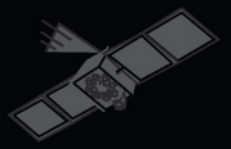


Using GPS Data to Learn about Tectonic Plate Movement, Earthquakes, Volcanoes, and Other Applications:

Ideas for Teaching

Shelley Olds
UNAVCO
February 11, 2008

URLs

- UNAVCO Data for Educators
  - http://www.unavco.org/edu_outreach/data.html
- UNAVCO Educations Resources
  - http://www.unavco.org:8080/cws/modules/
- Jules Verne Voyage map tools
  - http://www.unavco.org/edu_outreach/maptools.html
- IDV GEON
  - http://geon.unavco.org/unavco/IDV_for_GEON.html

About this presentation

- This presentation presents visualization tools and learning materials developed at UNAVCO that use GPS data to explore plate motion, Boundary zones, Transient deformation, Earthquakes and tectonics, Volcanoes and active magmatic systems, Glacial movements and isostatic adjustment, Hydrologic/seasonal changes.

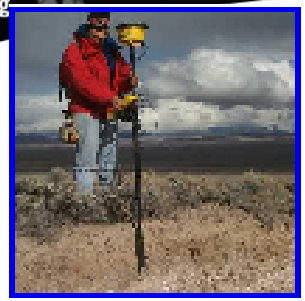
- Three main levels of interactivity are presented:
  - *Explore concepts & relationships with visualization tools: Jules Verne Voyager tools and Google Earth overlays
  - *Digging deeper: Examine evidence through data products. Data for Educators & GPS time series plots
  - * Starting at the source: Access & analyze GPS data to investigate trends. GPS data sets

What is UNAVCO

- NSF and NASA funded
- Membership-governed
- Non-profit
- Consortium

- Supports and promotes Earth science by advancing high-precision techniques (such as GPS) for the measurement and understanding of Earth deformation

UNAVCO-supported science



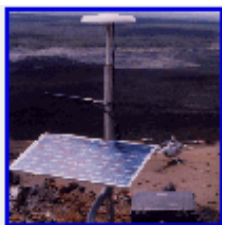

Data from GPS permanent stations to study:

- Plate tectonics
- Boundary zones
- Transient deformation
- Earthquakes and tectonics
- Volcanoes and active magmatic systems
- Glacial movements and isostatic adjustment
- Hydrologic/seasonal changes







Education and Outreach

- Mission:
  - **Promote a broader understanding of Earth science**
  - **Foster collaboration** between the scientific and educational communities
    - Faculty & Teacher-in-Residence Programs
  - **Increase the number and diversity of students**
    - RESESS

- Goal: **Broaden the use of UNAVCO data and products** by a wide audience of educational and research users.

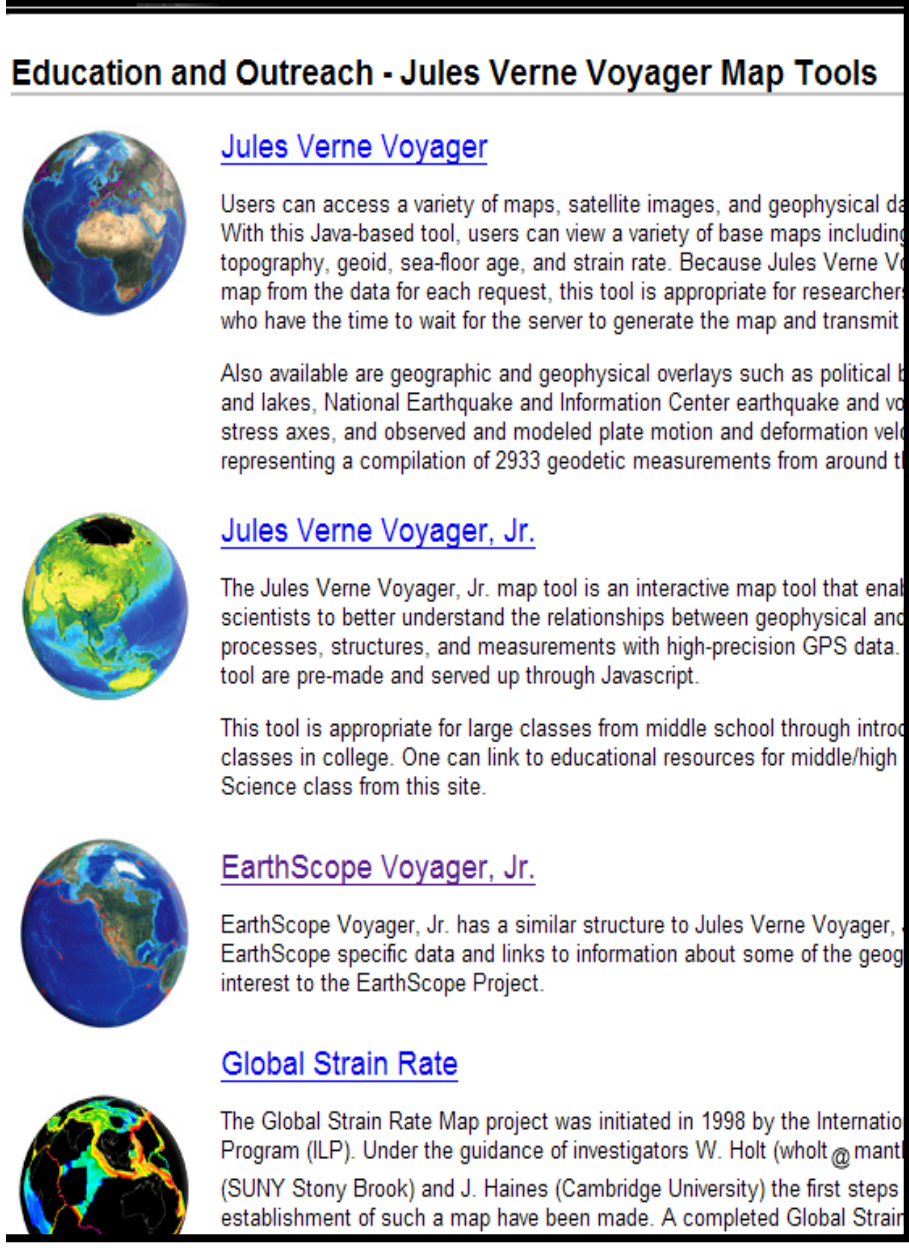
Using data and visualizations to teach

Today:

- **Explore concepts & relationships with visualization tools:** *Jules Verne Voyager tools and Google Earth overlays*
- **Digging deeper: Examine evidence through data products.** *Data for Educators & GPS time series plots*
- **Starting at the source: Access & analyze GPS data to investigate trends.** *GPS data sets*

Purpose of Jules Verne Voyager

- **To better understand Earth**
- **Provide** on-line, interactive geophysical data visualization tool
- **Develop**
  - Conceptual understandings of relationships among many complex types of data and
- **Audiences**
  - Secondary Earth Science Students
  - Secondary Teachers
  - Undergraduate non-science majors in introductory classes
  - Undergraduate geoscience majors
  - Undergraduate faculty



Education and Outreach - Jules Verne Voyager Map Tools

Jules Verne Voyager

Users can access a variety of maps, satellite images, and geophysical da
With this Java-based tool, users can view a variety of base maps including
topography, geoid, sea-floor age, and strain rate. Because Jules Verne V
map from the data for each request, this tool is appropriate for researcher
who have the time to wait for the server to generate the map and transmit

Also available are geographic and geophysical overlays such as political b
and lakes, National Earthquake and Information Center earthquake and vo
stress axes, and observed and modeled plate motion and deformation velo
representing a compilation of 2933 geodetic measurements from around t

Jules Verne Voyager, Jr.

