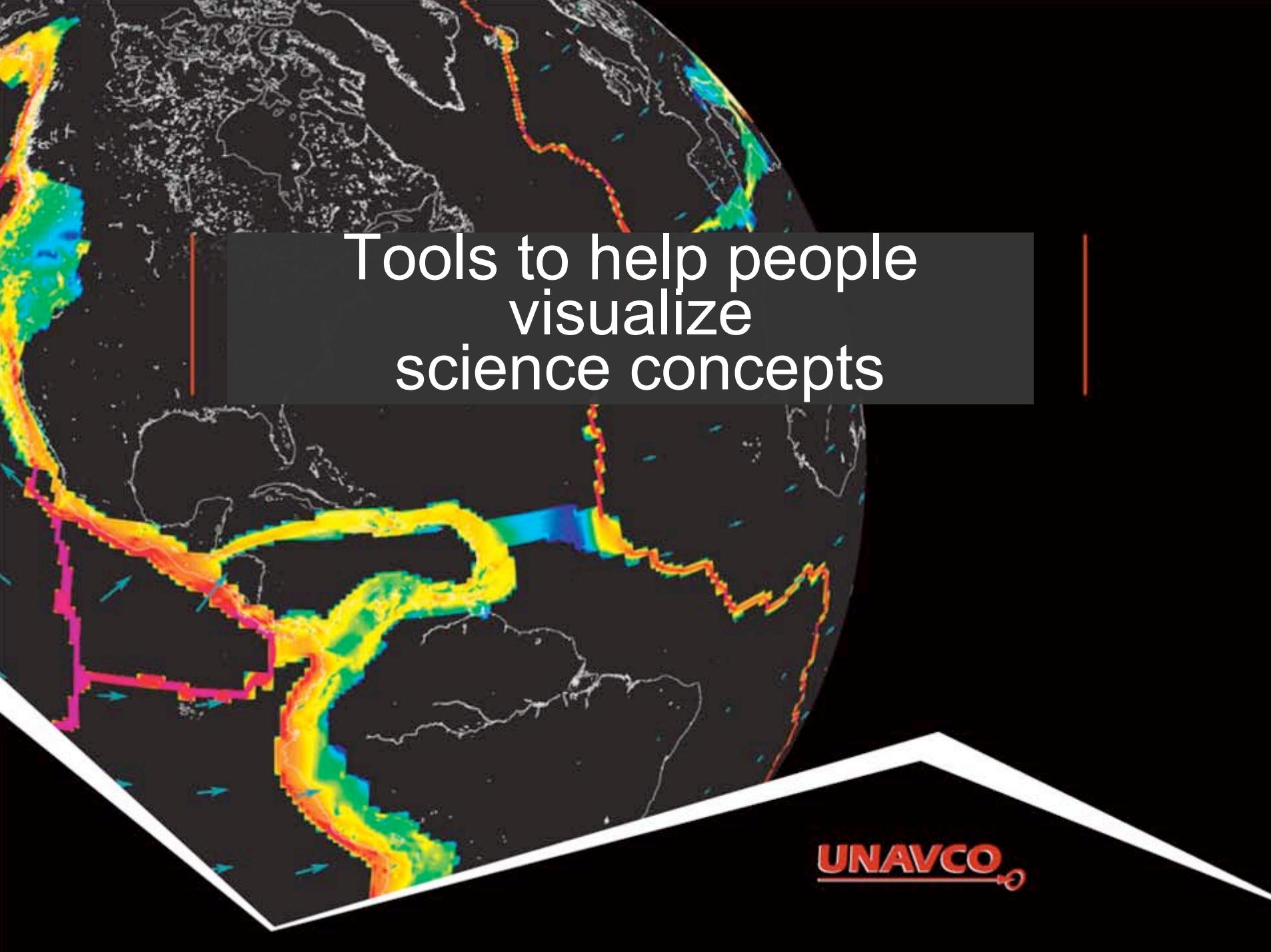




Which Way are We Going? Online Mapping Tools to Help People Visualize Plate Motions with GPS Data

Shelley Olds, UNAVCO





Tools to help people
visualize
science concepts

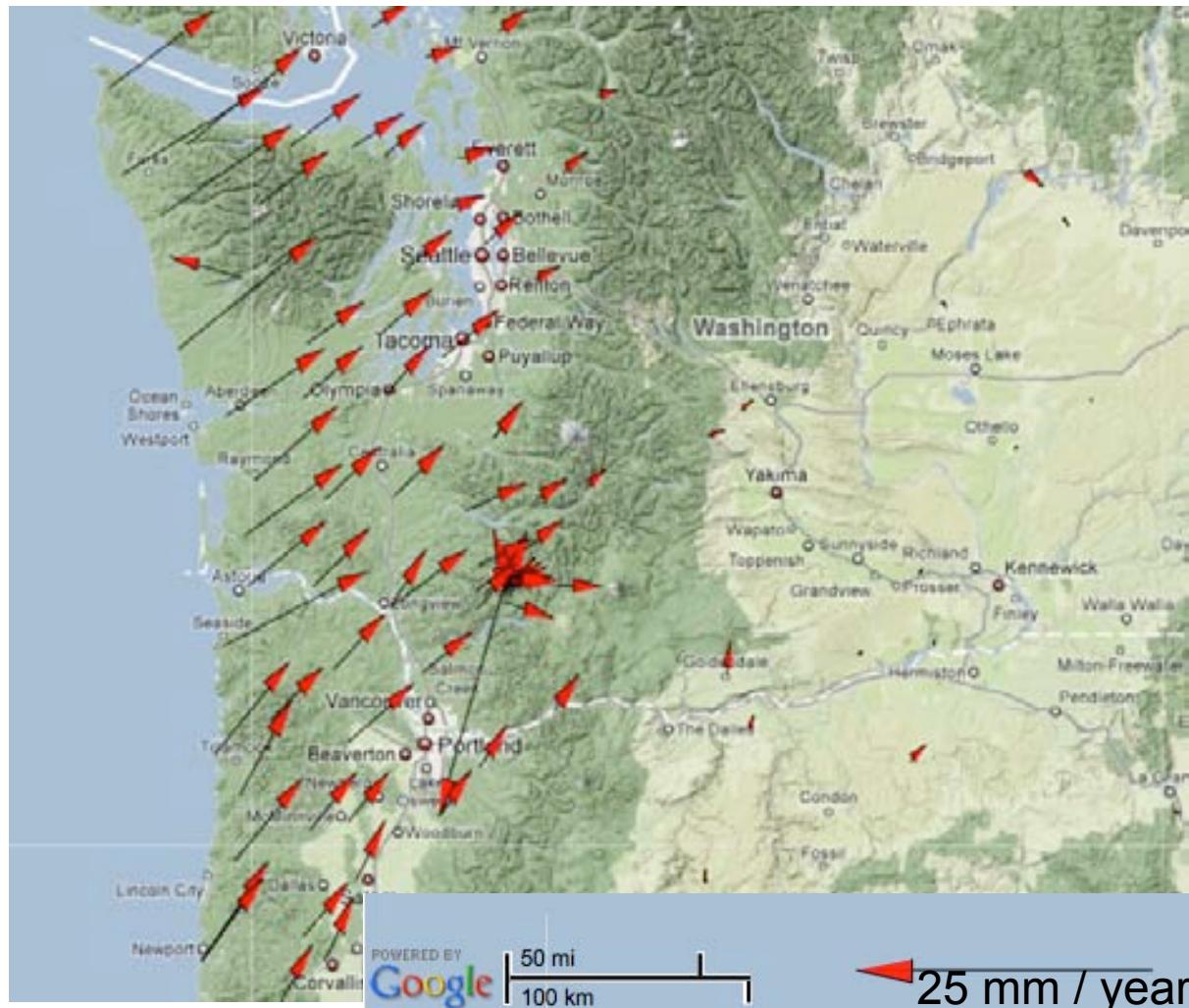
UNAVCO


Temporal & Spatial scales can be difficult to grasp



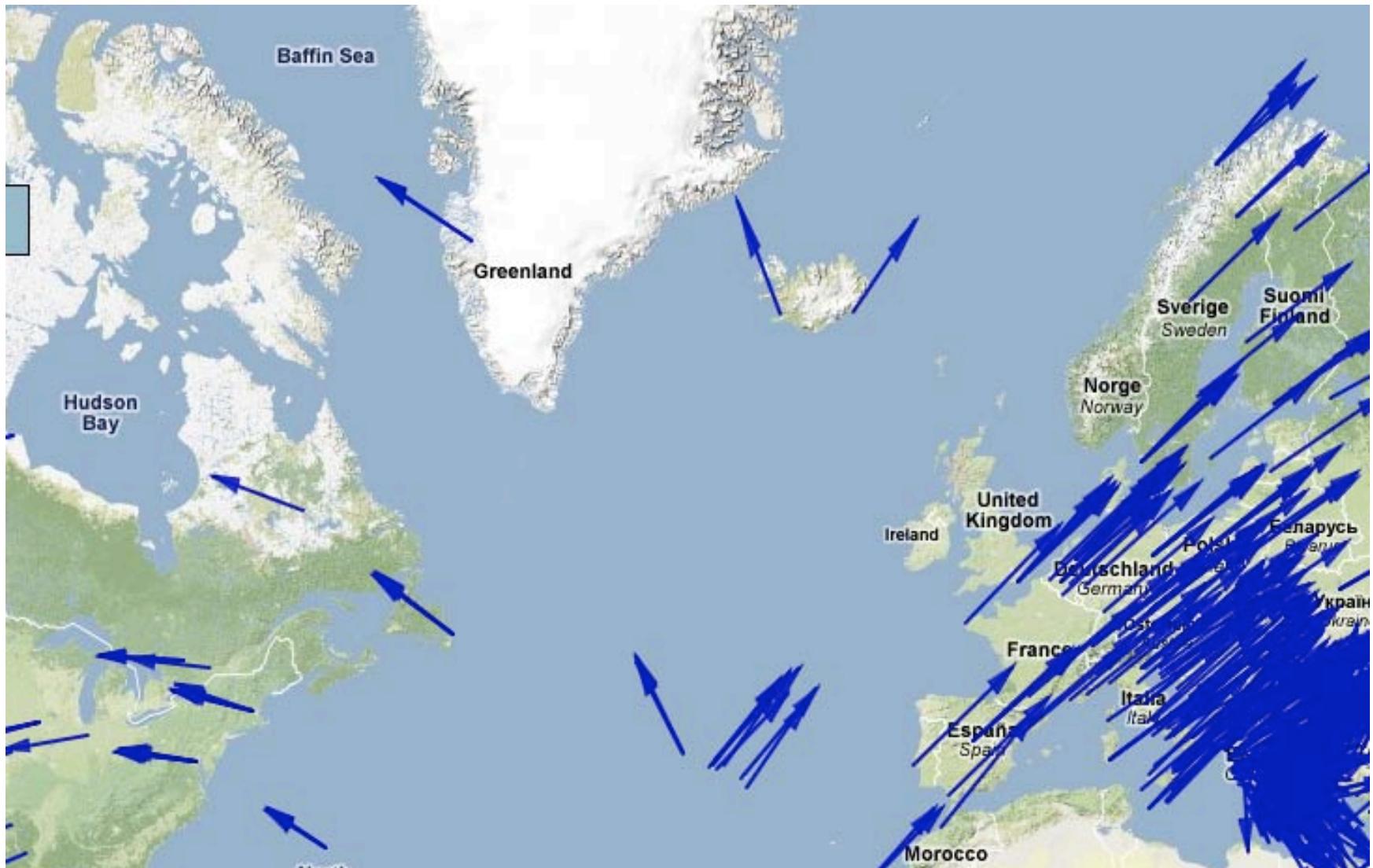
UNAVCO

GPS vectors bring plate tectonics to the human scale ... millimeters per year



Data Source: UNAVCO Plate Boundary Observatory: North American Reference Frame
UNAVCO GPS Velocity Viewer: <http://geon.unavco.org/unavco/GEV.php>

Learners can see the plates moving apart

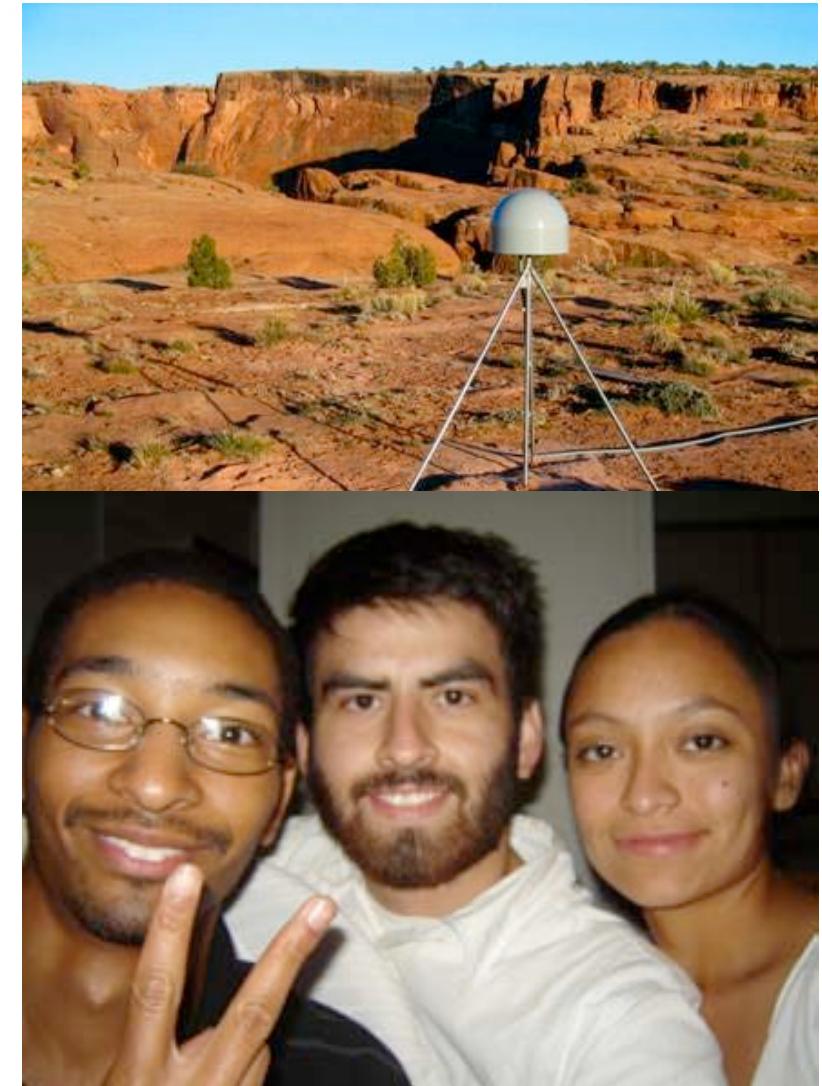


Data source: Global Strain Rate Map Project ; Reference Frame: **No Net Rotation**
UNAVCO GPS Velocity Viewer: <http://geon.unavco.org/unavco/GEV.php>

