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Sabino Canyon near Tucson, Arizona draws over 1 million visits per year. The centerpiece of the canyon is Sabino Creek, an ephemeral stream fed by seasonal snowmelt and monsoon rains. Frequently asked questions by canyon visitors include: How can a stream flow in the desert environment? Why are the surrounding mountaintops so much cooler and wetter? How can the stream flow without recent rain or snowmelt? Where does the water go?

The NSF STC for Sustainability of semi-Arid Hydrology and Riparian Areas (SAHRA) has partnered with the USGS and the USDA Forest Service to develop static displays and a touch-screen electronic kiosk for the Sabino Canyon Visitors Center that explain what streamflow is, where the waters of Sabino Creek originate, where they go, what conditions produce flash flooding, and the hydrology of sky island environments. The kiosk, and an associated Web site, also give current weather and streamflow conditions at various points in the canyon, plus typical and extreme conditions for the current date.

Designing displays that attract and inform a diverse mix of visitors with varying levels of interest, reading levels, and attention spans is a major challenge. We have integrated static displays featuring light boxes with a touch-screen kiosk featuring graphics, animation, video, sound effects, and voice-overs. Optional sub-titles are in five languages. The goal is to attract visitors to the display and then meet their various interests and information needs.

Hydrology is a foreign subject to the great majority of people, and opportunities to informally educate them are relatively scarce. This presentation will show how current multimedia technology can be combined with proven methods of informal experiential education to communicate some basic hydrologic principles.

URL: <http://www.sahra.arizona.edu/sabinocanyon>

ED61B-0028 0830h POSTER

Communicating Pacific Rim Risk: A GIS Analysis of Hazard, Vulnerability, Population, and Infrastructure

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Exploding population and unprecedented urban development within the last century helped fuel an increase in the severity of natural disasters. Not only has the world become more populated, but people, information and commodities now travel greater distances to service larger concentrations of people. While many of the earth's natural hazards remain relatively constant, understanding the risk to increasingly interconnected and large populations requires an expanded analysis.

To improve mitigation planning we propose a model that is accessible to planners and implemented with public domain data and industry standard GIS software. The model comprises 1) the potential impact of five significant natural hazards: earthquake, flood, tropical storm, tsunami and volcanic eruption assessed by a comparative index of risk, 2) population density, 3) infrastructure distribution represented by a proxy, 4) the vulnerability of the elements at risk (population density and infrastructure distribution) and 5) the connections and dependencies of our increasingly 'globalized' world, portrayed by a relative linkage index.

We depict this model with the equation, Risk = f(H, E, V, I)

Where H is an index normalizing the impact of five major categories of natural hazards; E is one element at risk, population or infrastructure; V is a measure of the vulnerability for of the elements at risk; and I pertains to a measure of interconnectivity of the elements at risk as a result of economic and social globalization. We propose that future risk analysis include the variable I to better define and quantify risk.

Each assessment reflects different repercussions from natural disasters: losses of life or economic activity. Because population and infrastructure are distributed heterogeneously across the Pacific region, two contrasting representations of risk emerge from this study.

ED61B-0029 0830h POSTER

Mapping Natural Disasters: Inquiry at its Best

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Mapping natural disasters utilizing GIS technology is a unique tool for learning earth science. Aided by this visualization enhancer, students can better associate disasters locations and magnitudes to the underlying natural forces that generate them. Furthermore, the extent of the damage can be tied to a combination of physical and social parameters and thus can be used to integrate earth science with other disciplines, such as statistics, health and social sciences. All these associations can be applied to real life situations that make the student investigations more authentic, while they help in their understanding the complexity of real-world phenomena.

Examples of inquiry-based activities (e.g., volcanoes, hurricanes, earthquakes, floods) and special projects ranging from middle school to college level are included. Inquiry is integrated to every aspect of the study of natural disasters: Natural disasters form a collection of periodic but unpredictable events, while predicting natural disasters offers a very productive path for student inquiry as they investigate the evolution of monitoring and warning equipment. An additional advantage is that the monitoring and reporting of these events in a timely and comprehensive manner are now accessible from Internet sites.