The Jules Verne Voyager, Jr. map tool is an interactive map tool that enab
scientists to better understand the relationships between geophysical and
processes, structures, and measurements with high-precision GPS data.
tool are pre-made and served up through Javascript.

This tool is appropriate for large classes from middle school through introd
classes in college. One can link to educational resources for middle/high
Science class from this site.

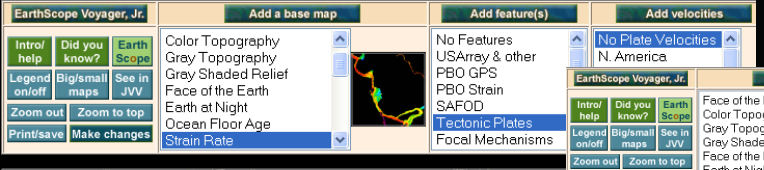
EarthScope Voyager, Jr.

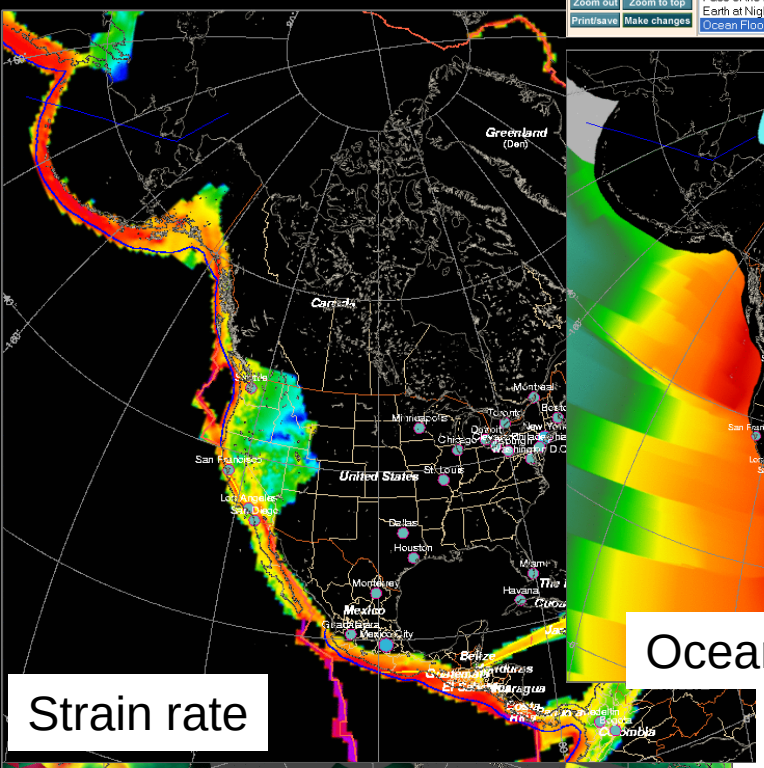
EarthScope Voyager, Jr. has a similar structure to Jules Verne Voyager,
EarthScope specific data and links to information about some of the geog
interest to the EarthScope Project.

Global Strain Rate

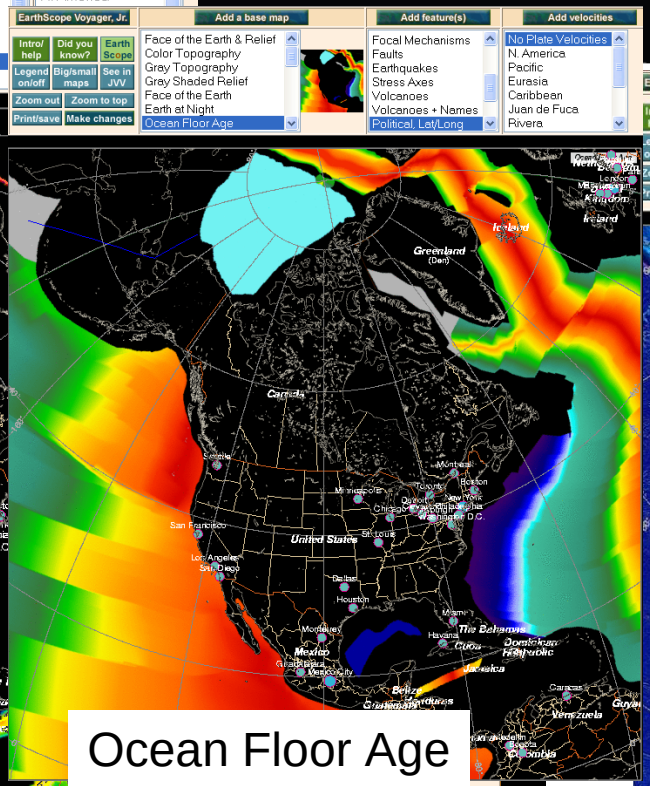
The Global Strain Rate Map project was initiated in 1998 by the Internatio
Program (ILP). Under the guidance of investigators W. Holt (wholt@mant
(SUNY Stony Brook) and J. Haines (Cambridge University) the first steps
establishment of such a map have been made. A completed Global Strain

Compare datasets



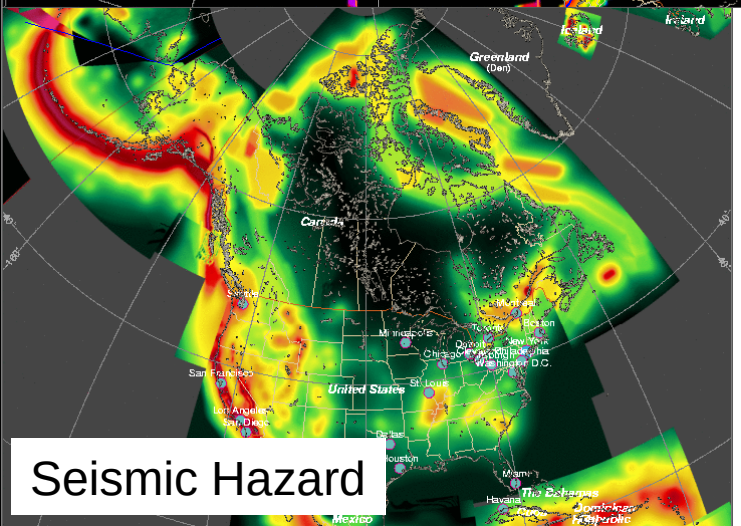


Strain rate

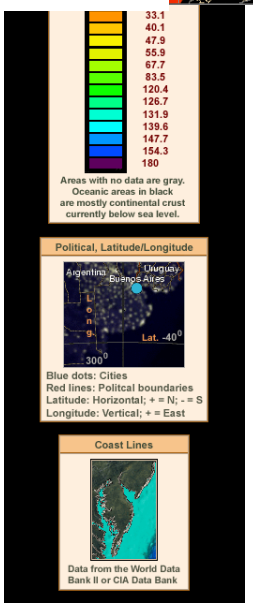


Ocean Floor Age

Face of the Earth & Relief



Seismic Hazard



Color Topography

Investigate relationships

UNAVCO
www.unavco.org

JV Voyager, Jr.

