration Pinpoint Location With GPS

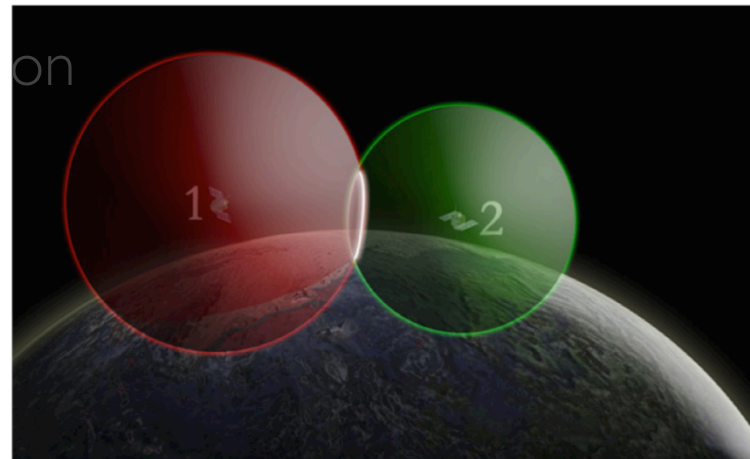
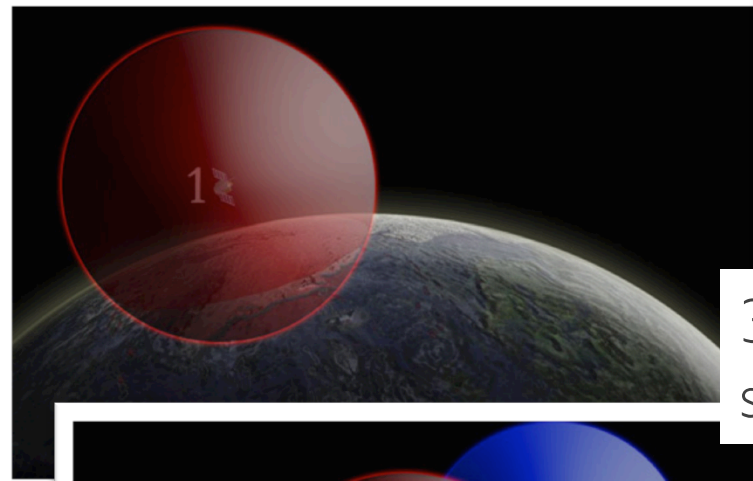


How to
demonstrate this:
[http://
www.youtube.com
/watch?
feature=player_e
mbedded&v=s_C
eiMiO5Pc#!](http://www.youtube.com/watch?feature=player_embedded&v=s_CeiMiO5Pc#!)



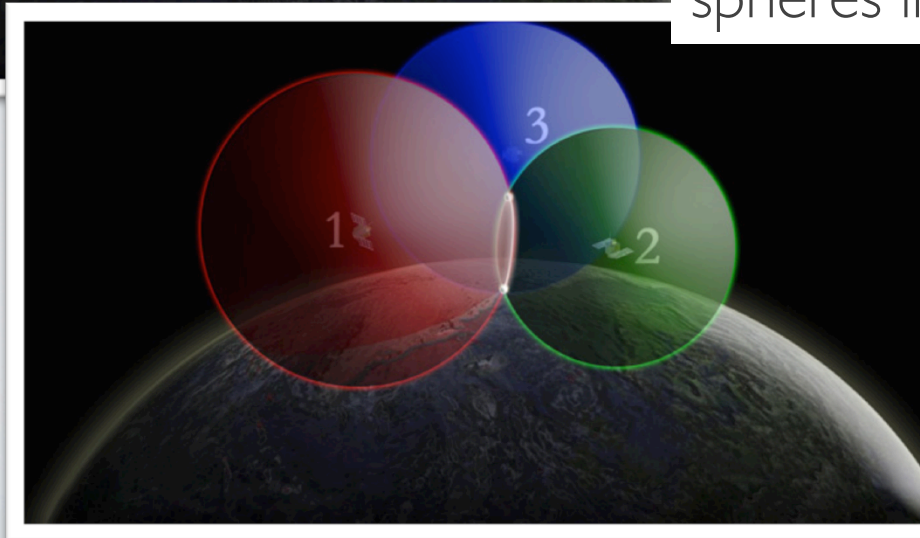
One way to find your location – 4 intersecting spheres

One satellite,
the GPS could be anywhere on
the edge of the sphere.