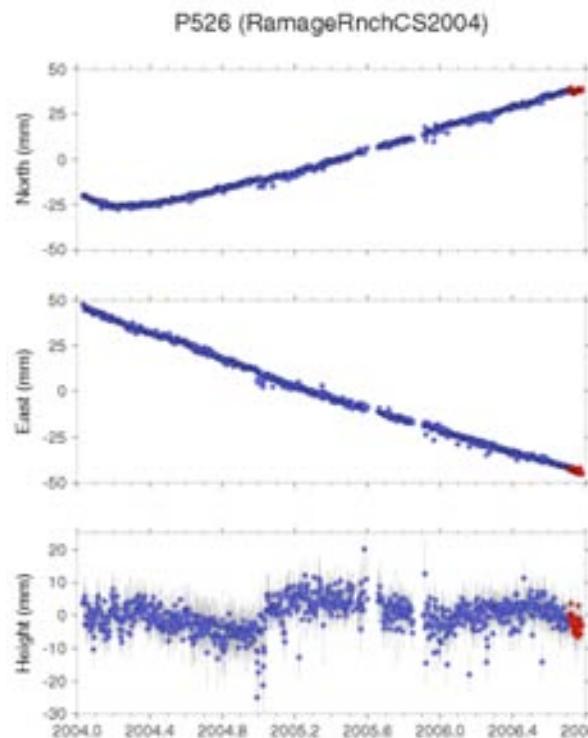
- NSF and NASA funded
- Non-profit
- Consortium
- Membership-governed
- **Facilitates
geoscience research
and education using
geodesy.**

Education & Outreach Goal:

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



Types of Data & Products



- Multiple search interfaces
- GPS, LiDAR, InSAR, strain, tilt ...
- Data/Data Products
 - Time Series Plots
 - Images
 - Velocity Vectors
 - Visualizations
 - Data formats
 - Raw
 - Processed



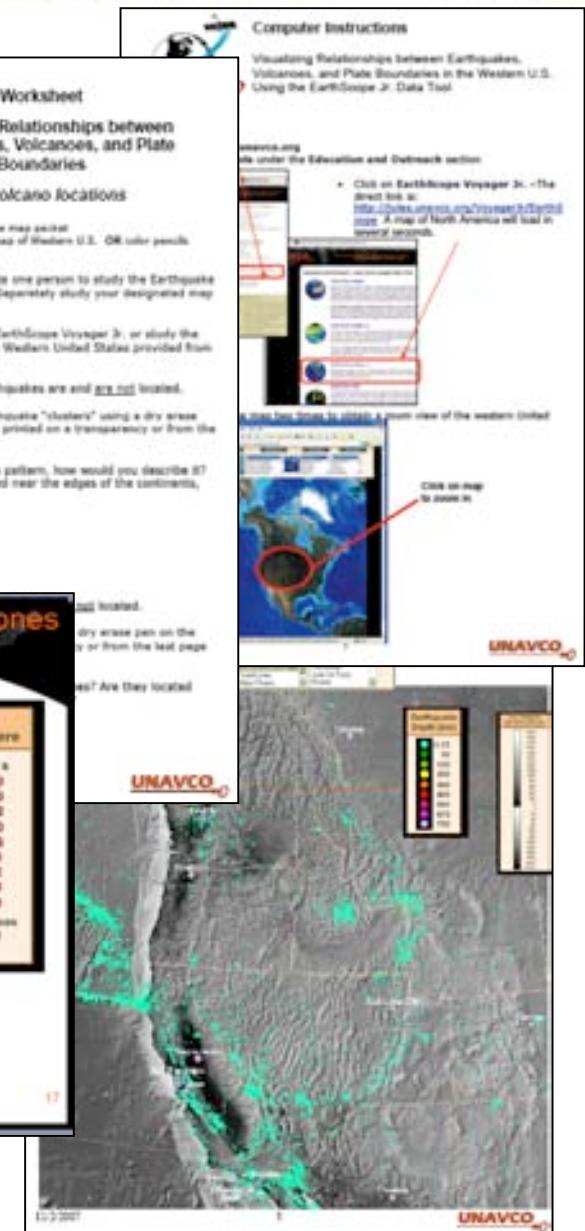
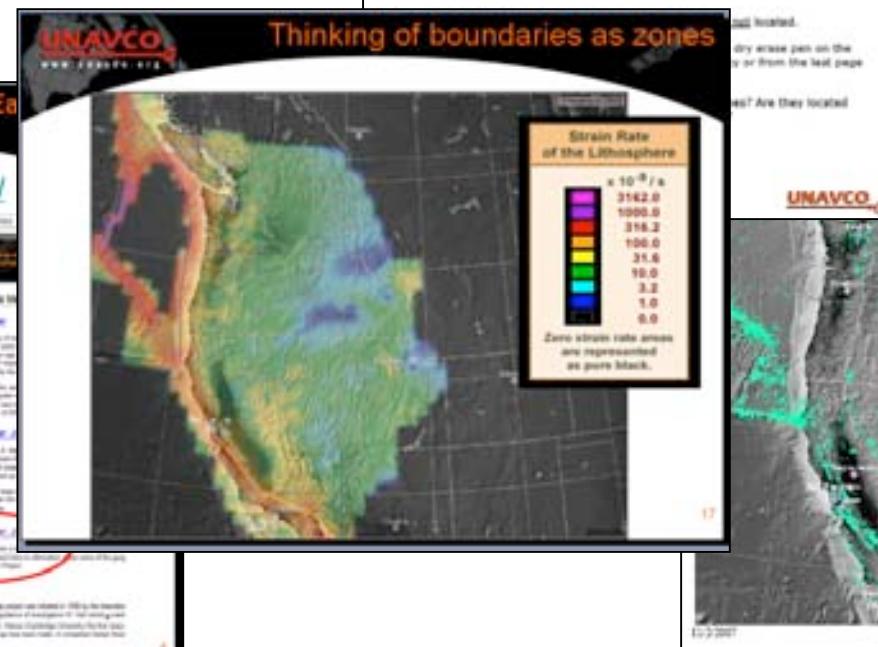
Learning Materials

- Instructor Presentations
- Computer instructions
- Student worksheets
- How to download data ...

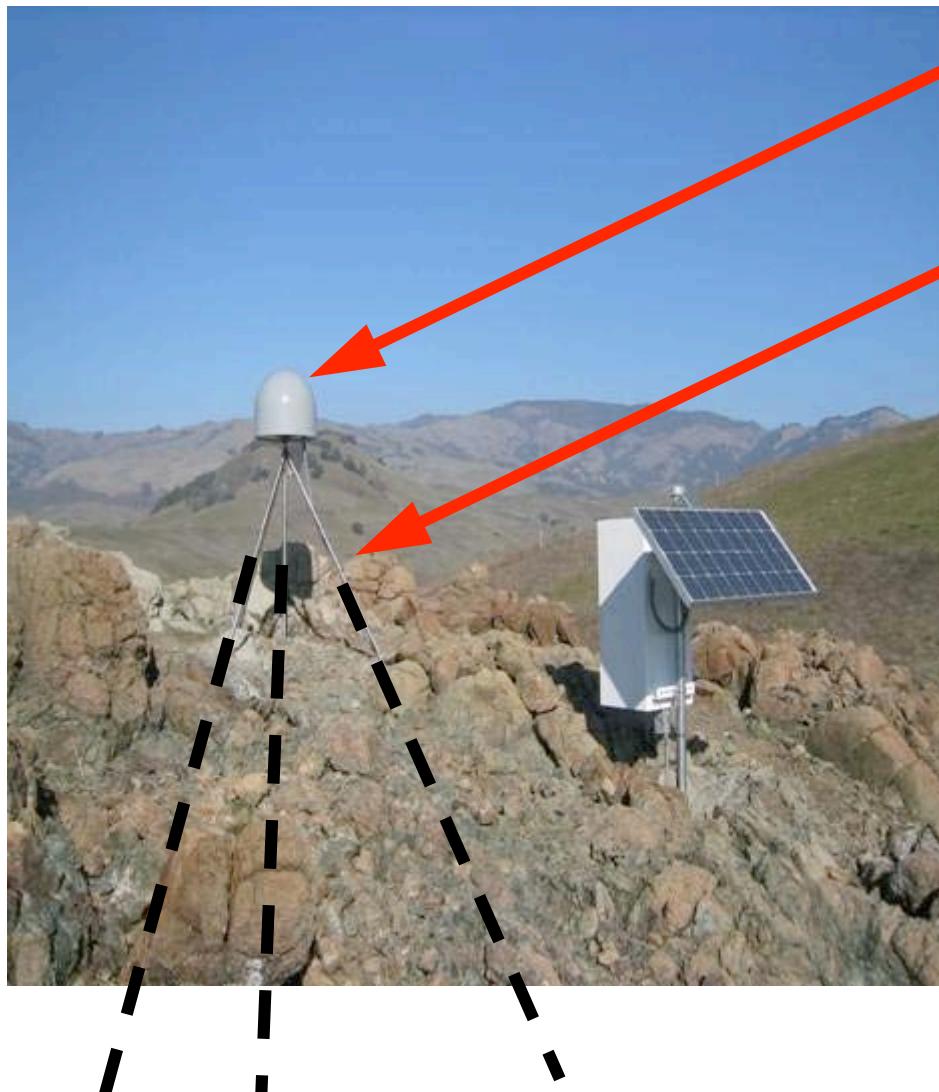
Part I: Comparing Locations of Earthquakes and Volcanoes

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

The screenshot shows the UNAVCO website with a red circle highlighting the 'Earthquakes & Volcanoes' link under the 'Education & Outreach' menu.



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.

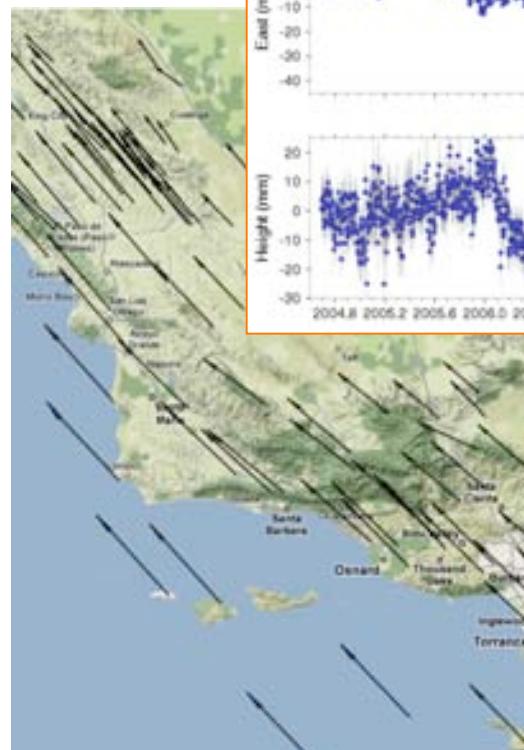
Solar panel for power

Equipment enclosure

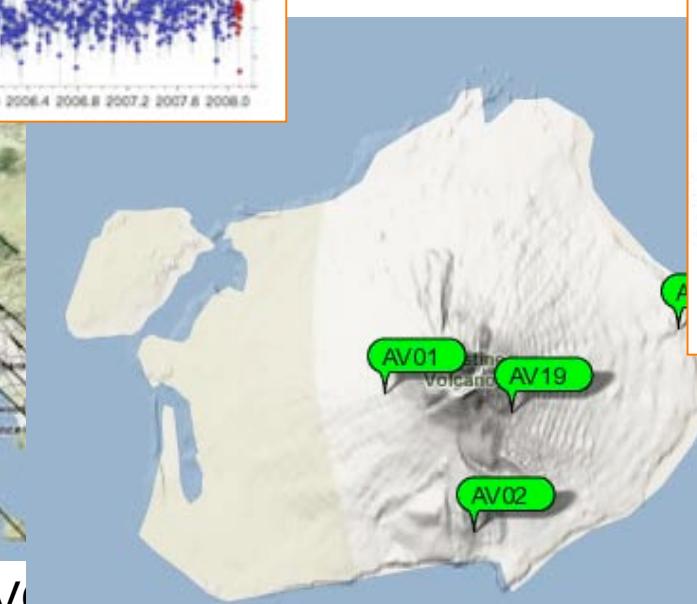
- GPS receiver
- Power/batteries
- Communications/ radio/ modem
- Data storage/ memory