Intro / Help | To Ed. Site
Legend on / off | Big / small maps
Print / save | World map
See in JVV | Zoom out
Make changes

Select a base map

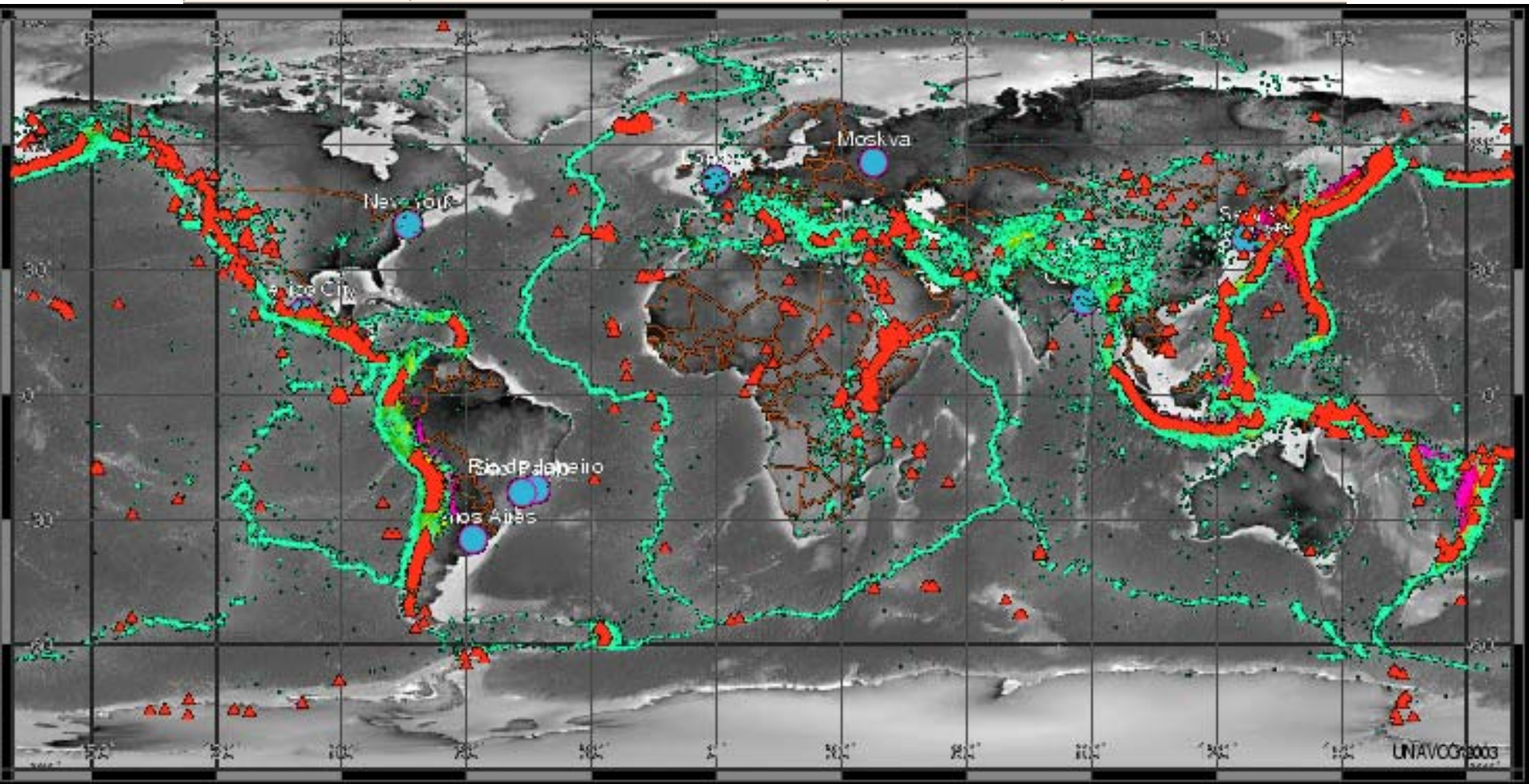
- Face of the Earth & Relief
- Color Topography
- Gray Topography
- Gray Shaded Relief
- Face of the Earth
- Earth at Night
- Ocean Floor Age

Add feature(s)

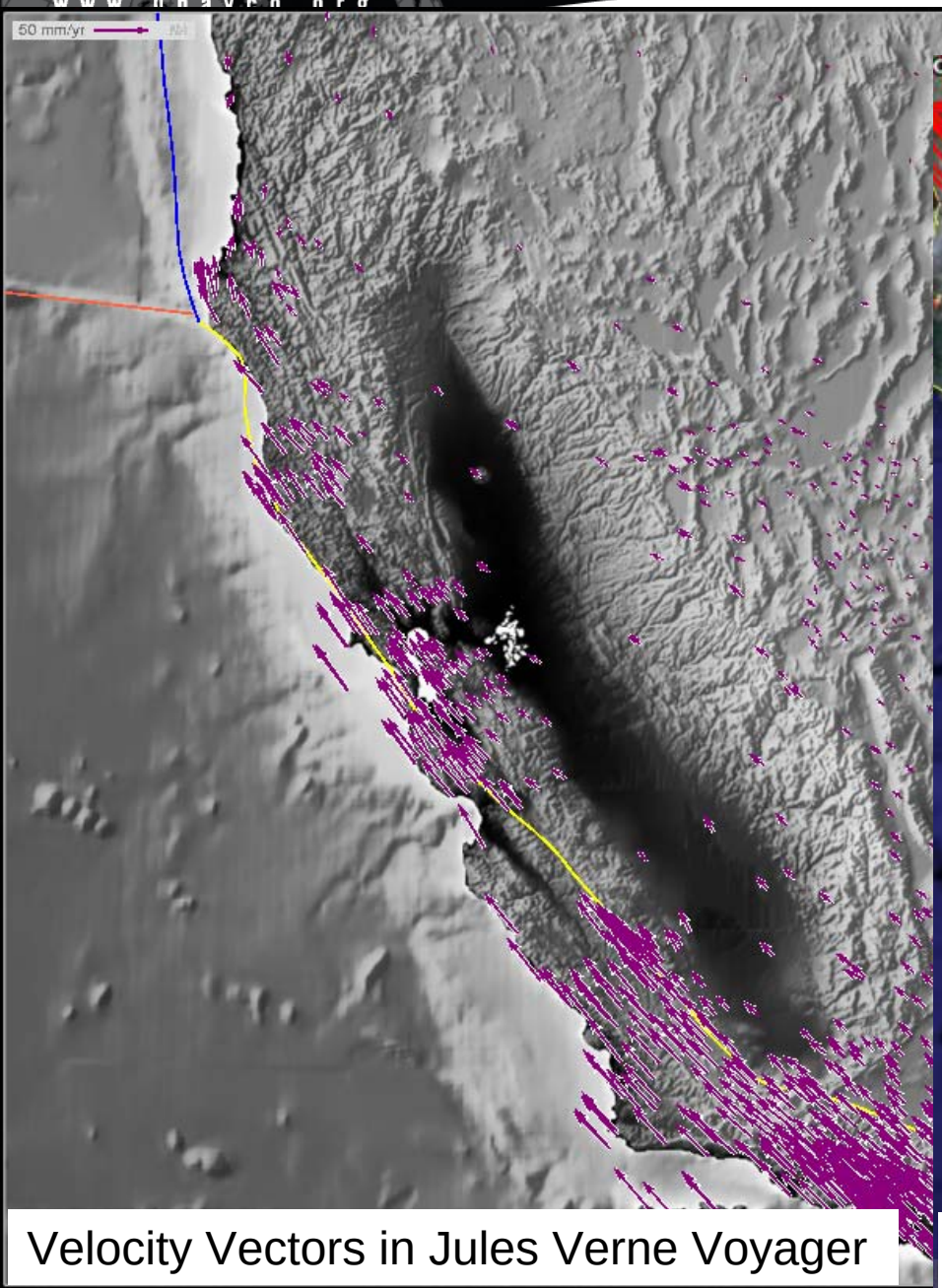
- Coast Lines
- Political, Lat/Long
- Tectonic Plates
- Focal Mechanisms
- Earthquakes
- Stress Axes
- Volcanoes

