Incorporating Plate Boundary Observatory and Other EarthScope Data Products in Broader Objectives for Geoscience Education and Outreach: 2005 Activities

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Abstract

A community-based EarthScope Education and Outreach (E&O) Program Plan (2002) includes fostering the use of EarthScope data products, discoveries, and new technology to address societal needs. Collecting, manipulating and aggregating real scientific data for classroom use is also a current priority in science education. Educators particularly want their students to use these data to make conclusions, following the logical processes characteristic of the scientific endeavor. The education programs of the NSF-funded EarthScope will be designed to make data products available to a variety of audiences in formal education (students and instructors in middle/high school, community colleges, undergraduate science majors and students in general science education, graduate students) and in informal education (museums, park information centers, science centers, and media).

Part of PBO's mission is to generate, archive, and distribute a variety of high-quality geodetic data products to support EarthScope scientific research in atmospheric, space physics, and crustal deformation processes. These products will include raw and quality-checked data from 891 continuous GPS stations, up to 174 borehole strainmeters and seismometers, and five long-baseline strainmeters. While these raw data will be used directly by some researchers, PBO is also committed to produce higher-level products such as station velocities, strain time series, and the like for a user community with a wide range of technical expertise and data product requirements. Scientific applications of these higher-level products will include improved finite-fault earthquake source models, regional and local strain fields, and high-level integrated crustal deformation models.

Generating and using these higher level data products will be the responsibility of the EarthScope E&O program, EarthScope facilities (PBO, USArray, SAFOD), and the broader science and education communities. Many existing organizations, networks, and programs will help provide the synergy needed to accomplish this important task and avoid duplication of efforts. Some examples include the Digital Library for Earth System Education (DLESE), particularly the Data Services Working Group which sponsors workshops in curriculum development. Resources such as *"Using Data in Undergraduate Science Classrooms* (Manduca and Mogk, 2003) and other resources from Science Education Resource Center at Carleton College will help in the design of EarthScope data products in undergraduate classes. PBO is already working on a chapter for the Earth Exploration Toolbox (http://serc.carleton.edu/eet/) for a general undergraduate audience.

More challenging is the use of similar data products in middle and high schools. A well established and full curriculum, high stakes testing, and a general population of science teachers with little knowledge of geoscience are factors to overcome in taking EarthScope data products into secondary education. However, teachers' desire for using real data, the excitement of the EarthScope project, compelling tools for data visualization, and 'teachable moments' related to natural events are positive factors. In development are tools such as the EarthScope Voyager, interpretation in parks based on local geoscience and geological hazards (East Bay Parks, San Francisco area and Johnston Ridge Observatory, Mount St. Helens National Volcanic Monument), and workshops in which teachers will help set priorities for using PBO data products and incorporating data products into lesson plans for the 2005-2006 school year.

Lastly, providing education at the graduate and upper undergraduate levels and including diversity as a core value will ensure a robust scientific community using PBO and other EarthScope facilities. UNAVCO has scheduled two workshops for 2005, one on strainmeter data processing and the other on use of GLOBK/QOCA, to address this goal.

GPS data at Level 0 and 1 are generally used by researchers, but Level 2 and higher will be accessible and useful by a large range of audiences for both research and educational purposes.

GPS Data Products

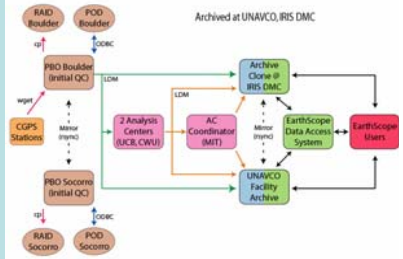
Level 0: Raw data and Metadata
- 15-sec, 24-hour BINEX files, downloaded at least daily
- 5-sps BINEX, triggered downloads
- 1-sps real-time BINEX & RTCM streams, where possible

Level 1: QC'd data and metadata
- QC'd 15-sec and 5-sps BINEX data

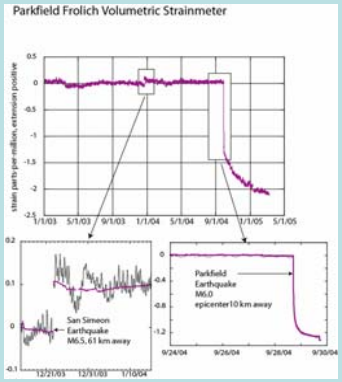
Level 2: Low-level derived products & metadata
- GPS position solutions
- Processing input and output files
- Combined position & velocity solutions
- Combined position & baseline time series
- Coseismic offsets

PBO Data as of the end of March, 2005

Preliminary station locations identified	487
Final station locations identified	346
Permits submitted	296
Permits accepted	153
Monuments installed	102
Data available	100
Routine archiving	82



Examples of Level 0 through Level 3 data for Borehole Strainmeters and their use in education



Data from the Frolich dilatometer at Parkfield
The times around the San Simeon and Parkfield earthquakes have been expanded .The top plot is "raw" data (Level 0) (artificial steps and glitches edited out – Level 1).
In the two lower plots the same "raw" data are shown and the superimposed purple line is the data with the tidal and atmospheric pressure effects removed (Level 2).

