



Building a Strategic Plan for Education and Outreach in the context of the Plate Boundary Observatory Nucleus

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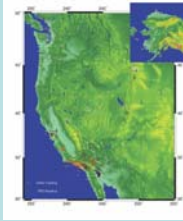


Abstract. Using authentic data in the classroom is a current priority in science education. The Plate Boundary Observatory (PBO) Nucleus consists of 6 regional GPS networks in the western United States co-administered by UNAVCO and several educational institutions. The data from these networks have led to numerous discoveries on regional and plate boundary-scale crustal deformation processes but have yet to be fully disseminated to the K-16 community. UNAVCO's E&O team is currently developing modules with real data for K-12 Earth science, undergraduate general education, and geophysics courses. We will work with inservice and preservice teachers to develop and test the modules, gain feedback, and make modifications. Building sustainable relationships among scientists, educators of appropriate levels, and UNAVCO staff will be imperative in designing and implementing these products.

Mission and program goals. UNAVCO's Education and Outreach Program mission is to promote a broader understanding of Earth science by making accessible the data, scientific methods, and results of the unique suite of scientific research in which UNAVCO's community of scientists is engaged. We will foster collaboration between the scientific and educational communities and will strive to increase the number and diversity of students to strengthen and sustain the next generation of Earth scientists.

- Goals:**
- Increase the understanding and public appreciation of geodynamics, Earth deformation processes, and their societal relevance
 - Broaden the use of UNAVCO data and products by a wide audience of educational and research users
 - Increase the diversity and broaden participation in geoscience education and research
 - Build a sustainable community of UNAVCO scientists and educators engaged in education and outreach
 - Collaborate with other organizations to provide systemic impact on geoscience education

Plate Boundary Observatory (PBO) Nucleus: integrating the 6 existing U.S. GPS networks into PBO



- Built by U. of Alaska, Berkeley, Caltech, Central Washington, U. of Utah, USC, and others (locations shown in Figure 1, right)
- \$4.4 M project to operate, maintain, upgrade, and integrate 209 stations into PBO (funded 3/05 by NSF)
- Administered by UNAVCO in cooperation with universities listed above
- Many stations located near K-12 schools, community colleges
- Station data have yielded high-profile discoveries on regional and plate boundary scales for many years

PBO Nucleus education and outreach project plan

- We plan to create resources for E&O that:
- Are based on sound pedagogical theory, research, and practice
 - Include students collecting and/or using authentic data
 - Are professionally evaluated with respect to the design process and the final products
- Project plan:**
- Produce one module each for:
 - Earth science classrooms (8th-9th grade)
 - Undergraduate general education courses
 - Geophysics courses
 - Collaborate with other organizations to integrate into existing resources (DLESE Teacher Toolboxes, IRIS, Electronic Encyclopedia of Earthquakes, etc.)
 - Solicit scientists, teachers, and UNAVCO staff to design and write modules
 - Convene workshops for testing modules and teacher professional development
 - Build an interactive website for module development, dissemination, and formation of a community of scientists and teachers working together
 - Increase awareness of resources through brochures and posters

Examples of borehole strainmeter data and their use in geoscience education

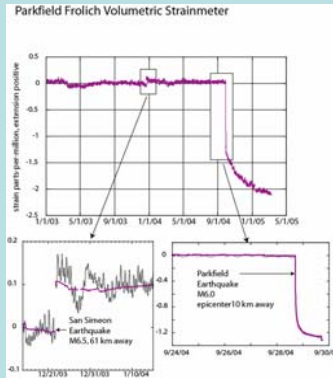


Figure 2 (above), strain data from the Frolich dilatometer, Parkfield, CA. The times around the San Simeon and Parkfield earthquakes have been expanded. The top plot shows "raw" data, with artificial steps and glitches edited out. In the lower plots, the same "raw" data are shown in addition to the superimposed purple line, which represents the data with tidal and atmospheric pressure effects removed.