UNAVCO

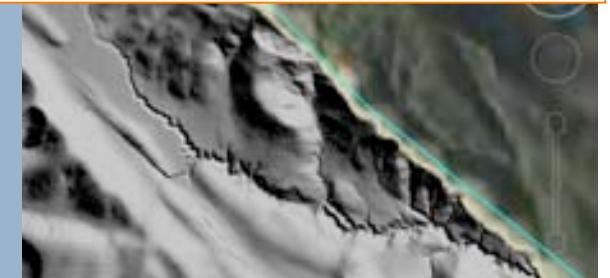
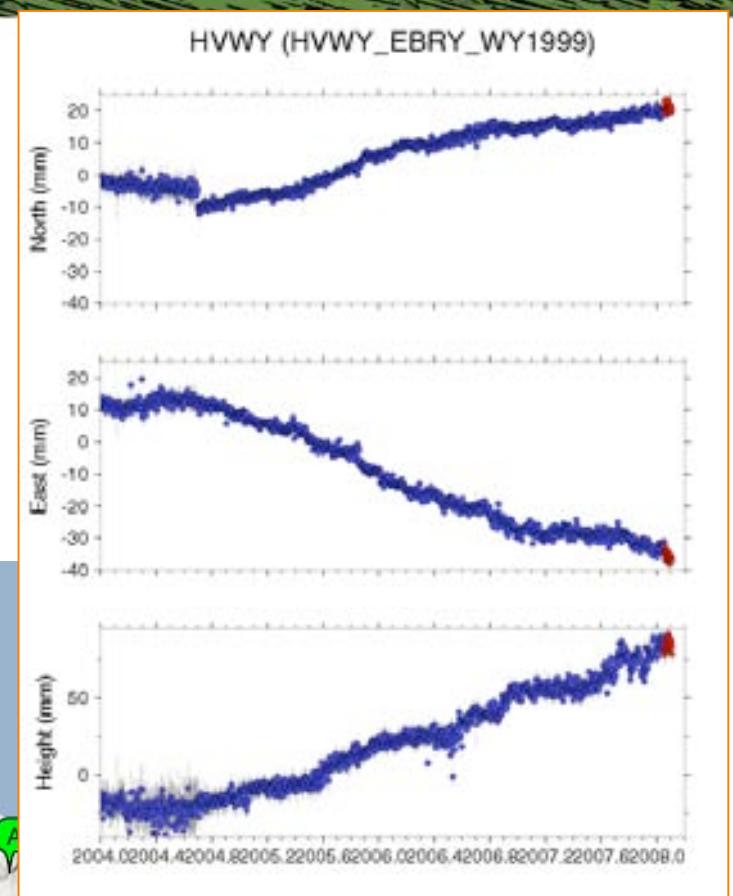
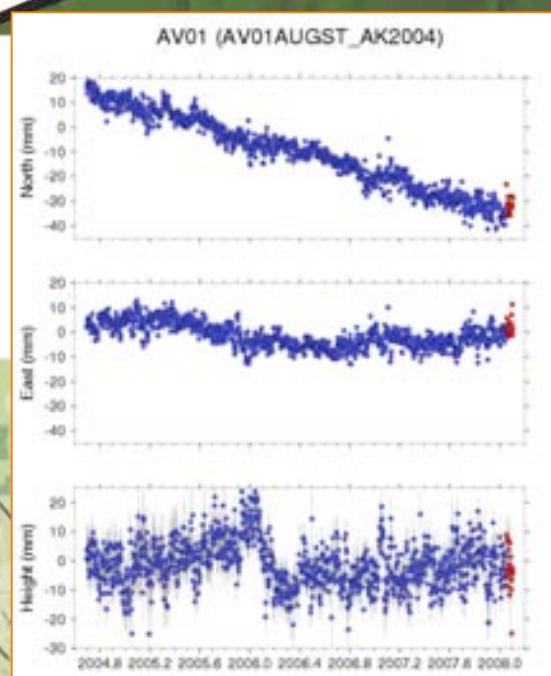
Explore & Compare Data



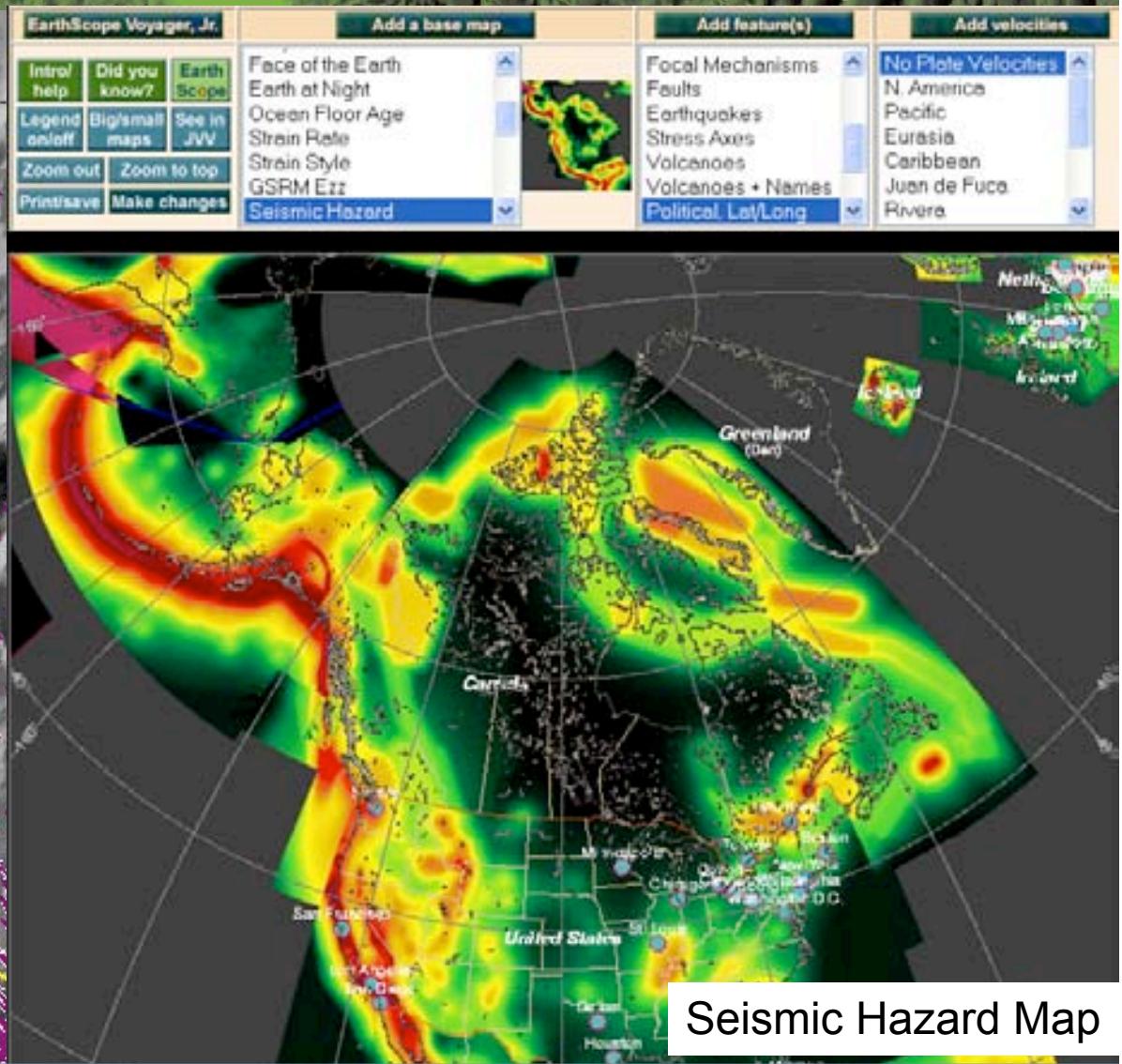
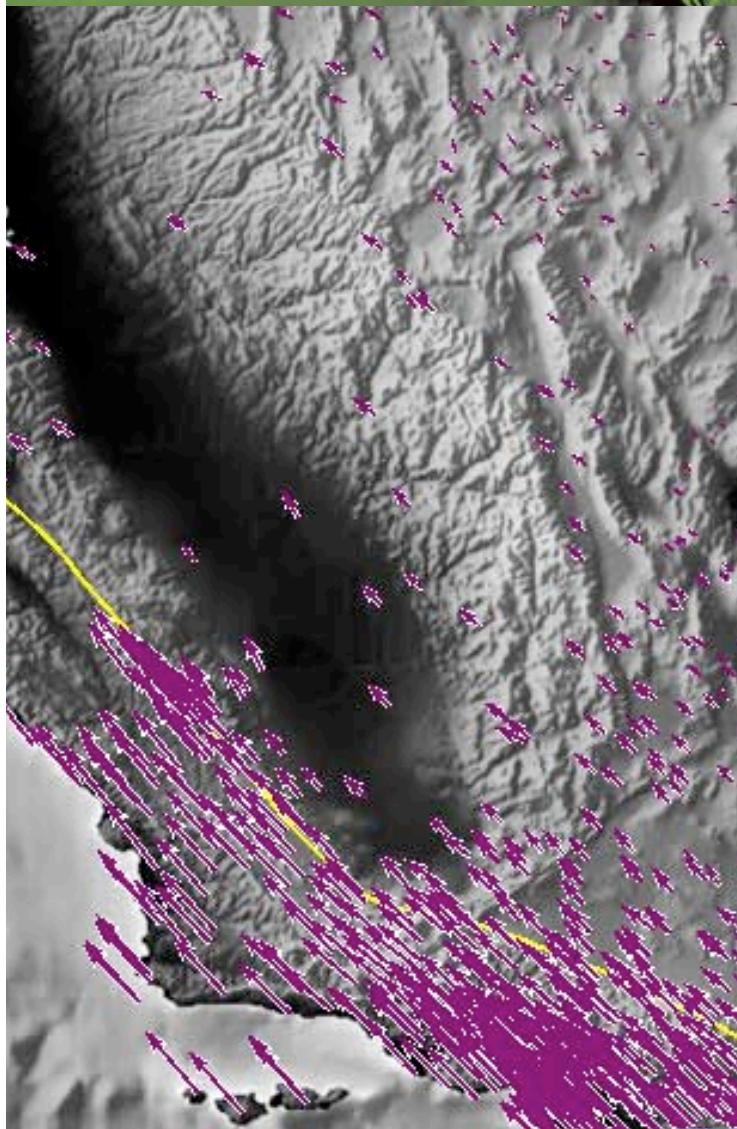
GPS Velocities in UNAVCO
Viewer using Google Maps
<http://mole.unavco.org/gmaps/GPSInteractiveViewer.php>



GEON LiDAR image in Google Maps
<http://opentopo.sdsc.edu/gridsphere/gridsphere?cid=otgoogleearth>



Jules Verne & EarthScope Voyager Jr.



Velocity Vectors

http://www.unavco.org/edu_outreach/maptools.htm

Data for Educators

**GPS data that show...
...tectonic plates moving**

GPS Data Products

Station ID	Location
ALBH	Albert Head, Victoria, Canada
BEMT	Twenty-nine Palms, CA
NEAH	Neah Bay, WA
SACB	Mission Viejo, CA
SEAT	Seattle, WA

Educational resources using these stations

- Using GPS Time Series Plots to Determine Plate Motion in California
- 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

... movement on different sides of a fault

GPS Data Products

Station ID	Location
BPMT	Twenty-nine Palms, CA
SACB	Mission Viejo, CA

Educational resources using these stations

- Using GPS Time Series Plots to Determine Plate Motion in California
- Visualizing Relationships between Earthquakes, Volcanoes, and Plate Boundaries in the Western United States

... rebound of plates after an earthquake!