Some reasons for using scientific data in a classroom environment are to

- Develop students' ability to use scientific methods, including consideration of the values and ethics of working with data
- Prepare students to address real-world complex problems
- Teach students how to critically evaluate.....data and their consequent interpretations and conclusion, and
- Provide training in scientific, technical, quantitative, and communication skills. (Manduca and Mogk, 2003)

Specifically, even relatively esoteric data, such strain data, can provide the opportunity for:

- Identifying change
- Using spreadsheets and otherwise manipulating data
- Learning statistical analysis
- Using an Earth System approach (tidal influence on solid earth)

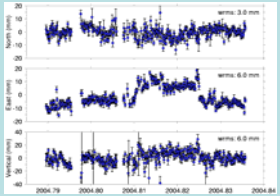
..... and you don't know much about borehole strainmeter data?

Consider attending the PBO-sponsored summer short course...see bottom, right hand box for details.

GPS data provide opportunities for data manipulation, analysis, and comparison to other spatial data

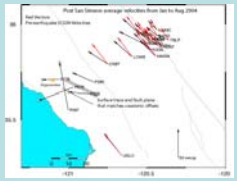
Engaging students with Earth system data

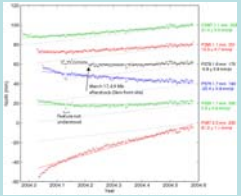
- Quantitative skills
- Visualization of data
- What are Models?



Mt. St. Helen 2004

P697 Hourly Data, Analyzed by Eric Calais, Purdue





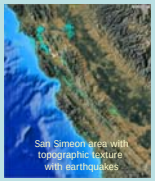
Time series of North position estimates for the San Simeon earthquake. The expected rate of the motion of all these sites is about 33.2 mm/yr (based on SCIGN estimated velocities at USLO and CRBT.
The feature lasting a few days around Feb 16, 2004 is not understood. It shows up most strongly on the three handing wall sites (P278, P576 and P526).If the PBO sites had not been installed, the only record would have been CRBT.

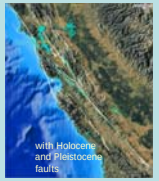
High Level Data Products for Education will include a contextual framework for data, integrating various types of data, working with visualization, and be tailored for specific audiences

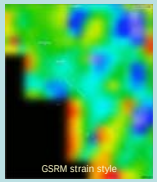
An EarthScope team will work on a chapter for the **Earth Exploration Toolbook** on using GPS data in an **undergraduate, general education classroom** (DLESE Data Workshop in April, 2005). This will be part of a topical collection on EarthScope for the Digital Library for Earth Systems Education (DLESE). IRIS and UNAVCO are partnering in E and O efforts with each other and with EarthScope to provide a coherent program of programming and products for EarthScope.

For more details on the **EarthScope Voyager** – the educational version of the Jules Verne Voyager mapping tool, visit the poster by Hamburger et al.

The **"Did You Know"** portion of the educational materials developed for the Jules Verne Voyager Map Tool is targeted at secondary school and general audience. The project team is working toward inquiry-based, student centered educational materials in support of teaching standards and EarthScope goals. More specific modules targeted at upper level geoscience majors can be modified from researchers' existing curriculum at their universities and colleges.







Tools such as the **Jules Verne Voyager** can provide multiple data sets which provide a context for students (and researchers) to compare and contrast data for making and testing hypotheses.

Short Course on using Borehole Strainmeter Data

aimed at researchers (including graduate students)
July 13-15, 2005 at UNAVCO, Boulder, CO

Strainmeters and tiltmeters
Long-term trends in data
Data formats
Tides and ocean loading
And more!

A limited number of scholarships are available.

Please contact the UNAVCO Education and Outreach Coordinator (eriksson@unavco.org) for more information on how to participate in connecting research to various educational audiences.

Other upcoming events

Short Courses on GPS data processing using GLOBK (Tom Herring from MIT) and QOCA (Danon Dong from JPL)
Times to be determined (probably fall 2006)

New York Teacher Workshop on using GPS data and visualization tools in the classroom
at Stony Brook University, August, 2005