ED61B-0030 0830h POSTER

Cooperative Public Outreach - It can be Accomplished

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The U.S. Department of Agriculture, Forest Service (Santa Catalina Ranger District of the Coronado National Forest), the U.S. Geological Survey (Water Resources Discipline, Arizona District), and the National Science Foundation sponsored Science and Technology Center (Sustainability of semi-Arid Hydrology and Riparian Areas) have created a series of exhibits on the hydrology of Sabino Creek, an ephemeral stream within the Sonoran Desert (USA) visited by over 1 million people annually. A clear set of educational objectives established at the beginning of the process and interagency cooperation resulted in a cohesive grouping of exhibits while minimizing single agency dominance. The multimedia exhibits are a collection of visual displays along with a touch-screen kiosk that has animations and other links that expand along many avenues to educate people on ephemeral streams, sky islands, siltation, and ground-water recharge within the Sonoran Desert. In addition, the exhibit incorporates real-time climate and streamflow data collected by four science agencies. The real-time data incorporated into the kiosk and linking web page is used to educate visitors about the natural environment within Sabino Canyon and inform them about flash-flooding and fire dangers. Thus, before entering the canyon, a visitor can view the exhibit and readily determine the air and water temperature, stream activity, and several other current and historical environmental variables. In summary, the cooperative efforts between the agencies resulted in a series of exhibits that are far more beneficial to the public than if the efforts had been attempted separately.

ED61C MCC: Hall D Saturday 0830h

Teaching the Teachers: What Have We (They) Learned? I Posters (joint with OS, GC, PA)

Presiding: J Thieman, NASA Goddard Space Flight Center; S Stockman, Science Systems and Applications, Inc.; F Ireton, Science Systems and Applications, Inc.

ED61C-0031 0830h POSTER

REVEL* sails in a new direction. (* Research and Education: Volcanoes, Exploration and Life)

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The REVEL Project started as an education and outreach program designed to integrate elementary to high school science teachers into fully-funded research cruises that study the full spectrum of processes associated with submarine volcanoes. Since its inception at the University of Washington in 1996, REVEL provided 47 science teachers an opportunity to explore the nature of mid-ocean ridge volcanism and the life it supports along the Juan de Fuca spreading center in the Pacific Ocean. Two of these outstanding teachers have explored the seafloor in the submersible Alvin and one became a teacher-leader mentoring new educators in the program during their sea-going experience.

The program focused on exposing science educators to the scientific process through direct interaction and collaboration with scientists on board research cruises. As a result of their combined, sea-going and research experiences, these educators injected into the classroom the issues and ideas associated with this rapidly growing research effort, and a first-hand exposure to the approaches, successes, failures and essential tenacity that are the integral components of successful research into the unknown. The "ripple effect" of their personal experience has reached far beyond their own classrooms as they have exposed thousands of students and hundreds of science teachers to the scientific process. They have also shared the excitement of interdisciplinary exploration of the deep crustal processes capable of supporting extensive microbial activity within the volcanically active portions of the earth at regional and national conferences. The REVEL Project developed an extended community of teachers and researchers who can communicate and work together to ensure the successful translation of the research experience to the classroom.

Building on the lessons of the first five years, REVEL has evolved into a professional development program for K-12 science educators. Teams of teachers recruited nationally will collaborate over a period of 3 years to the study of the planetary ocean system at the scale of a tectonic plate as the contextual basis for capturing the interest of their students and the public. Starting in 2002, REVEL and its new partner the NEPTUNE Project will 1) Facilitate the active participation of teachers in cutting-edge, sea-going ocean research 2) Recruit teachers at the national level 3) Provide participants with activities over multiple years for a sustained effort 4) Evaluate REVEL as a model for teachers experiencing research.

The presentation will emphasize the lessons learned for effective teachers professional development programs in earth and ocean sciences.

The REVEL Project is funded by the National Science Foundation with additional support from the University of Washington.

URL: <http://oceanweb.ocean.washington.edu/outreach/revel>

ED61C-0032 0830h POSTER

A graduate physics education research course for teachers

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Physics and physical science (including space science) is perhaps the most difficult topic for the secondary schools to teach because of the lack of well-prepared teachers. To be well prepared to teach this subject teacher must have both a knowledge of physical science and some knowledge of cognitive science as it relates to the teaching of physical science. In this talk I will describe a graduate course in physics education research currently being offered to middle school and

high school teachers who teach physics, astronomy, and physical science. The course itself is an experiment, comprising training in both scientific and pedagogical content knowledge, along with the application of that knowledge to the classroom through action research. A special focus of the course is a review of appropriate topics in space science, along with evaluation by the teachers of student difficulties with space science concepts that students are expected to master according to Texas states guidelines.