Add velocities

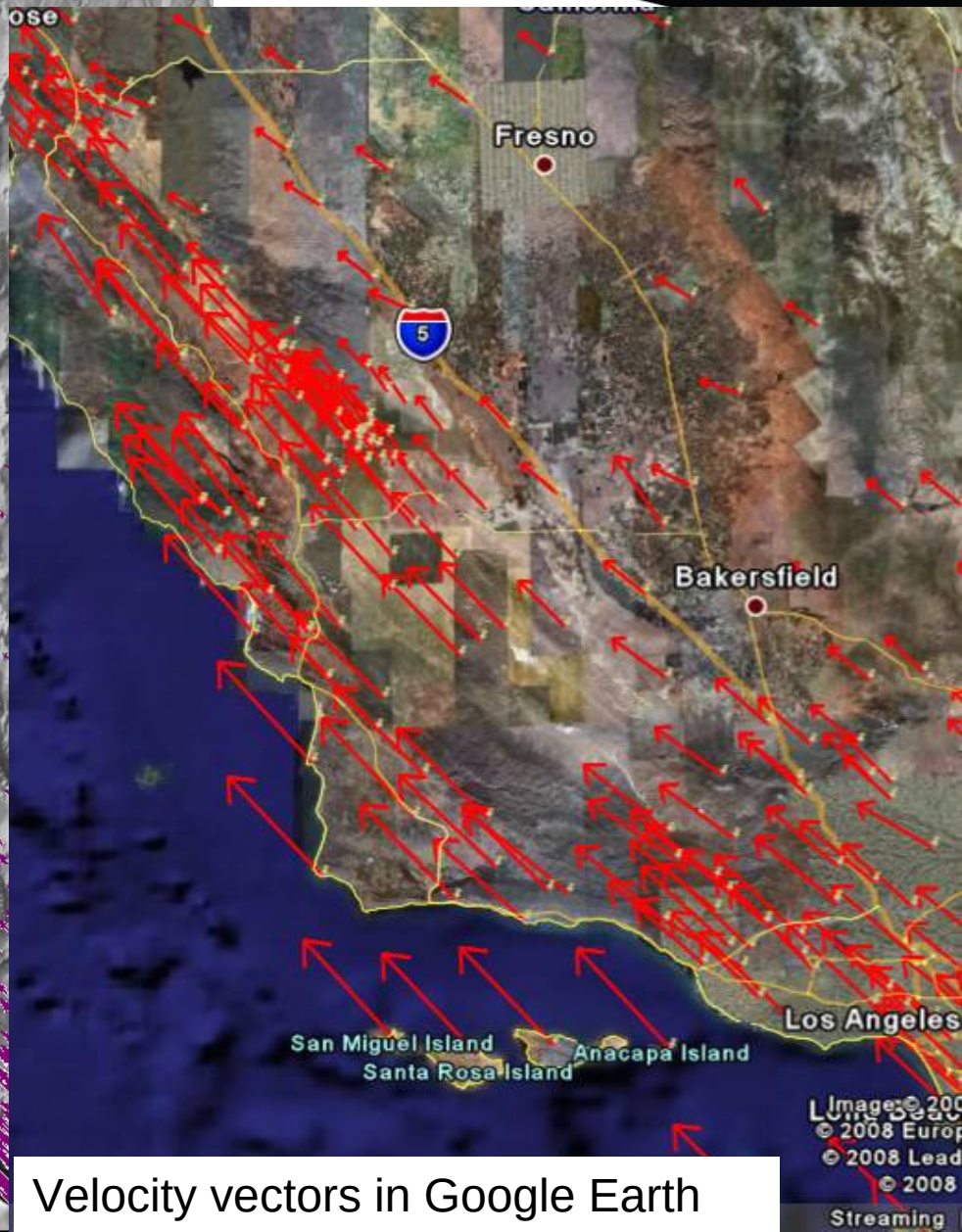
- No Plate Velocities
- No-Net-Rotation
- Amuria
- Antarctic
- Arabia
- Anatolia
- Australia