Reasons for using scientific data in the classroom:

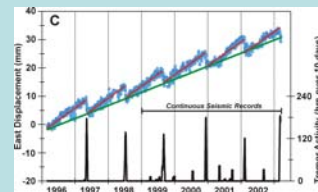
- Develop students' ability to use scientific methods, including consideration of the ethics of working with data
- Prepare students to address complex problems
- Teach students how to critically evaluate.....data and their consequent interpretations, and conclusions
- Provide training in scientific,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

Even relatively esoteric data like strain data can provide opportunities for:

- Identifying change
- Using spreadsheets and manipulating data
- Learning statistical analysis
- Using an Earth system approach (example: tidal influence on solid Earth)

Investigating tremor and slip

Tremor and slip, relatively newly recognized in the Pacific Northwest, is an example of how GPS and seismic data are used together to provide an independent method of identifying a phenomenon. The EarthScope suite of instrumentation will facilitate research on this project. GPS data provide opportunities for data manipulation, analysis, and comparison to other spatial data. Figure 3 (below, from Dragert et al., 2001) shows 6 years of seismic records and reveals a correlation between tremor activity (black data) and slip events (blue data). While tremors did occur during intervals between slips, tremor activity at those times was significantly less than during a slip event.



Potential ways in which these and other data sets may be used in the classroom:

- Awareness of the questioning nature of science:**
- Implications of cycles and periodicity
 - Based on the data, when do we expect the next event?
 - Do we see the phenomenon everywhere in space and time?
 - How would we test our hypotheses?
 - What are models?
 - How do scientists develop models?
- Building skills:**
- Quantitative reasoning
 - Visualization
 - Identifying change
 - Constraining rate and direction of movement
 - Use of spreadsheets, statistical analysis
- Integrating data:**
- Geodetic and seismic data essential
 - How does this displacement relate to plate movement seen on a map? How does it relate to where earthquakes and volcanism occur?
 - What other kind of data are necessary?

Data products for education. We plan to develop educational materials tailored to specific audiences that integrate various types of authentic data in a contextual framework.

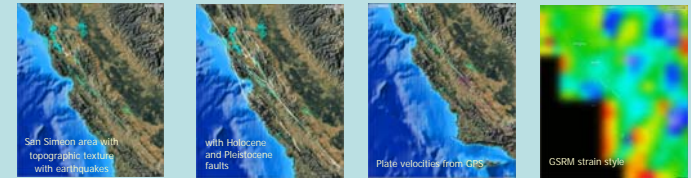
Earth Exploration Toolbox for general education undergraduate geology courses



An EarthScope team will work on a chapter for the **Earth Exploration Toolbox** (Figure 4, left) on using GPS data in a general education undergraduate classroom. This chapter will be part of an EarthScope topical collection for the Digital Library for Earth Systems Education (DLESE).

IRIS and UNAVCO are partnering in education and outreach efforts with each other and EarthScope to provide a coherent program of programming and products for EarthScope.

The Jules Verne Voyager for undergraduate geophysics courses and researchers



Tools such as the Jules Verne Voyager (Figures 5-8, above) contain multiple data sets that give students and researchers the capability to visualize spatial data, compare and contrast the data, and formulate and test hypotheses.

"Did You Know?" modules for middle school Earth science courses



Figures 9 and 10 (above): The "Did You Know?" portion of the educational materials developed for the Jules Verne Voyager Map Tool is targeted at middle school Earth science classrooms and general audiences. The project team is working toward inquiry-based, student-centered educational materials that comply with the National Science Education Standards and EarthScope goals. More specific modules targeting upper level geoscience majors can be modified from researchers' existing curriculum at their universities and colleges.

References.

- Dragert, H., Wang, K., and James, T.S. A silent slip event on the Deeper Cascadia Subduction interface. *Science*, 292, 1525-1528, DOI: 10.1126/science.1060152, 2001.
- Manduca, C.A., and Mogk, D.W., *Using Data in Undergraduate Science Classrooms*. Final Report on an interdisciplinary workshop at Carleton College, 36 p., 2003.

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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. Watch for announcements on upcoming workshops.