GPS Data Products

Station ID	Location
CAND	Panfield, CA
CARH	Panfield, CA

Educational resources using these stations

- Using GPS Time Series Plots to Determine Plate Motion in California

... movement on a subduction zone

GPS Data Products

Station ID	Location
NEAH	Neah Bay, WA
PASH	Pacific Beach, WA
P071	Lind, WA
SACB	Ellensburg, WA
SEAT	Seattle, WA

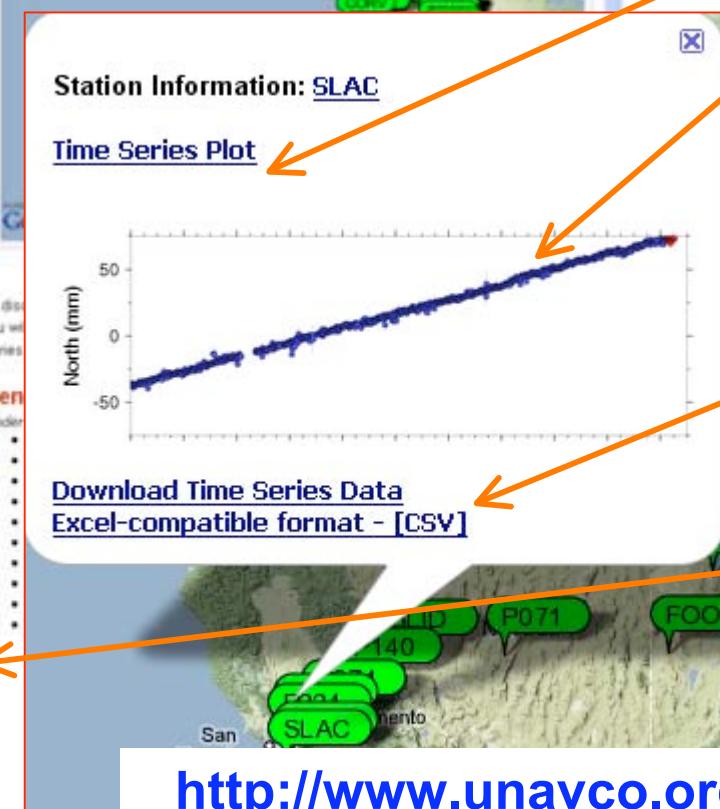
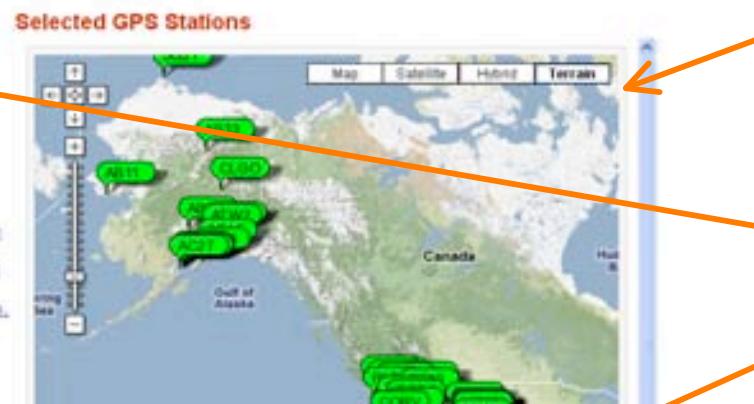
Educational resources using these stations

- 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

... ground motions from volcanic activity

GPS Data Products

Station ID	Location
EW097	Mt. Adams, Pierce, WA

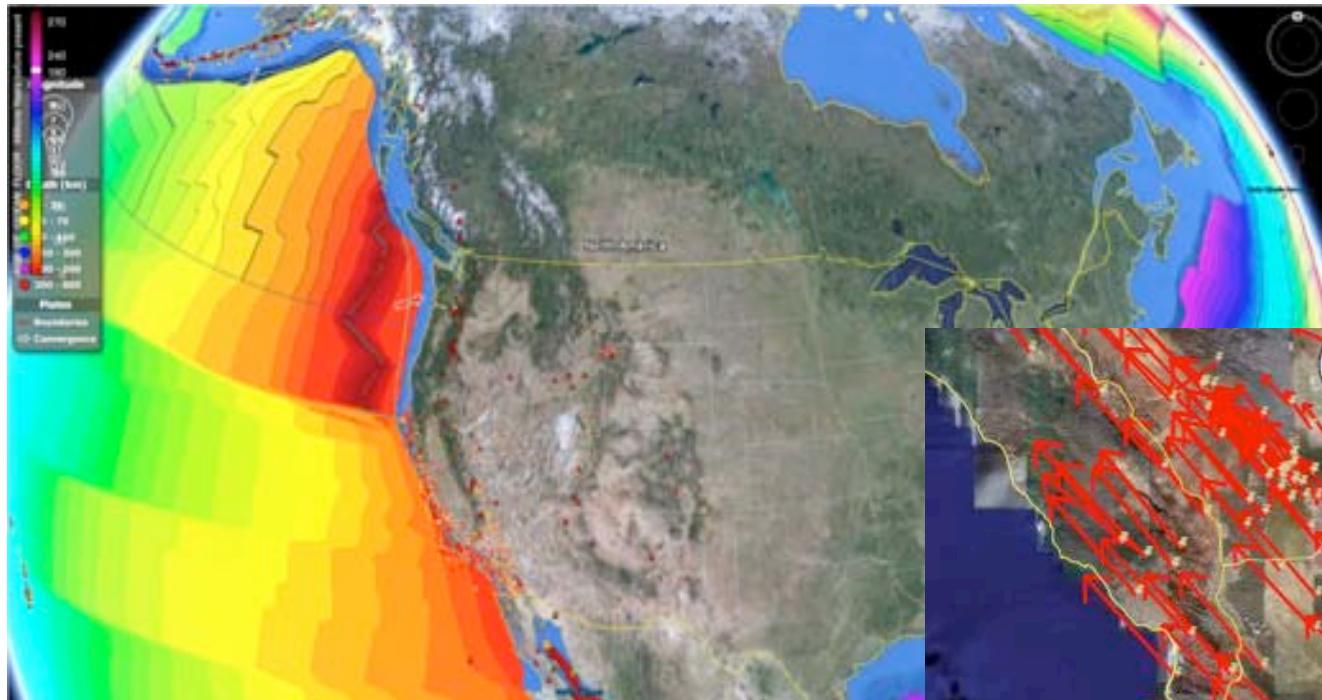


- Visual display of station locations
- Interesting data
- Full data plot
- Quick data preview
- Excel readable formats
- Associated Activities

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

UNAVCO

UNAVCO Geophysics / Learn about Plate Tectonics, Google Earth KMZ



Google Earth KMZ

[http://geon.unavco.org/unavco/GE/
Learn_about_Plate_Tectonics.kmz](http://geon.unavco.org/unavco/GE/Learn_about_Plate_Tectonics.kmz)

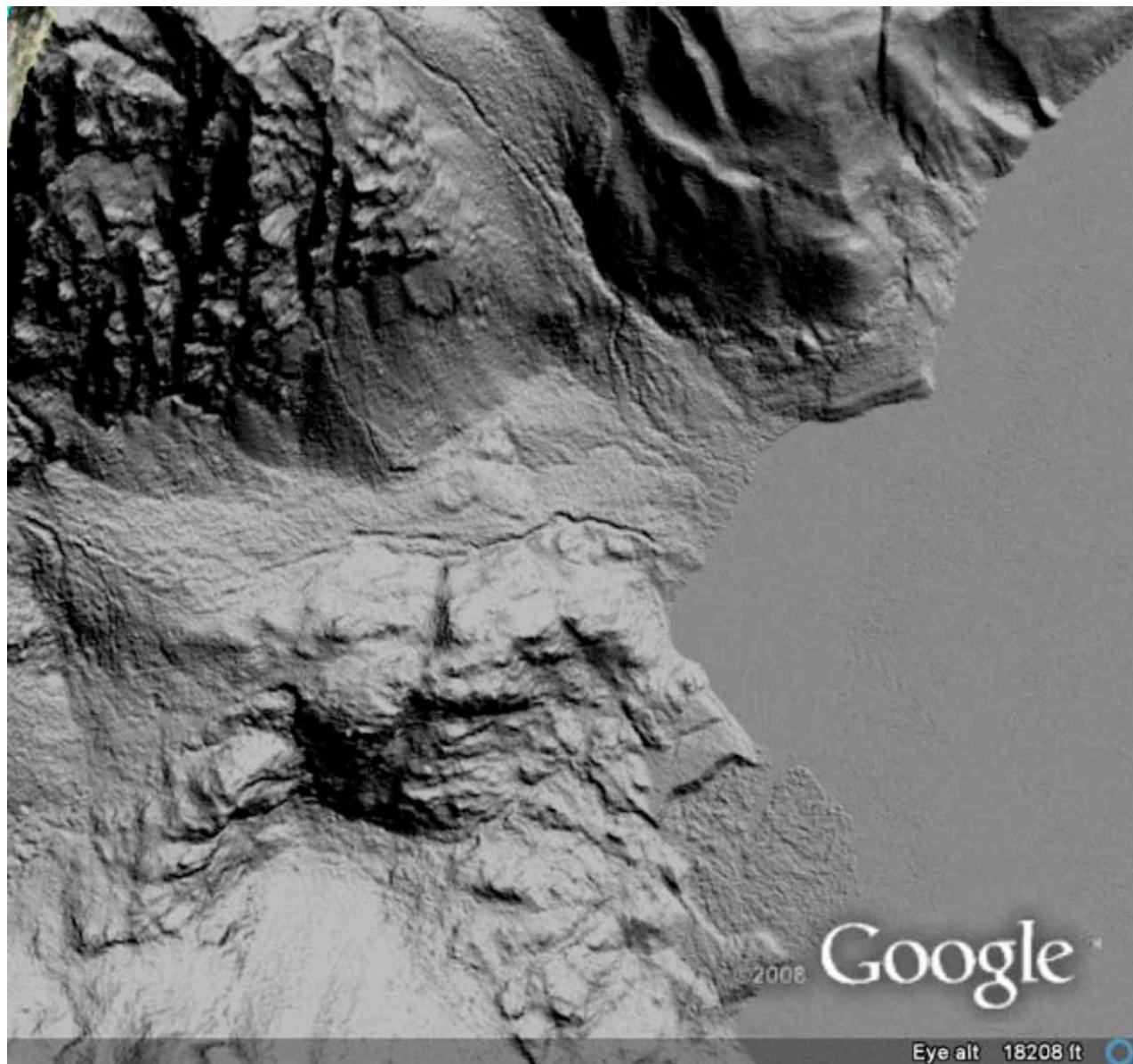


GPS Velocities Google Earth KMZ

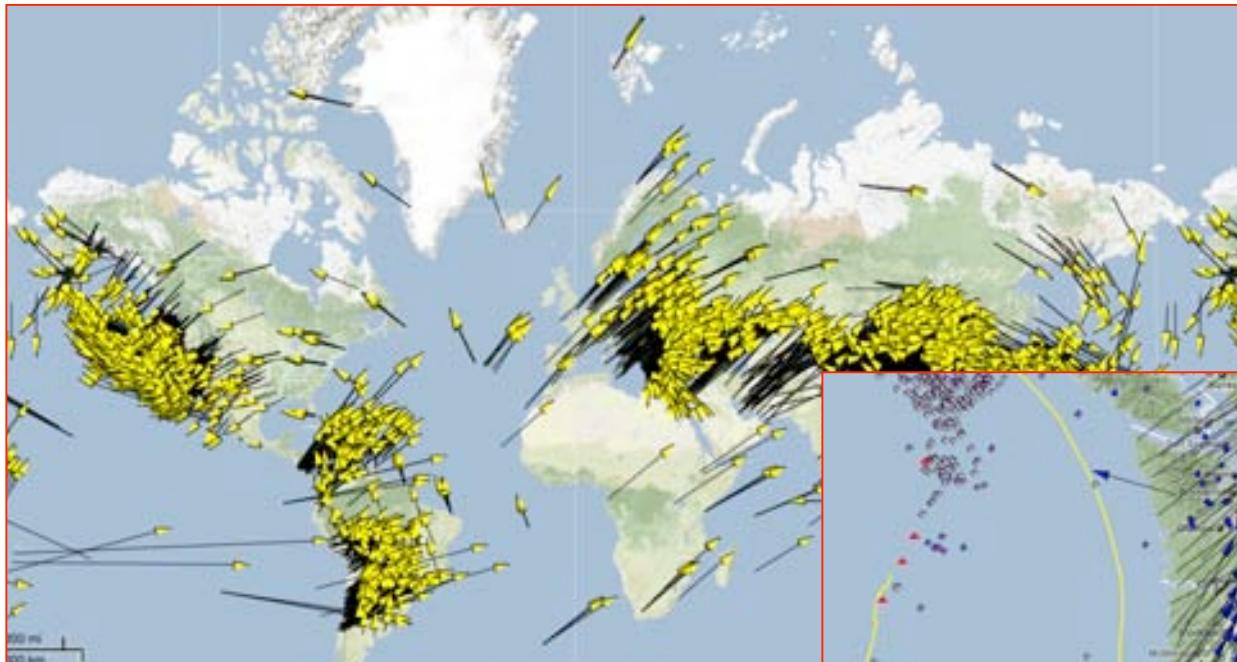
http://pboweb.unavco.org/products/velocity/pbo_final_frame.kmz
<http://facility.unavco.org/data/maps/maps.html>