Study plate motion using GPS velocity vectors



Velocity Vectors in Jules Verne Voyager



Velocity vectors in Google Earth

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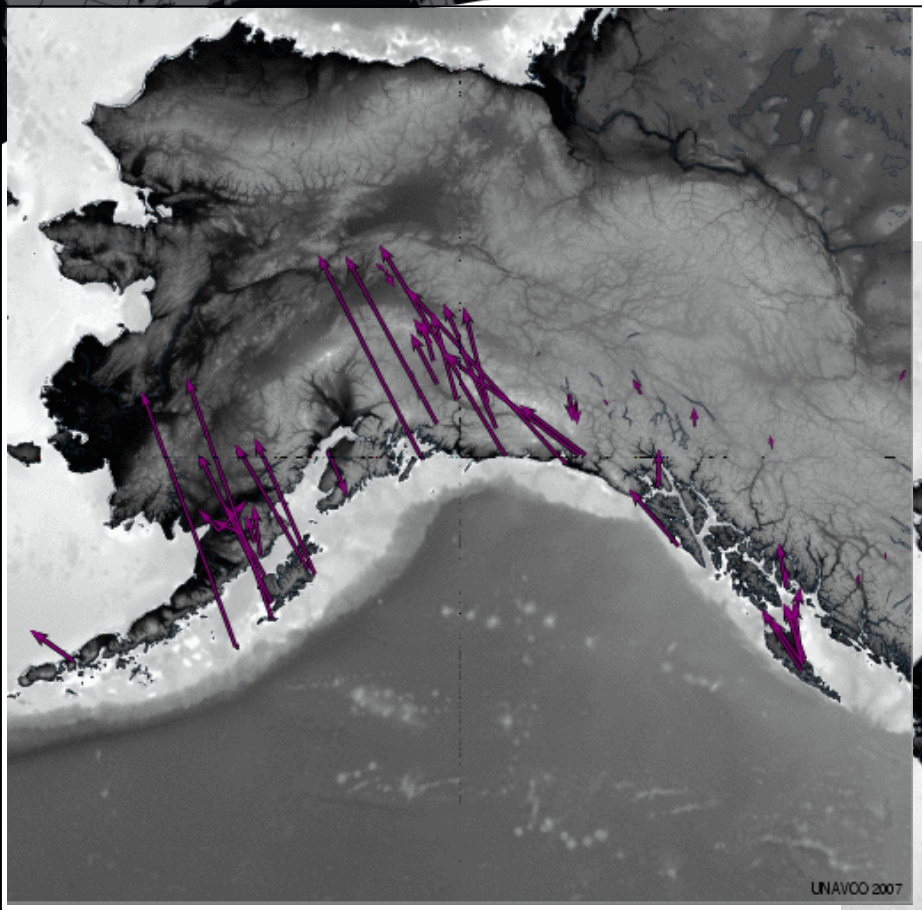
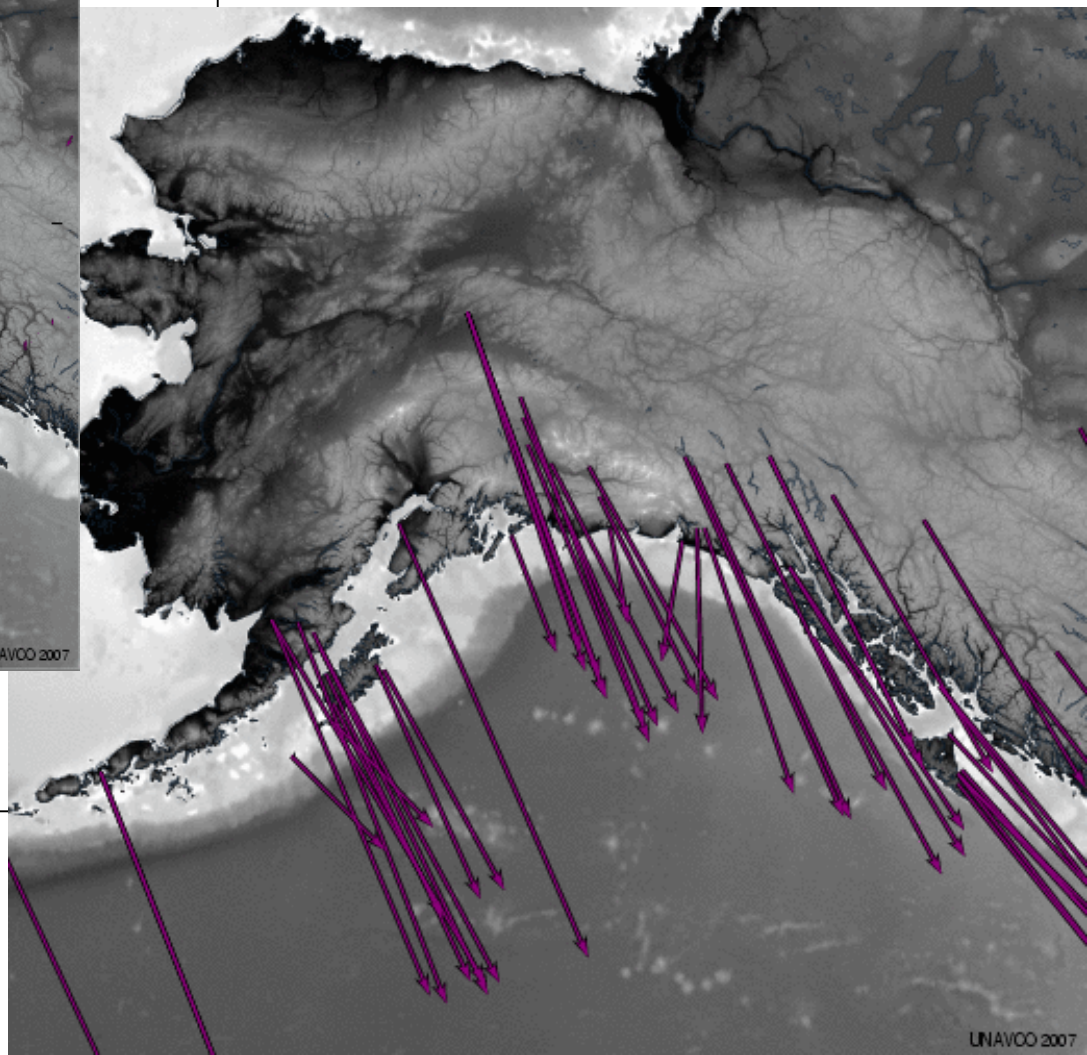
Explore Frames of Reference





UNAVCO
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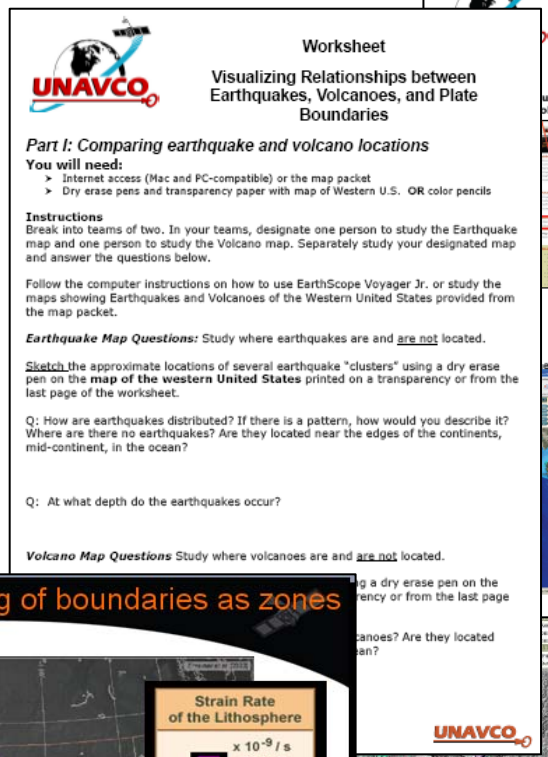
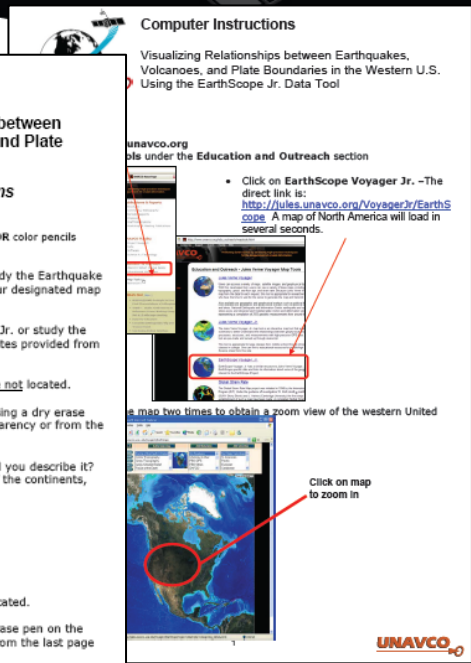
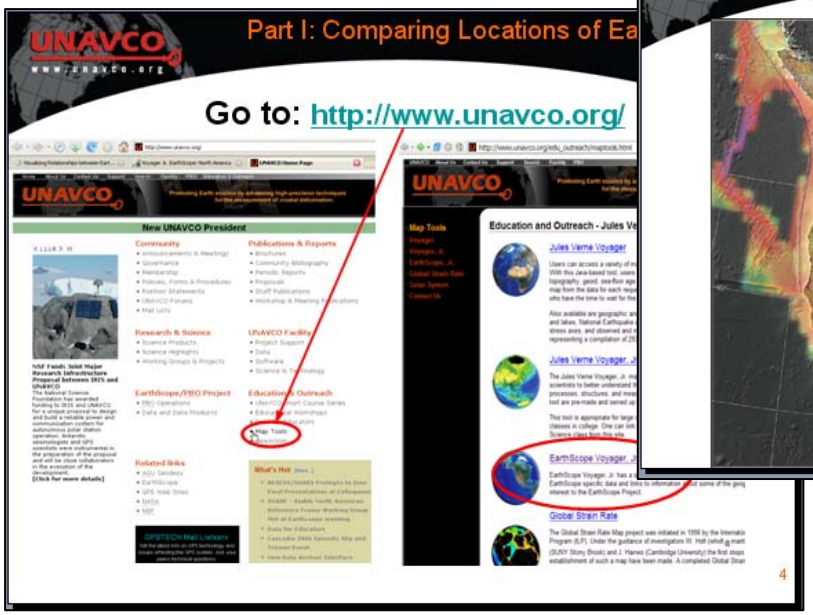
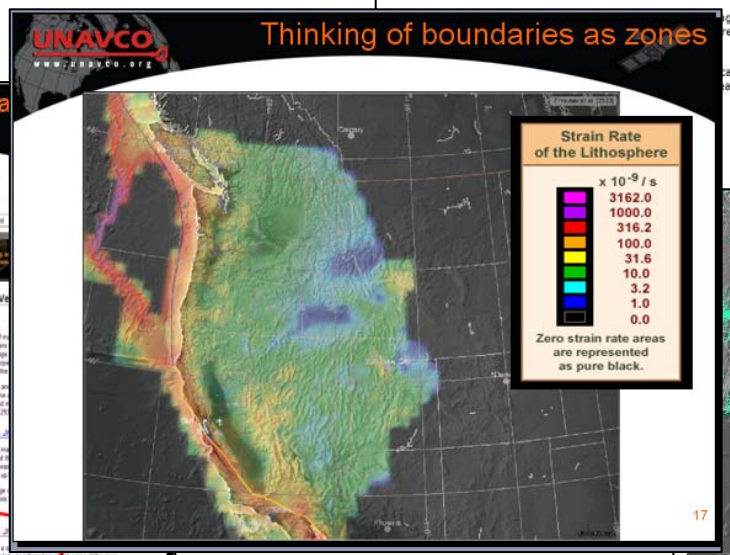
Learning Materials

