An Education and Outreach Component of the Plate Boundary Observatory

Mini-Proposal to Plate Boundary Observatory Workshop

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Rationale

In this mini-proposal, we make a case for Education and Outreach as a primary component of the PBO planning process. The development of the PBO initiative provides extraordinary opportunities for advancement of a broad scientific agenda to our communities and educational system. It offers us an opportunity to stimulate interest in basic research in our schools and communities, which ultimately will help build a broad base of support for the PBO initiative itself. The goals of the PBO are relevant to topics that inspire strong public interest in science earthquake and volcano hazards, global plate tectonics, and global climate change. We must use the PBO initiative to capitalize on this broad interest and expand public awareness of natural hazard mitigation, of the value of earth science, and of the importance of scientific research in general.

In addition to its value as a tool for traditional modes of instruction, the PBO offers an opportunity to bring real scientific research into the schools, to foster interaction between a variety of scientific disciplines within schools, and to enhance interaction between the research community and educators. This comes at a time when, on a national level, educators are reassessing the goals of secondary school science education. National science standards have been promoted with a strong component of hands-on, inquiry-based learning. The PBO is a logical beneficiary of that movement.

At the same time, we contend that an E&O component is *in our interest as well.* Deployment of PBO instruments in schools and community colleges will advance the PBO research agenda by offering improved siting for PBO facilities. It can decrease the cost of deployment and maintenance of GPS instruments, and it can offer access to ancillary data that would not otherwise be available to the research community. And it can offer opportunities for extended research projects that build on the infrastructure of the PBO.

We contend that it would be an error to leave E&O as a secondary afterthought to this major science initiative. It should be an integral part of the planning process and should become one of the most effective and visible parts of the program. And it should begin now, in an effort to build a strong public consensus for advancement of the Earthscope initiative. This proposal is intended to be a provocative starting point for discussion of E&O issues related to PBO, and to lay the seeds for broader involvement and collaboration with the entire PBO community.

We divide this proposal into five principal components: (1) partnerships with other E&O efforts; (2) general E&O activities and products; (3) development of web-based materials for educational applications; (4) siting of PBO facilities at educational institutions; (5) supplemental deployment of PBO instruments at educational sites; and (6) human resource issues.

Educational Partnerships

We cannot take on such a major educational initiative in a vacuum. There is a broad array of other educational initiatives that should be linked to a PBO E&O program. Of particular importance are the E&O efforts of the related Earthscope initiative. We note, in this regard, that USArray has made E&O a very high-profile component of their initiative, including a proposed budget approaching $1M and 6-7 full-time staff. Major research organizations such as the USGS, NSF, IRIS, and SCEC already have large E&O programs, and we must seek to build on their efforts. And major new technical developments, such as the Digital Library for Earth Science Education (DLESE)[1] and GeoInformatics[2], offer opportunities for management of large data sets for educational applications. We also must seek to identify educational partners at the local and regional level, through interaction with state geological surveys, public universities, and community colleges. There are also related GPS deployments through other scientific initiatives, with whom we may be able to share facilities and data. Examples include Project GLOBE[3], ATLAS[4], and Suominet[5]. Similar educational deployments are being developed in the seismology arena as well, and we can benefit from collaborative efforts with these groups as well. Specific partnerships we envision include:

- Digital Library for Earth Science Education (DLESE)
- Southern California Earthquake Center (SCEC)
- USGS, NSF, IRIS E&O programs
- Suominet, Project GLOBE, ATLAS
- National Educational Seismograph System (NESS)[6]
- partnerships with regional agencies (e.g., state geological surveys)

General E&O Efforts

The breadth and visibility of the PBO initiative offers unique opportunities for furthering the educational mission of our scientific community. E&O efforts should be concentrated preceding and during installation of PBO sites to develop public interest and cooperation with the program. As results begin to accumulate, E&O efforts should be used to disseminate and stimulate interest in these scientific findings. Efforts should include outreach through schools and the media, participation of E&O specialists in the site identification/permitting team, discussions with regional and local scientific and educational groups to maximize coordination with those agencies; workshops for interested educators in PBO-related science; presentations at regional and national teachers' conferences; and efforts to improve linkages between researchers and educators. Examples include:

- museum-type displays of PBO-related science
- creation of PBO posters for distribution to schools
- printed materials accompanying museum display
- broadcast-quality educational videos
- press packet for media
- press conferences during deployment of PBO sites
- region-specific educational materials
- curricular modules for distribution to schools
- coordination with major TV producers (e.g., NOVA, Discovery, etc.)
- magazine/newspaper articles (Natural History, USA Today, local newspapers)