UNAVCO

LiDar in Google Earth

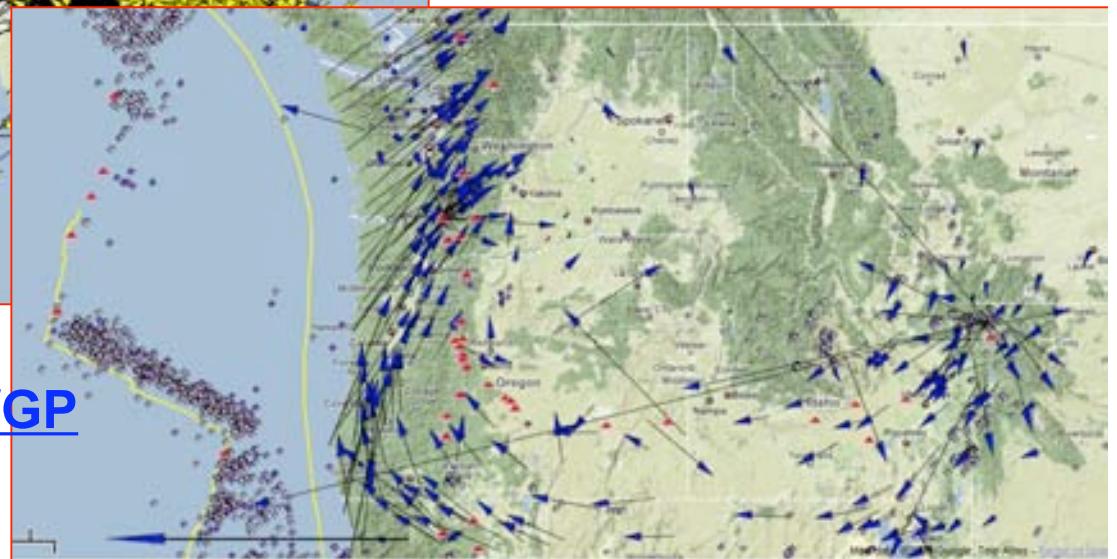


GPS Velocity Viewer ^{beta} V1 & V2 in Google Maps



V1: vectors only

<http://geon.unavco.org/unavco/GPSVelocityViewer.php>

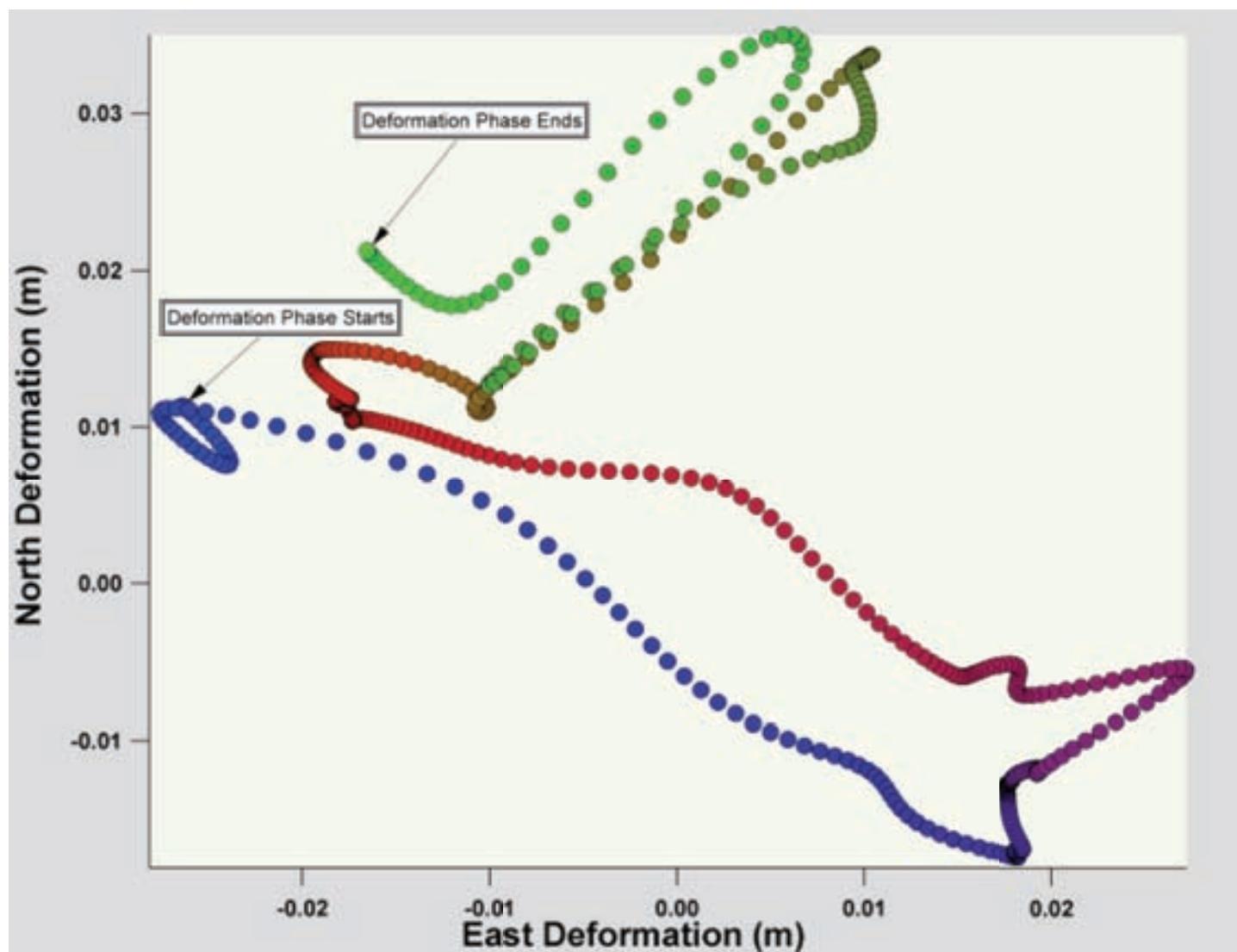


V2: vectors, volcanoes, earthquakes, plate boundaries

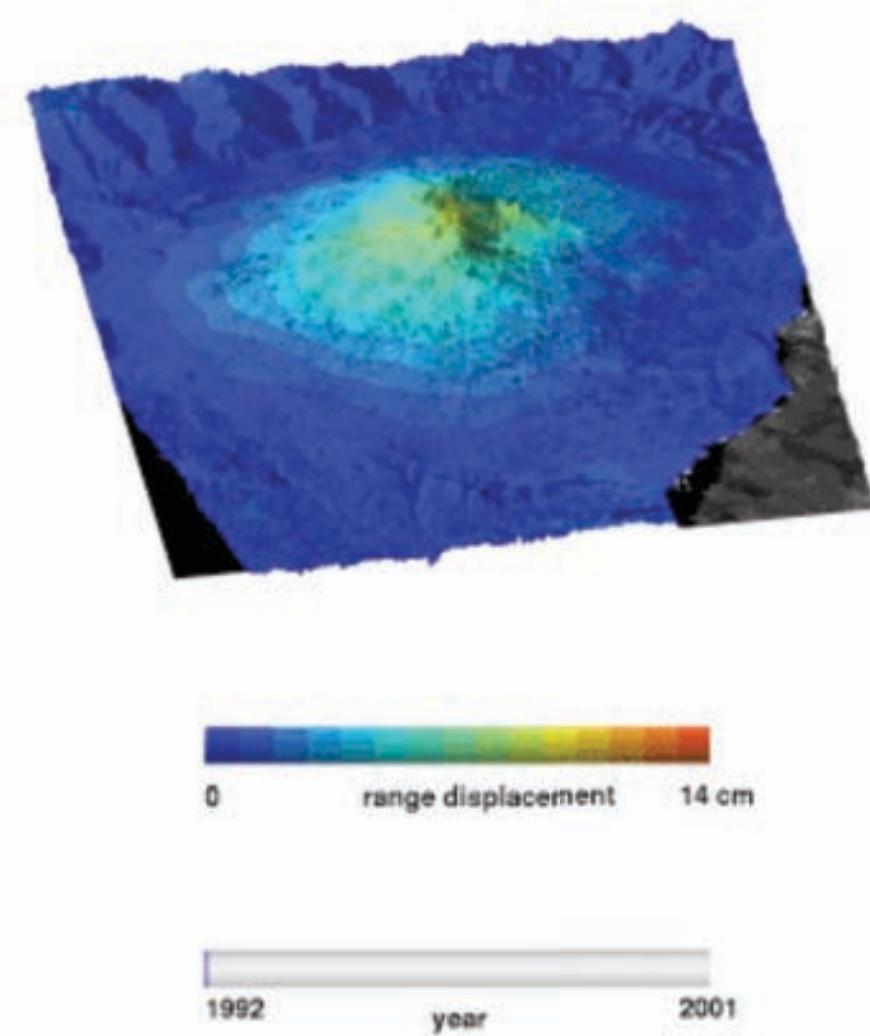
<http://geon.unavco.org/unavco/GEV.php>

UNAVCO

The Path of Station P697 on Mt. St. Helens



Volcanoes... inflate and deflate Mt. Etna, Sicily

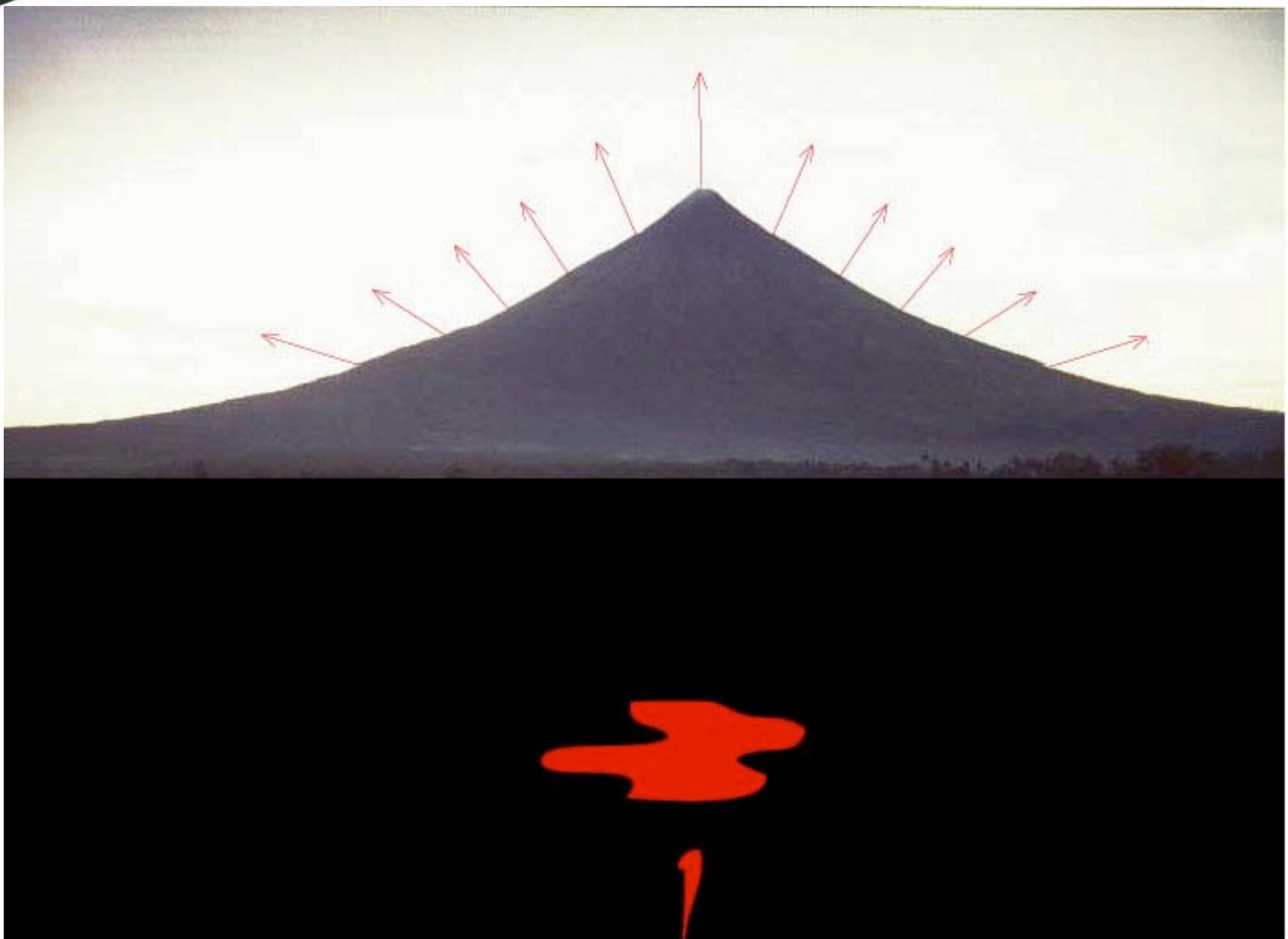


- Volcanoes inflate and deflate
Mt. Etna, Sicily
- ...the inflation
- ...DD...J...DDy...fr dona
- ...DDGI...DDy...fr dona
- ...DDyl...DD...fr dona
- ...DD...IGI...fr dona

Based on time series inversion algorithms of
Lundgren et al. (J. Geophys. Res., 2001) and
Berardino et al. (IEEE, 2002).