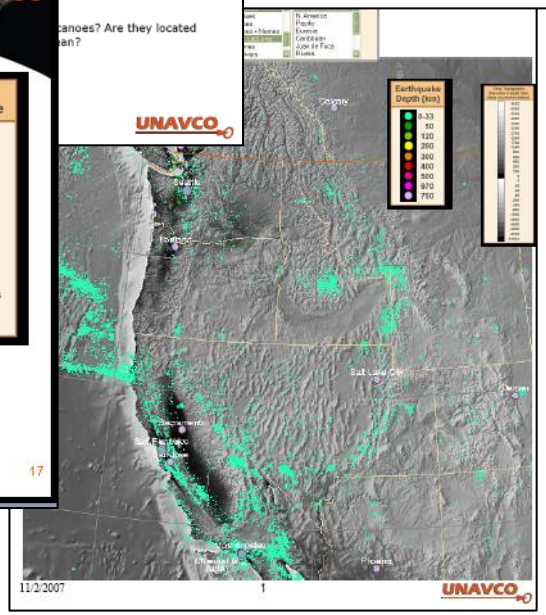
- Instructor Presentation
- Computer instructions
- Student worksheet
- Map packet











GPS data archived at UNAVCO

- Permanent GPS stations
  - Plate Boundary Observatory
  - PBO Nucleus
- Short Term, “Campaign”
- Multiple search interfaces
- Data/Data Products
  - Time Series Plots
  - Velocity Vectors
  - Data
    - Raw
    - Processed

Needs of faculty to use data

- **Single interface**, easy to figure out.
- **Interesting data** illustrating a geo-tectonic process
- Data in **Excel readable** formats
- Data with **column headings** & provenance information
- Multiple-pathways to access the data
  - **Visual display of GPS station locations**
  - **Quick previews** of time series plots of the data
  - Manageable file sizes
  - Capability to download multiple sets of data at one time *(soon)*

Data for Educators

Data For Educators

Looking for interesting data to use in your course? We've worked with educators and scientists to identify GPS stations that illustrate various Earth science processes. The data are the same quality that many scientists use in their research and is in a MS Excel readable format called CVS.

GPS data that show...

...tectonic plates moving

GPS Data Products

Station Id	Location
ALBH	Albert Head, Victoria, Canada
BEMT	Twentynine Palms, CA
NEAH	Neah Bay, WA
SBCC	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
BEMT	Twentynine Palms, CA
SBCC	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	Parkfield,, CA
CARH	Parkfield, 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
PABH	Pacific Beach, WA
P020	Lind, WA
SC03	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

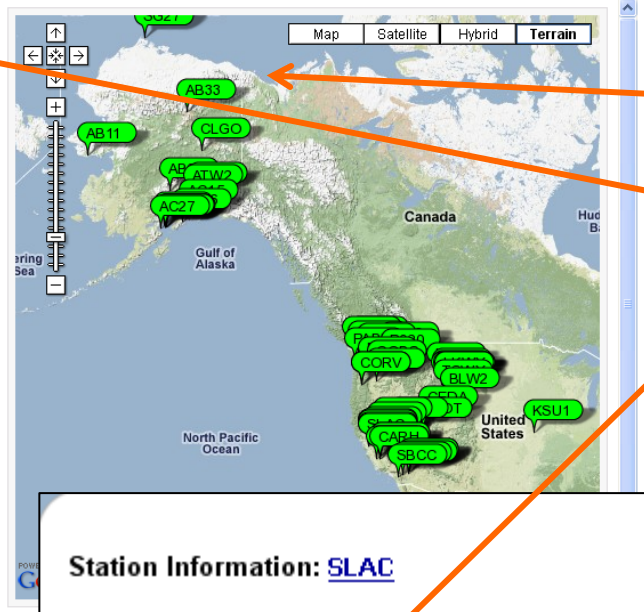
Station Id	Location
P697	St Helens, Cougar, WA