Two satellites,
GPS could be on the circle
where
spheres
intersect.

3 satellites:
spheres intersect in 2 places.



4 satellites,
spheres
intersect in
one place.



Thank You!

Contact: Shelley Olds

[Education –at- unavco.org](mailto:Education-at-unavco.org)

<http://www.unavco.org/>

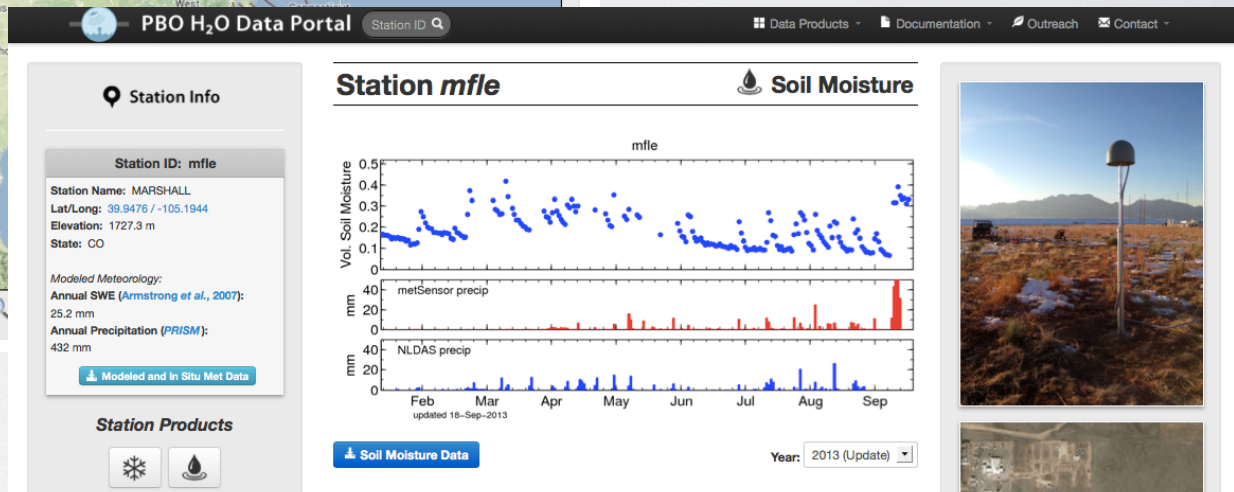
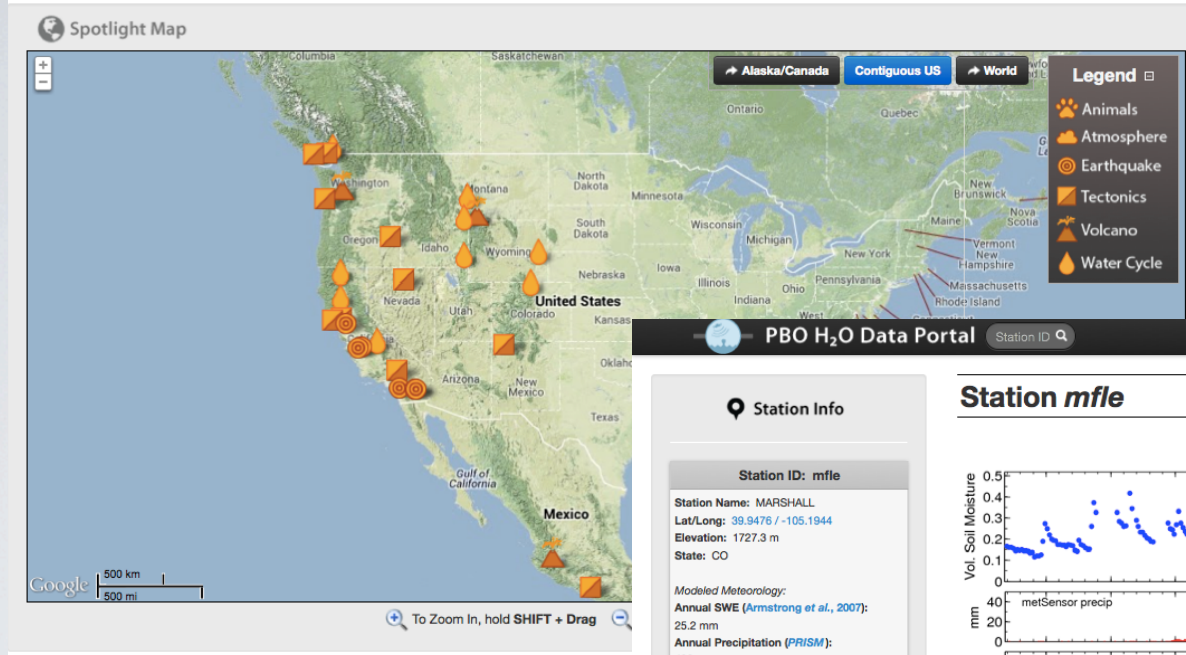
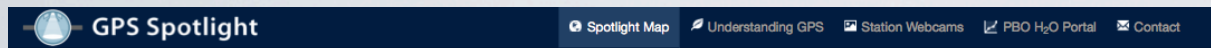
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Websites shown during demonstration