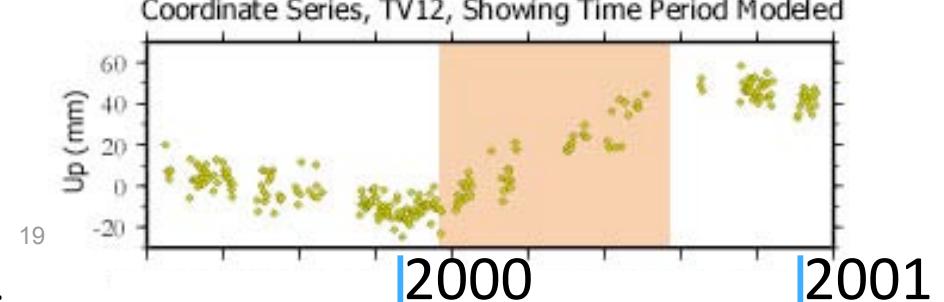
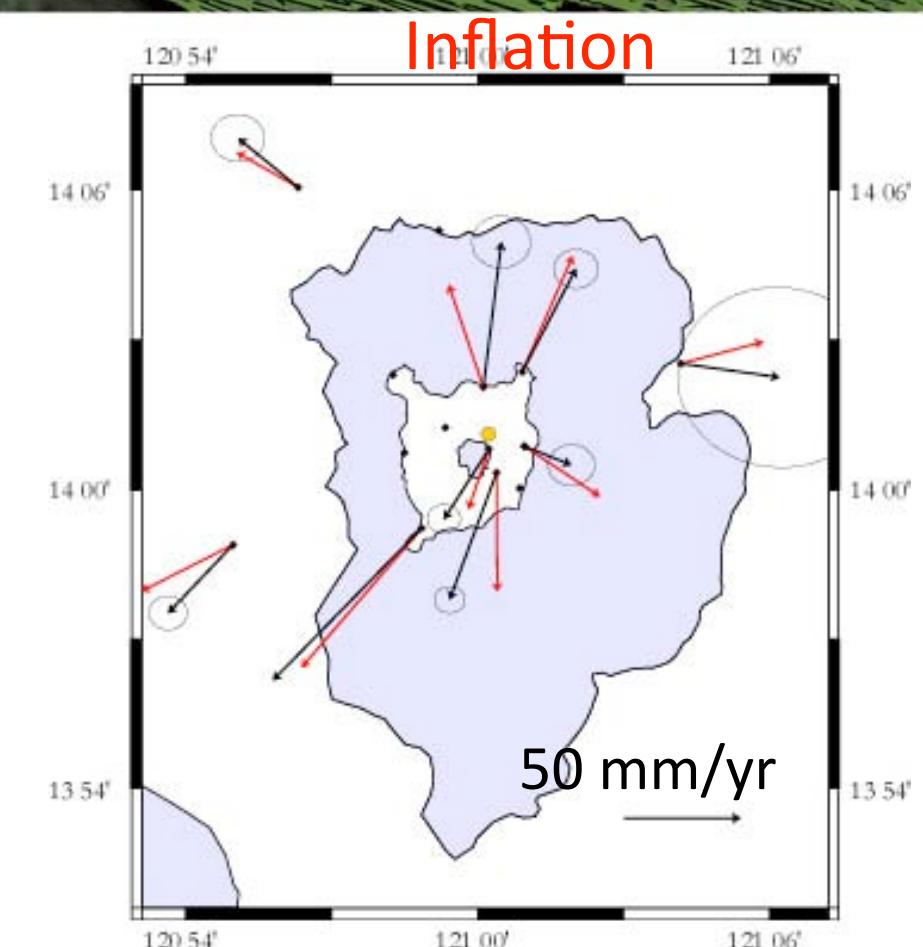
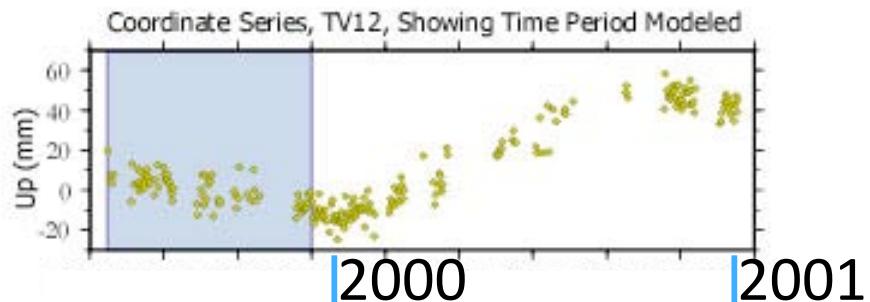
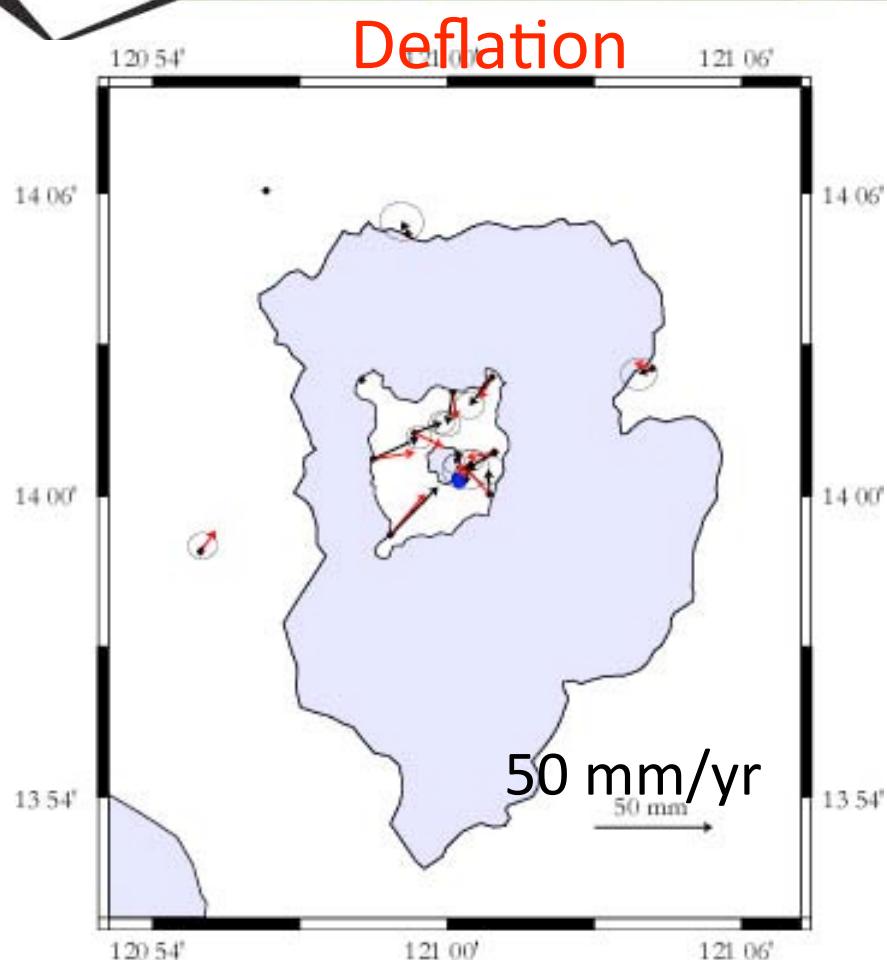
UNAVCO

Volcanoes...
inflate and deflate



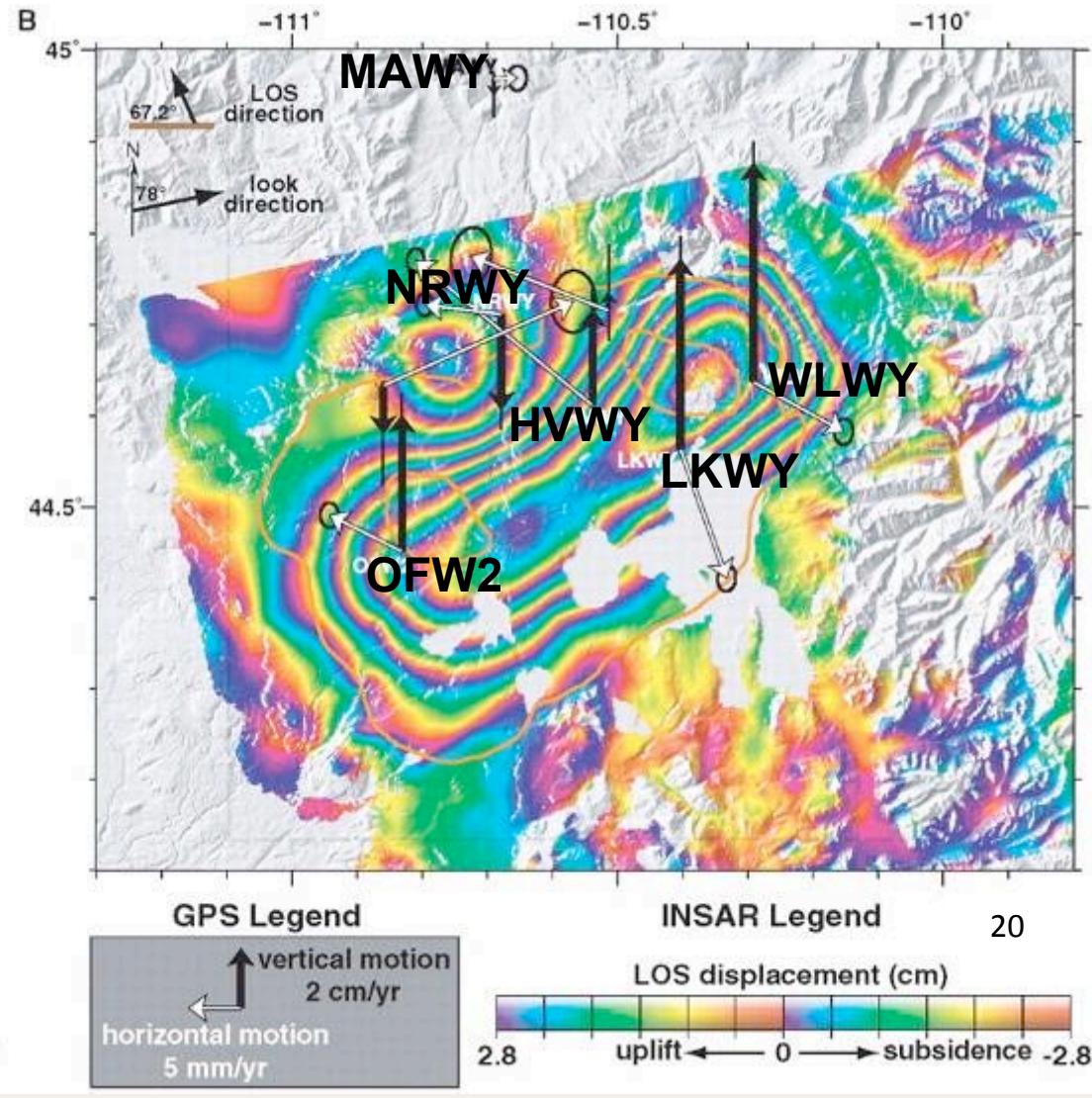
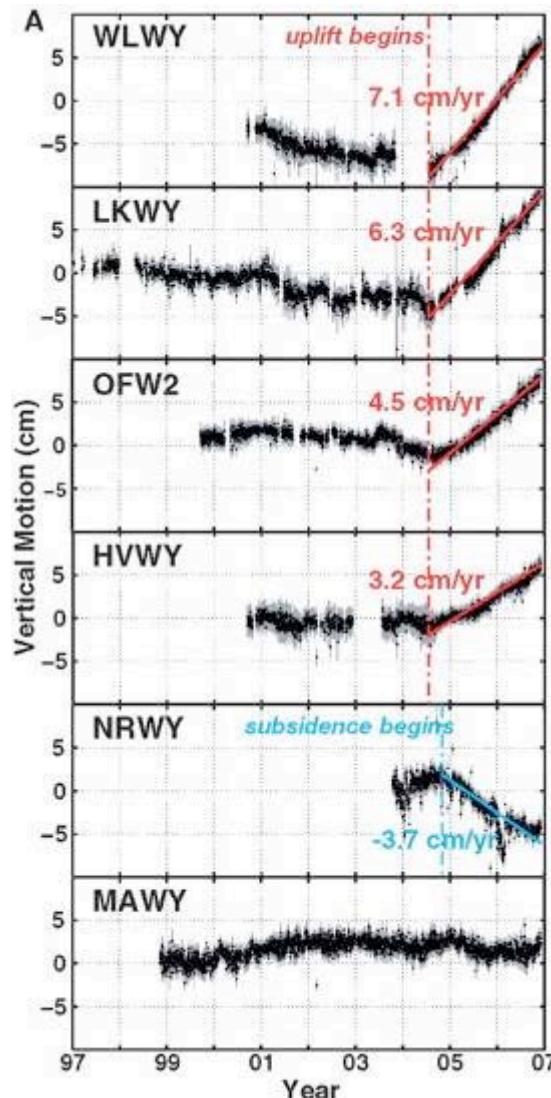
UNAVCO

Inflation & Deflation



Inflation @ Yellowstone Caldera

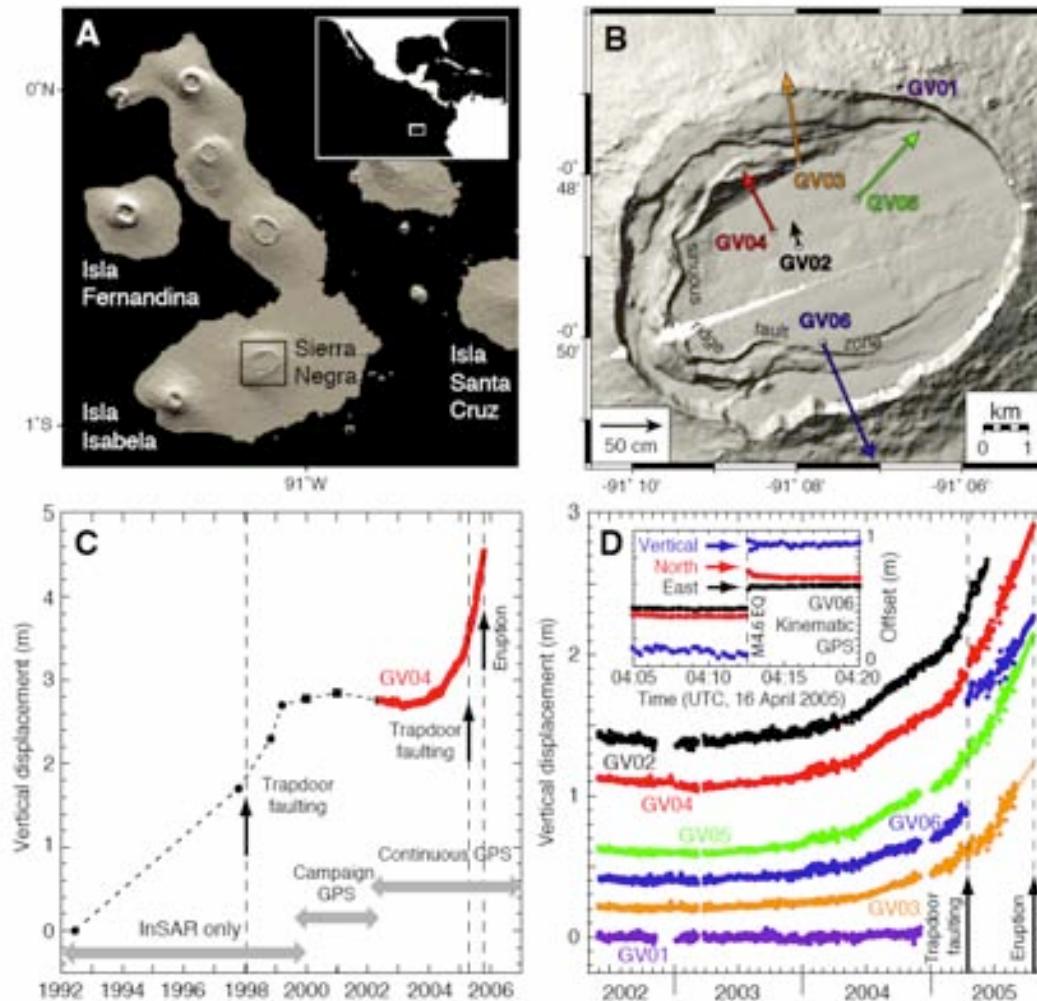
Fig. 2. (A) Temporal variation of vertical ground motions of labeled Yellowstone GPS stations