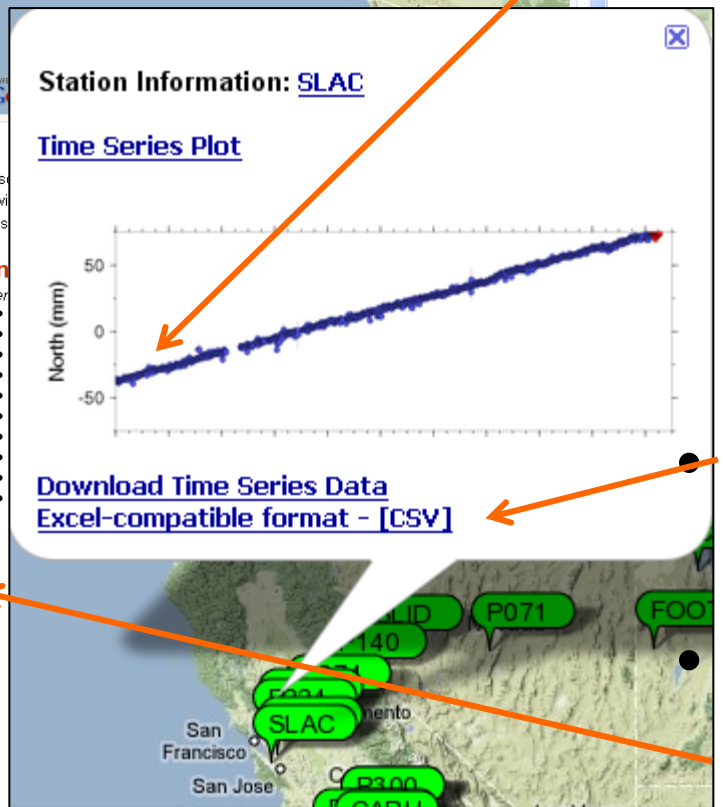
Educational resources using these stations

- *Coming soon...*

Help us make these pages better, please send us your comments and suggestions to olds @ unavco.org

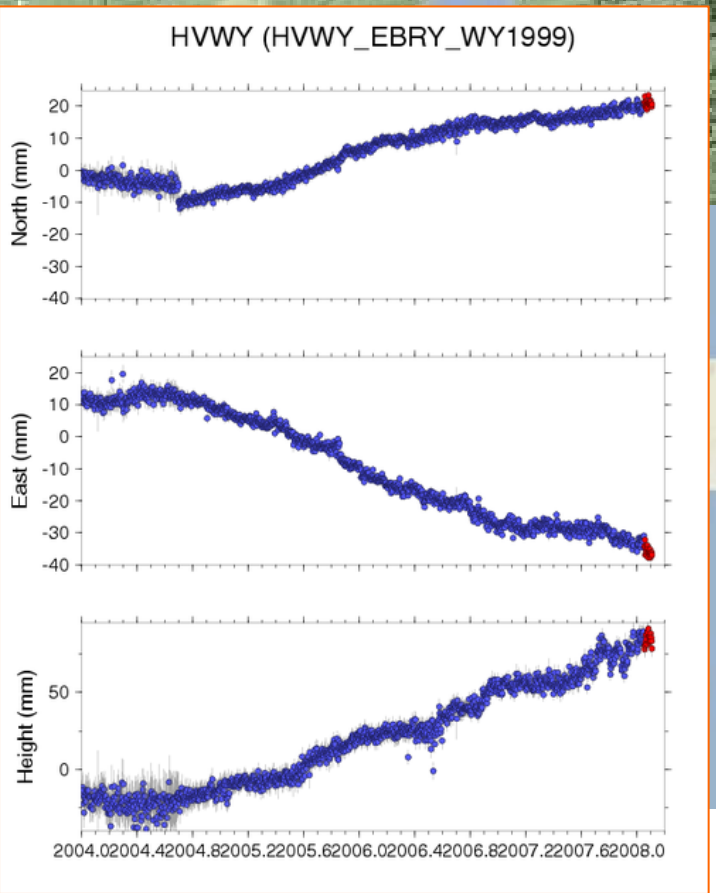
Selected GPS Stations

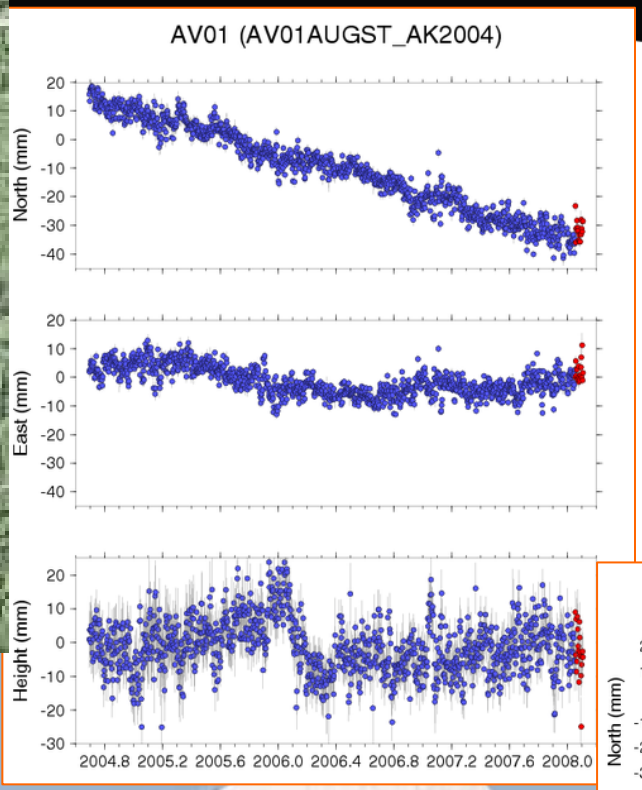


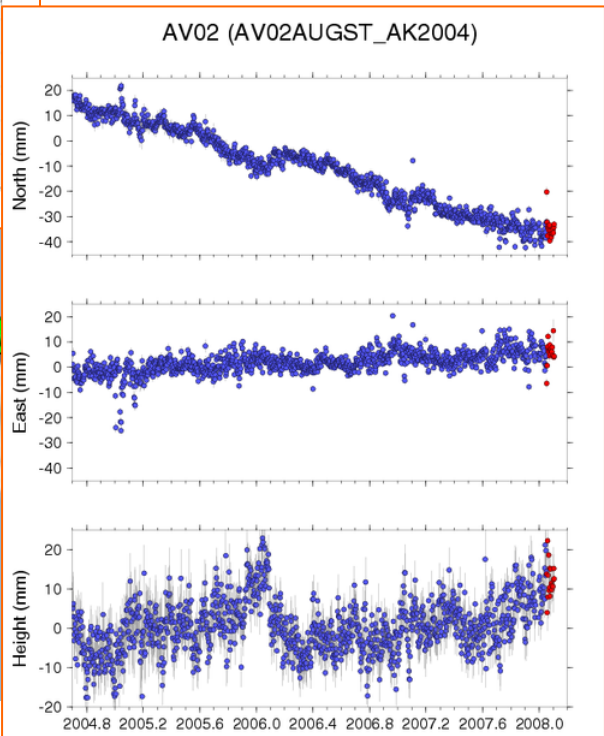


- Visual display
- Interesting data
- Quick data preview
- Excel readable formats
- Associated Activities