Web-based materials

The nature of the data and data products produced by PBO is particularly well suited to web-based presentation and analysis. We envision creation of a highly dynamic web site (or sites) that will provide PBO data (GPS coordinates, site velocity estimates, geodetic strain measurements, digital seismograms, etc.) in near-real time and in a form that teachers and students can comprehend. Such data should be combined with rigorous curricular materials that can enhance opportunities for schools to integrate these data directly into teaching programs. Such web-based tools will benefit not only educators, but will foster easier access to PBO and related data through high-quality web-based tools. Such programs may include:

- integration of PBO data products with other geophysical data, using web-based interactive GIS programs[7]
- user-friendly modules for accessing PBO data and models (GPSVEL/Strain)[8]
- web-based curriculum materials and exercises for K-12 applications
- web-conferencing tools for communication between schools and between schools and researchers
- user-friendly web-based tools for processing DGPS and geodetic-precision GPS measurements (see below)

Siting of PBO Instruments

We contend that where possible, priority should be given to siting of PBO instruments at or near schools and higher education institutions. We believe that it will provide a number of important advantages over deployment in remote areas. First, it would provide a site with some degree of security and local technical support. Second, schools tend to have grounds with broad open areas with maximum sky visibility. Third, because most schools now have internet connections, it would provide a low-cost access to power and data communications for PBO instruments. Fourth, the availability of a PBO "base station" may provide enhanced technical opportunities for schools and communities to access high precision DGPS and RTK surveying. Finally, such deployments play a major role in enhancing local support for the PBO effort. Students and teachers would have a sense of "ownership" over PBO measurements, which would certainly enhance schools interest in participation in the PBO initiative.

Supplemental Deployment of PBO instruments

In addition to providing possible sites for the primary PBO instruments, we propose that a primary component of the PBO effort should include efforts to disseminate GPS and other PBO-related instruments among schools throughout the PBO study area. This offers opportunities for collection of significantly broader collections of data than would otherwise be possible with PBO instruments alone. Such efforts could include:

- siting of supplemental continuous GPS instruments on/near school property, with less stringent monumentation requirements, but with high data communications rates for atmospheric applications (e.g., Suominet deployments)
- broad distribution of low-cost hand-held GPS instruments to schools, with accompanying discipline-specific curricular modules (biology, earth science, environmental science, etc.)
- provision of relatively low-cost single-frequency carrier-phase receivers for high-precision surveying applications

- involvement of school groups in supplemental campaign-based densification of GPS measurements surrounding PBO stations
- enhancement of user-friendly tools providing access to high-precision data processing from both DGPS and carrier-phase point positioning.

Human Resource Issues

A major initiative like the PBO provides unusual opportunities to extend educational linkages across a broad spectrum of our community. This includes linkages across disciplines, across educational levels, and across geographic, economic, and cultural barriers. We propose to develop programs to enhance such linkages by providing:

- Interaction between university-based researchers, teaching college faculty, and K-12 teachers
- support for in-service workshops for teachers
- support for teacher-researchers as "PBO Fellows" at participating universities
- contacts with local surveying community, both as educational collaborators
- involvement of Research Experience for Undergraduates
- emphasis on underrepresented groups and 'at-risk' students

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[1] The Digital Library for Earth Science Information, or DLESE, is a major new initiative of the NSF Geoscience Education program. DLESE is conceived as an information system dedicated to the collection, enhancement, and distribution of materials that facilitate learning about the Earth system at all educational levels. The DLESE Program Center (at UCAR) provides support to the emerging national digital library agenda. DLESE offers services in the development and maintenance of the technical infrastructure of the library, and in the coordination of the community efforts required to produce, share, and assess on-line inquiry-based earth system instructional materials. DLESE will provide access to high-quality educational materials; Earth system data sets, interfaces and tools to use these data; and communication networks linking all interests in Earth system education. Additional information about the DLESE initiative can be located at http://www.dlese.org/index.html.