Volcanoes change shape (volcanic deformation)

Volcanic Signals

Sierra Negra,
Galapagos

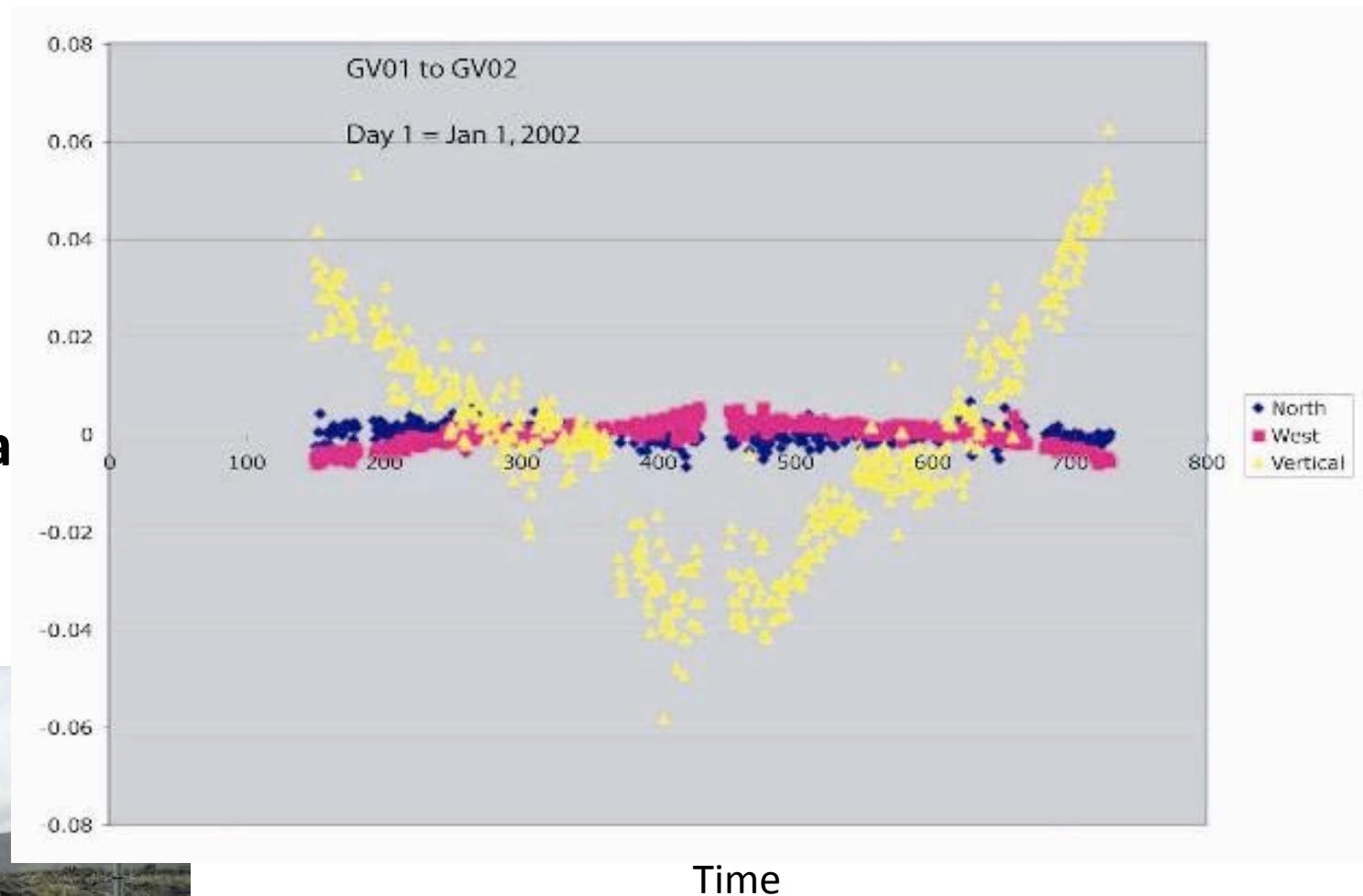
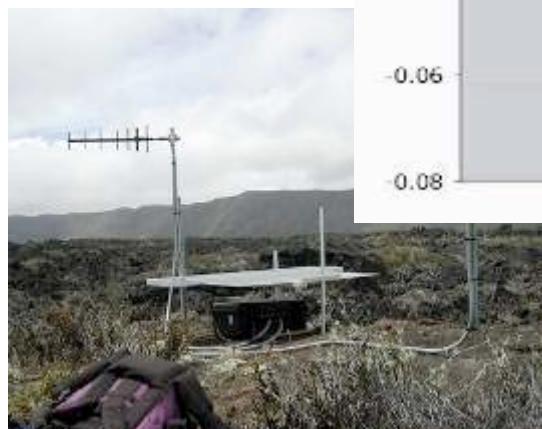


Dennis Geist, U. Idaho

Volcanic Deformation: Sierra Negra, Galapagos

Volcanic Signals

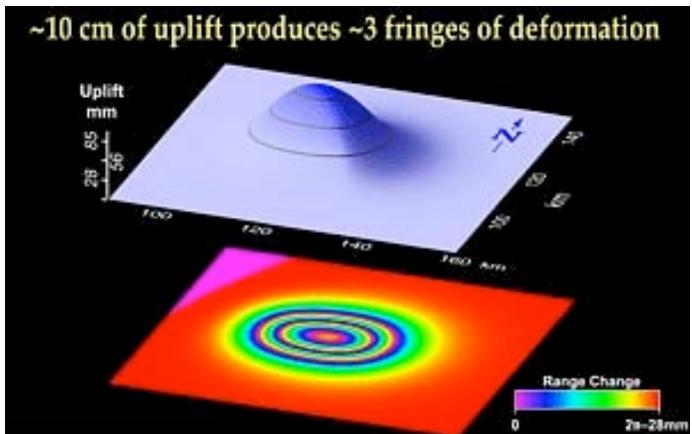
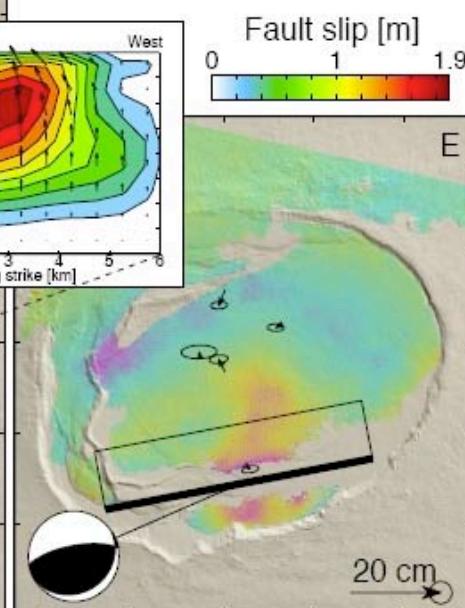
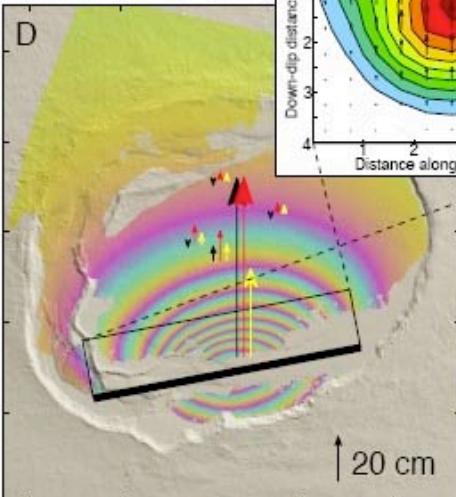
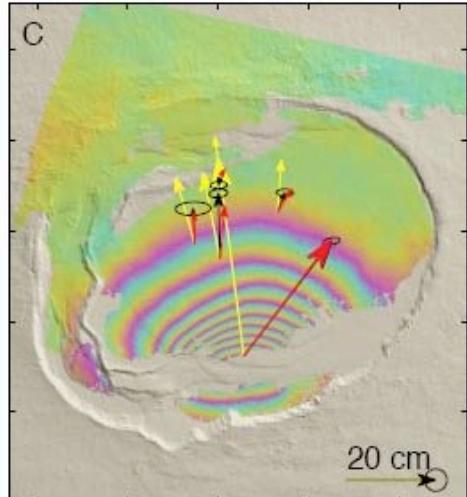
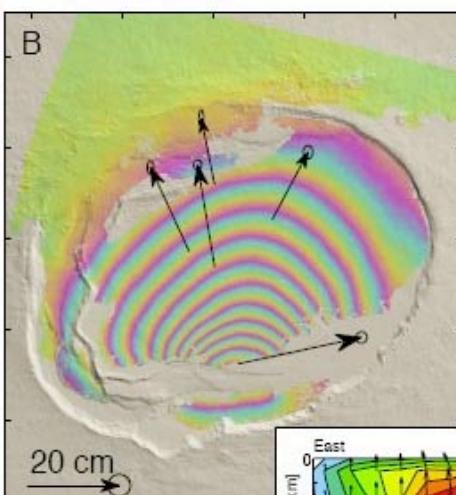
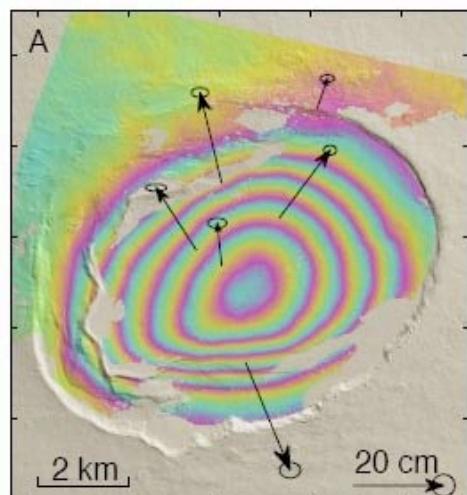
Sierra Negra
Galapagos