Learn more about how GPS works and the science learned through research

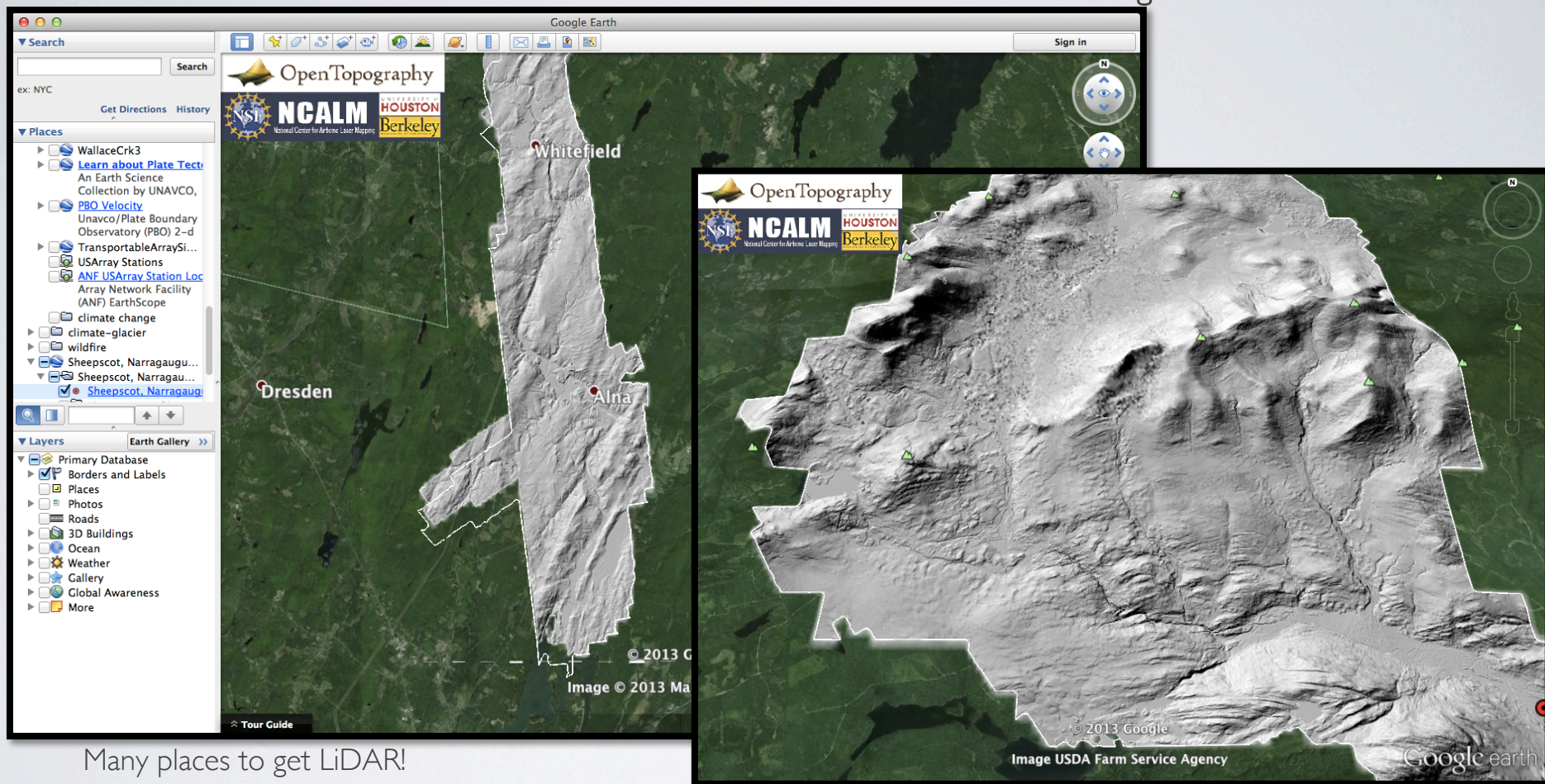


GPS Spotlight: <http://xenon.colorado.edu/spotlight/index.php>

PBO H₂O: <http://xenon.colorado.edu/portal/index.php>

Websites shown during demonstration

See the ground and forests with LiDAR



Many places to get LiDAR!

Open Topography: <http://www.opentopography.org/>

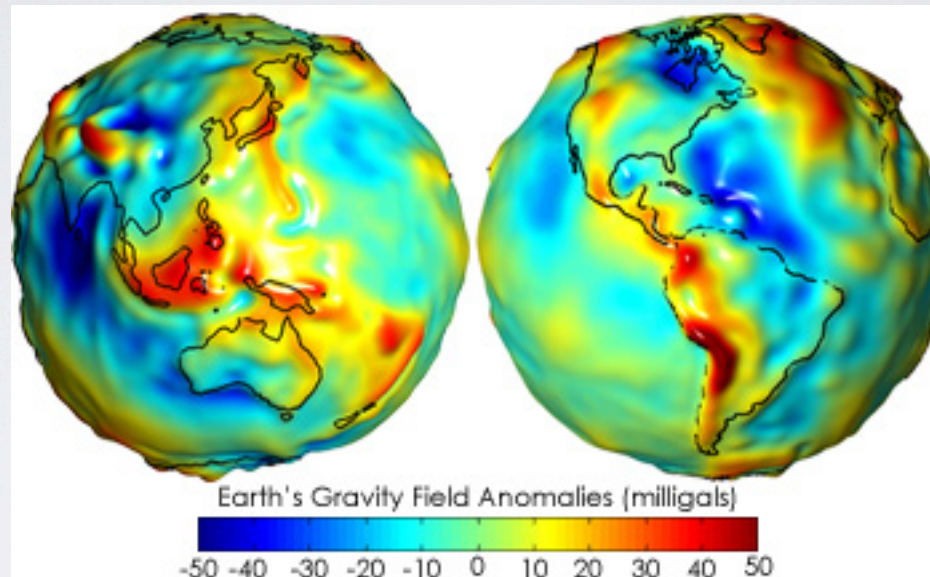
New York: <http://gis.ny.gov/elevation/lidar-coverage.htm>

Maine: <http://www.maine.gov/megis/projects/lidar.shtml>

Vermont: [http://vcgi.vermont.gov/warehouse/products/ALL-LDR MIX LIDAR STATE ALL](http://vcgi.vermont.gov/warehouse/products/ALL-LDR_MIX_LIDAR_STATE_ALL)

New Hampshire: <http://www.granit.unh.edu/resourcelibrary/specialtopics/lidar/>

About GRACE



<http://earthobservatory.nasa.gov/Features/GRACE/page3.php>

Measuring the Plates Move