[2] GeoInformatics is a new initiative that seeks to use new information technologies to create a comprehensive national program for earth sciences research with participation from universities, government agencies, and private industry. The ultimate goal is a fully integrated data system populated with high-quality, freely available data, as well as a robust set of software to analyze and interpret the data. This system is envisioned to benefit education as well basis scientific research. The data system would complement and contribute to the Digital Library for Earth Science Education described above. (see http://kokkik.la.asu.edu/geoinformatics/White_Paper_for_Geoinformatics.htm)

[3] Global Learning and Observations to Benefit the Environment (GLOBE) (http://www.globe.gov) is an international program that involves K-12 students in making scientific observations and reporting their data to the GLOBE Data Archive for use in research. This creates a worldwide network of students, teachers, and scientists working together to study and understand the global environment. GLOBE students make environmental observations at or near their schools and report their data through the Internet. Scientists in turn use GLOBE data in their research and provide feedback to the students to enrich their science education. Global images based on GLOBE student data are displayed on the World Wide Web, enabling students and researchers to visualize the student environmental observations. UNAVCO has been supporting this effort by sending hand-held GPS receivers to the teacher training workshops and to the schools so that the students can accurately locate their study areas (see http://www.unavco.ucar.edu/network/globeweb/globeweb.html). Since GLOBE began in 1995,

UNAVCO has shipped over 1000 receivers to schools across the country and the world. Additionally, UNAVCO's receivers have trained teachers in over 6000 schools and 70 countries worldwide.

[4] Another E&O program utilizing GPS is Project ATLAS (Assisted Transnational Learning using Artificial Satellites), a multidisciplinary, international educational outreach project aimed at school children in the age range of 12 14 years. At the core of the ATLAS project are a pair of cooperative, international scientific experiments through which student participants from around the world employ satellite and Internet technologies to learn about the world in which they live. More information on this project can be found at: http://cfa-www.harvard.edu/space_geodesy/ATLAS/.

[5] SUOMINET (http://www.unidata.ucar.edu/suominet/) is an effort by the university atmospheric community to establish a network of GPS receivers to be located at universities and other locations to provide real-time atmospheric precipitable vapor measurements and other geodetic and meteorological information. Whereas geodetic GPS measurements typically take years of time to produce, processing in real-time for atmospheric purposes (see example at http://www.gst.ucar.edu/gpsrg/realtime.html) provides continually changing results as weather phenomena occur.

[6] The National Educational Seismograph System (NESS) is a newly developing confederation of educational deployments of seismograph stations in secondary schools. This growing effort includes national programs such as the Princeton Earth Physics Project (PEPP), the Public Seismic Network (PSN), and regional deployments such as "Michseis" and the South Carolina Earth Physics Project (SCEPP). Efforts are underway to coordinate these programs into a national confederation of participating educational institutions. Together, they provide a broad array of data, software tools, and curricular materials that can benefit our program.

[7] Geographical Information Systems (GIS) applications provide a powerful means for displaying and interacting with map-based information. In spite of the fact that much of geological and geophysical research is inherently map-based, GIS has had limited use in the earth sciences. The overhead in utilizing GIS and converting data to GIS formats, the lack of precise, consistent coordinates, and the difficulty in presenting GIS on the web has prevented widespread use of GIS. As GIS applications are becoming more user-friendly, tools can be written to simplify data conversion and entry for geological and geophysical data. GPS is providing a readily accessible common coordinate framework for precise coordinates, and new GIS web applications are becoming practical. An example of interactive mapping using GIS on the web with and emphasis on geologic and geophysical data and educations outreach can be found at: http://atlas.geo.cornell.edu . A tool to provide interactive mapping built on the widely used Generic Mapping Tool (GMT), Perl and Java, can be found at: http://jules.unavco.ucar.edu/. This site presents GPS sites, vectors and strain results in addition to a number of other global geophysical data.

[8] The Global Velocity Synthesis Working Group (GPSVEL) is a fledgling effort initiated by the UNAVCO community to rigorously synthesize velocity vectors from the hundreds of GPS campaigns that have been conducted, and many permanent networks that are in operation, into a consistent global reference frame. The products developed in this effort, as well as seismic moment tensor data and Quaternary fault slip rates, will contribute to the Global Strain Rate Map project, sponsored by the International Lithosphere Program (ILP). The completed velocity and strain rate map projects will provide a large amount of new information on continental dynamics and quantification of seismic hazards and provide rich data sets of understandable and of interest to the general public. The PBO will large contributor to the GPSVEL and techniques being developed for GPSVEL and the Global Strain Rate Map for processing, analysis and visualization can be applied to PBO E&O activities. (More info at: http://www.unavco.ucar.edu/science_tech/crustal_motion/)