Dennis Geist, U. Idaho

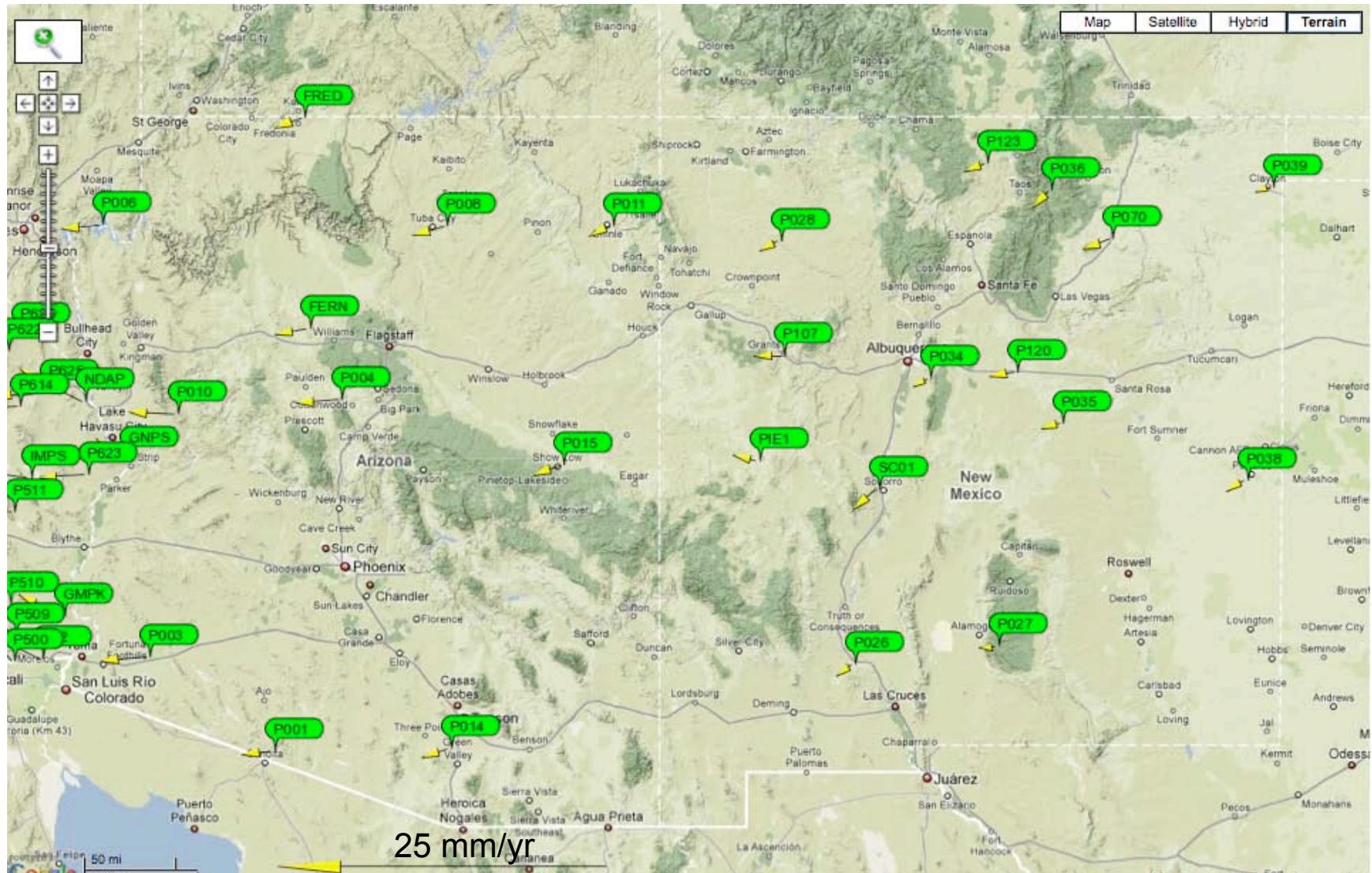
Using InSAR and GPS: Galapagos

InSAR and GPS Vectors
Showing trapdoor faulting event

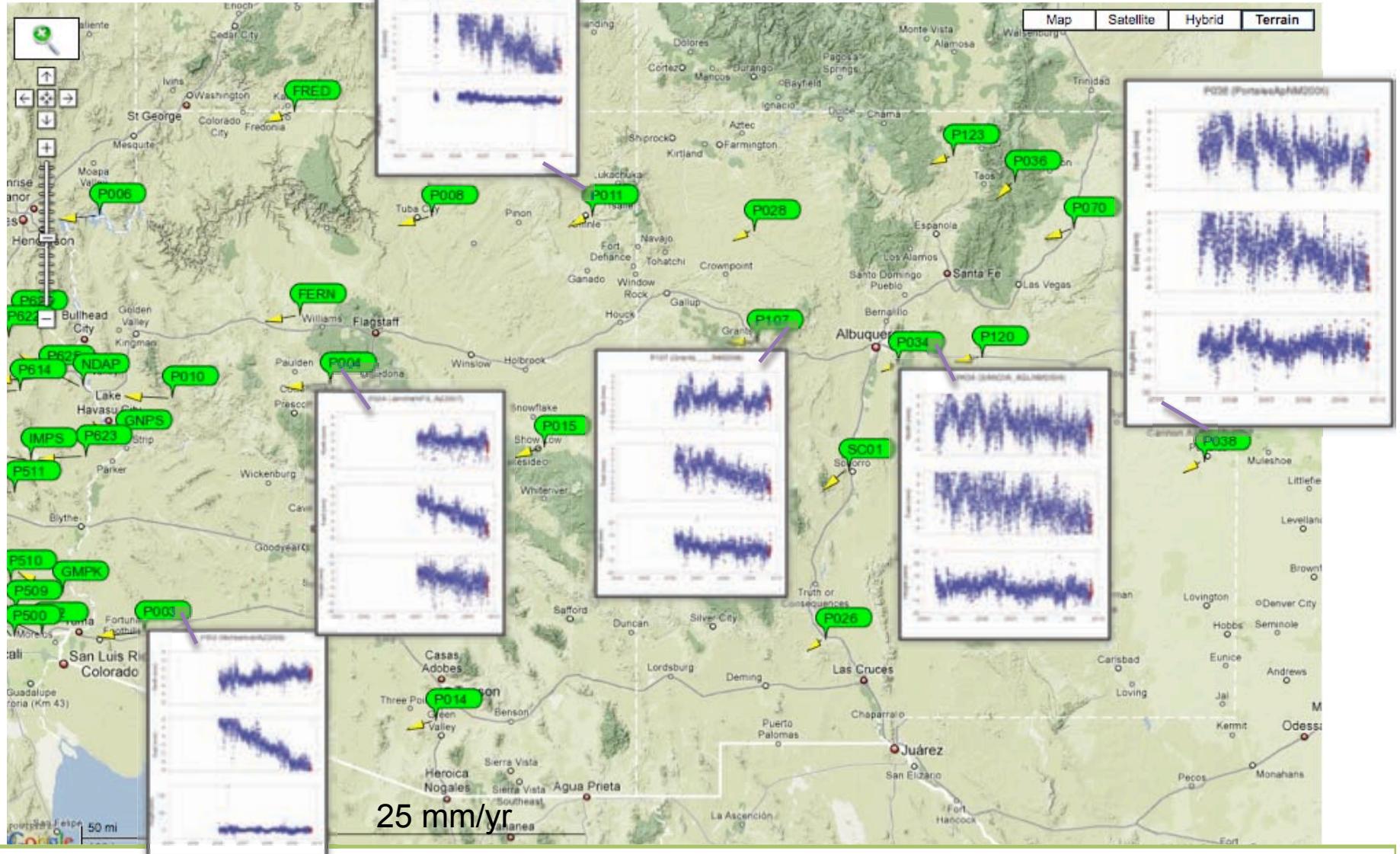


- Local Data
- Hawaii
- Mount St. Helens
- Yellowstone
- Mt. Etna
- Iceland

GPS Stations in Arizona and New Mexico

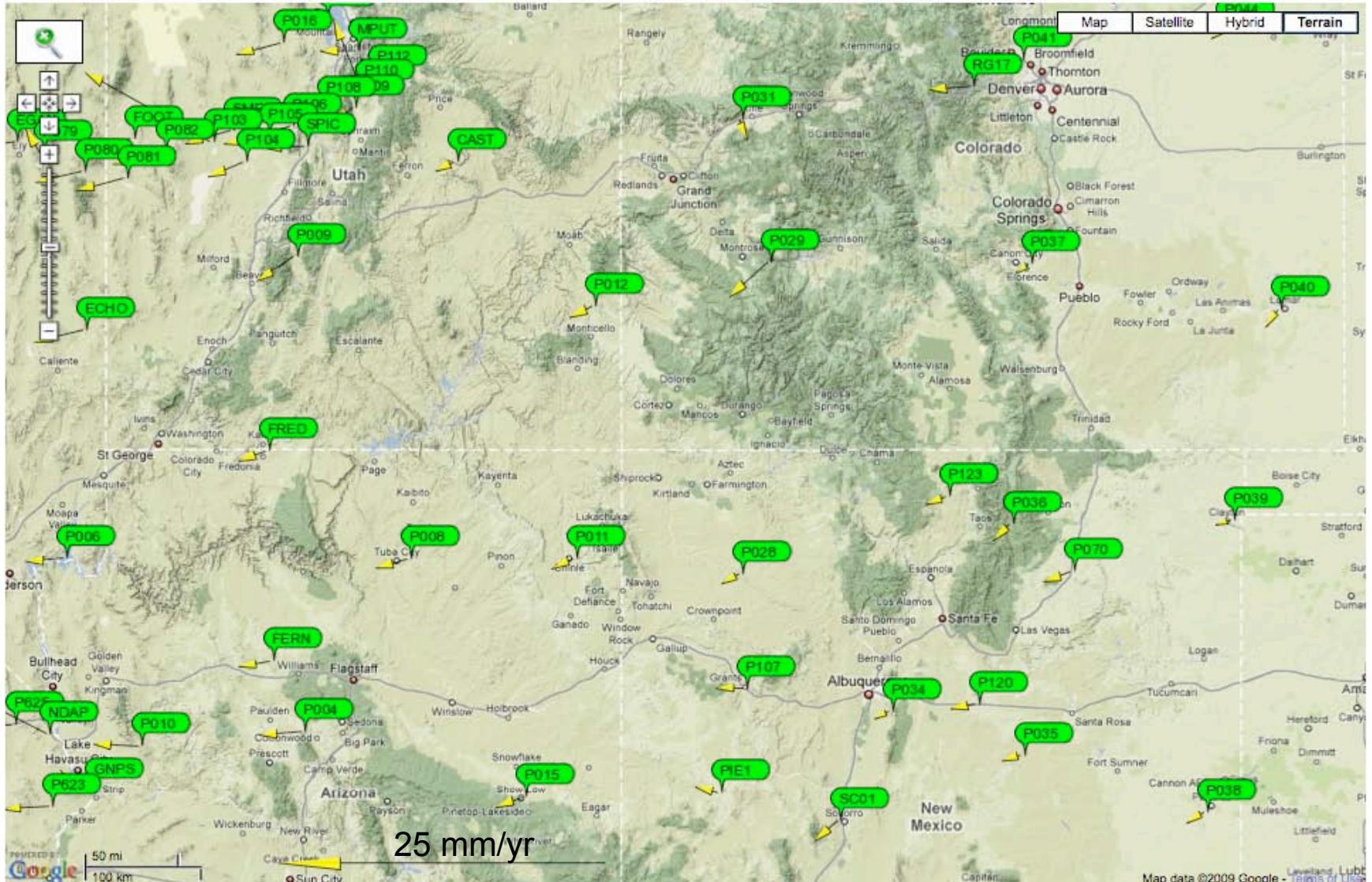


GPS Time Series Plots for a few stations



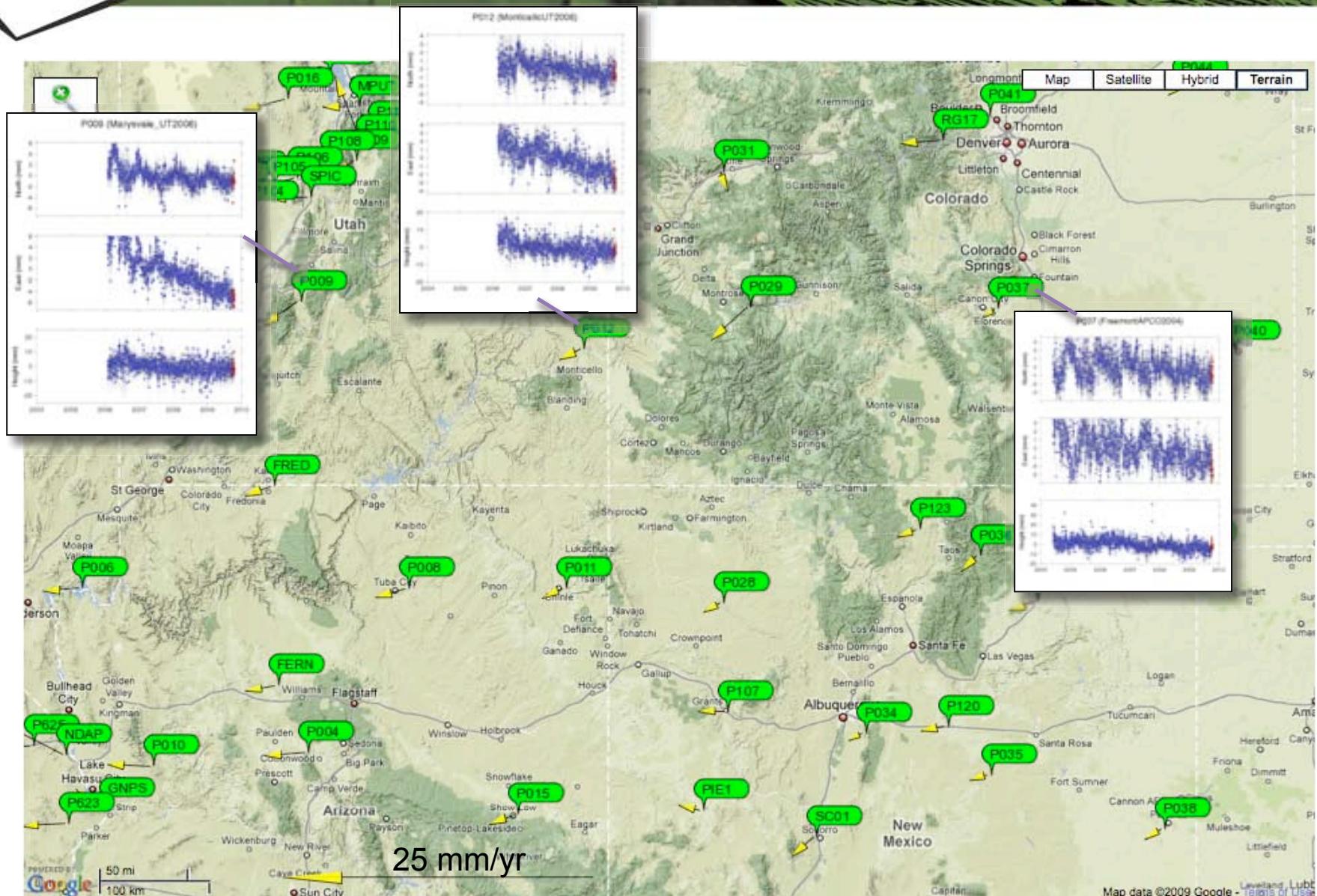
PdM nab a fi hbf vr a fi nv p p p f n s Nt fbd d

GPS Stations in Utah and Colorado



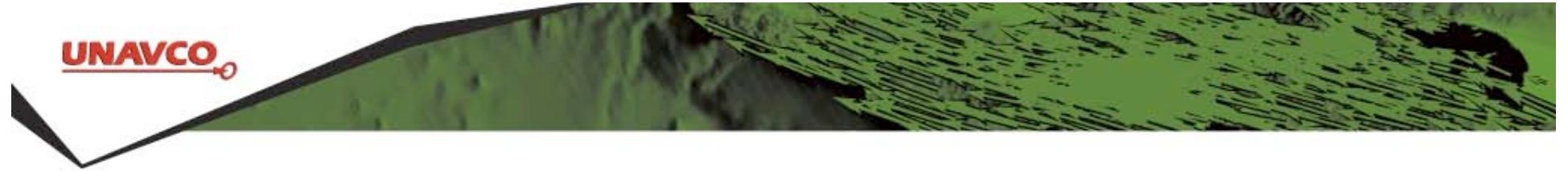
<http://geon.unavco.org/unavco/GPSVelocityViewer.php>

GPS Time Series Plots for a few stations in UT and CO



ppdM?nabafifnbnf?vr a?fi?nv? ??P?Fn?Ns? Nt ?fb?d

UNAVCO



?????????c

?nae??eM?/??H?s ?? fu

n?uw r a?fi?n bnf?

?pdMt t t b a?fi?n bnf?v

?nFnt ??? ? ? ? ? ? ha??



? ? PennState N?f