Student-led inquiry







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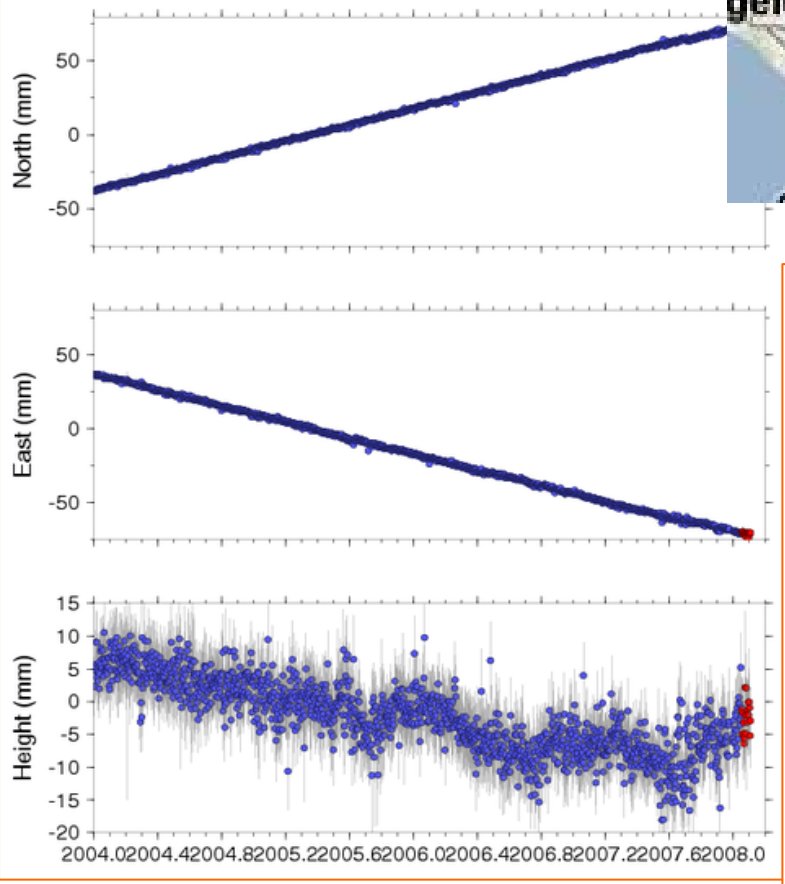
SBCC (SBCC_SCGN_CS1999)



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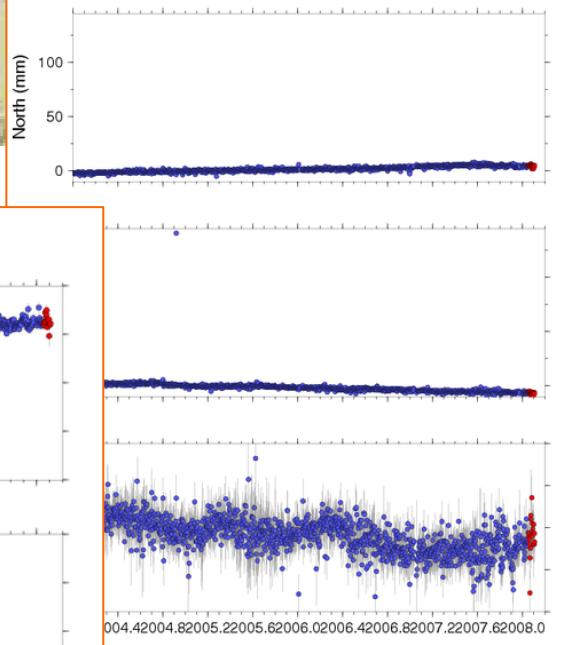
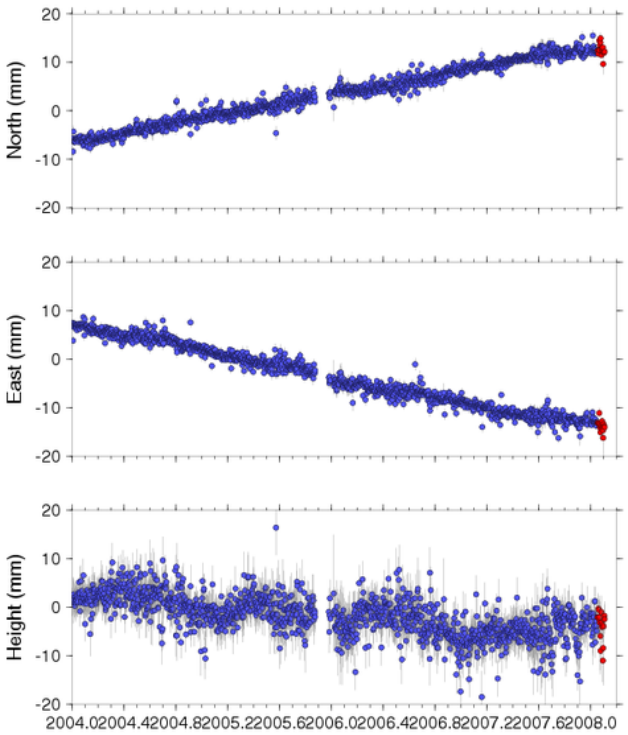
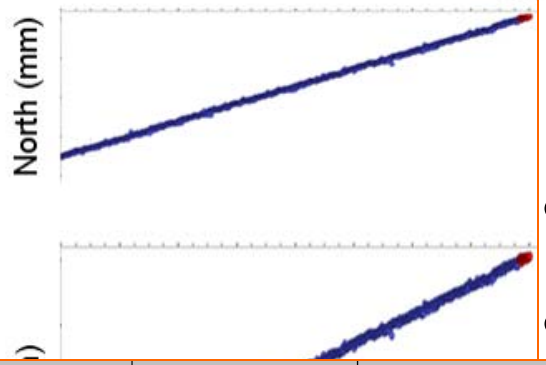


BEMT (BEMT_SCGN_CS2001)



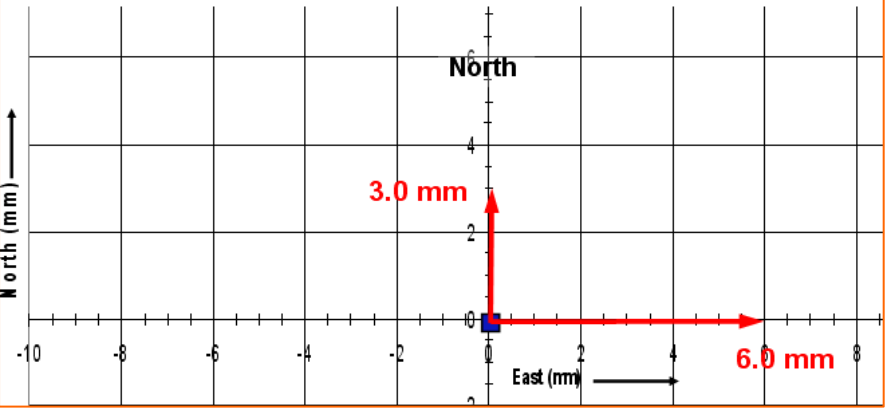
Learning Materials

- Positive slope
  - North-south time series: The station is moving **north**
  - East-west time series:



	North Position (mm)	East Position (mm)	Vertical Position (mm)
12/1/05	0	0	0.05
1/1/06	0.25	0.5	0
2/1/06	0.5	1	0
3/1/06	0.75	1.5	0.08
4/1/06	1	2	-0.02
5/1/06	1.25	2.5	0
		3	-0.03
		.5	0.1

- Station A moves
  - **3.0 mm / year to the North**
  - **6.0 mm / year to the East**



- Lecture ppts
- Student worksheet
- Computer worksheet
- How to download the data

The Future

- Data for Educators
  - Automate station information page creation
  - Find better way to indicate connection between activities and GPS Stations
  - Show complete Time Series Plots in Google Map window?
  - What would help you?

- Develop college-level specific versions – lab activity, homework, lecture-hall demonstrations, etc?
  - We want your help!
  - Faculty in residence – collaborating with our community
- JVV
- IDV