ED61C-0033 0830h POSTER

The Los Alamos Space Science Outreach (LASSO) Program

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The Los Alamos Space Science Outreach (LASSO) program features summer workshops in which K-14 teachers spend several weeks at LANL learning space science from Los Alamos scientists and developing methods and materials for teaching this science to their students. The program is designed to provide hands-on space science training to teachers as well as assistance in developing lesson plans for use in their classrooms. The program supports an instructional model based on education research and cognitive theory. Students and teachers engage in activities that encourage critical thinking and a constructivist approach to learning.

LASSO is run through the Los Alamos Science Education Team (SET). SET personnel have many years of experience in teaching, education research, and science education programs. Their involvement ensures that the teacher workshop program is grounded in sound pedagogical methods and meets current educational standards. Lesson plans focus on current LANL satellite projects to study the solar wind and the Earth's magnetosphere.

LASSO is an umbrella program for space science education activities at Los Alamos National Laboratory (LANL) that was created to enhance the science and math interests and skills of students from New Mexico and the nation. The LASSO umbrella allows maximum leveraging of EPO funding from a number of projects (and thus maximum educational benefits to both students and teachers), while providing a format for the expression of the unique science perspective of each project.

ED61C-0034 0830h POSTER

Lessons Learned from NCAR Professional Development Workshops for Educators

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Since the early 1990s, NCAR has been involved in the development and implementation of professional development workshops for educators. From 1991 through 2000, the NSF-funded Project LEARN (Learning Experiences in Atmospheric Research at NCAR), provided middle school educators training in atmospheric science content and opportunities to develop activities collaboratively with scientists. In 2002, NCAR initiated a new annual Geoscience Education Workshop on Climate and Global Change for skilled teacher trainers at the middle and high school levels. Both of these workshop series have provided numerous opportunities to learn lessons that may be useful to those considering development of similar training workshops. Our best practices come from formal program evaluation as well as informal interactions and observations. Ranging from big concepts to minutiae, careful planning and successfully taking care of the details can make the difference between a successful workshop and a disaster. For our most recent workshop, participants were selected from a national pool, based on their own preparation in the geosciences, experience in training, courses they are teaching, plans for dissemination and outreach to underrepresented groups, and geographic distribution. Methodologies include leadership and content training, field experiences, hands-on inquiry-based activities, computer modeling, experience in presentation, preparation for local training sessions, and discussion. Reflection on relevance to national education standards is a necessary underlying

theme of a successful workshop. Likewise, involving scientists not only in lecture presentations but also in some of the more informal components of a workshop such as hands-on activities and social events provides additional opportunities for scientists and teachers to get to know each other and build on-going relationships. Finally, work with educators does not end when the workshop is over - in order for the training investment to pay off, its very important to maintain a continuing relationship with educators in their efforts to improve science education in their classrooms, schools, and at the regional level.

ED61C-0035 0830h POSTER

Space Physics Workshops for High School Teachers: Lessons Learned

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We will discuss teacher workshops conducted within the program "Connecting Sun City with Sun-Earth Connections." This program involves faculty from the College of Science at the University of Texas at El Paso, local teachers, and science educators, working to increase awareness of and enthusiasm for space science in the El Paso area. A series of teacher workshops aimed at middle and high school science teachers and presented by university faculty in the College of Science was held throughout the summer. These workshops aimed to provide space science-related instruction combined with classroom activities geared towards middle and high school students. We present methods and results from these and from follow-up workshops held with the attendees. We focus on the aspects deemed most valuable by the teachers themselves in their assessments of the workshops.

ED61C-0036 0830h POSTER

GIFT: Geophysical Information For Teachers

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Starting in 1991 Geophysical Information For Teachers (GIFT) workshops were held in conjunction with AGU fall and spring meetings. These two-day workshops were designed to take advantage of AGU membership as presenters and to highlight recent developments in curriculum materials. Over a period of time the workshops evolved into a national program and a model for local or state workshops.

Typically at the fall meeting the first day was held at the Exploratorium and consisted of curriculum materials presentations. Teachers learned about the development of new products for classrooms and participated in activity demonstrations. The second day was held at the AGU meeting site and featured six science talks by AGU members who were presenting papers at the meeting. Presenters were chosen to cover a broad range of geophysical sciences and subjects of topical interest. A similar model was followed at the spring and Ocean Sciences meetings with both days being held at the meeting venue.

An AGU Council Project Grant was obtained in 1999 to expand the GIFT program to other venues and to develop a model for AGU members for setting up similar workshops in their home states. One-day workshops were held at the Washington State and South Carolina State Science Teachers annual meetings. These workshops consisted of science content lectures and curricular activities. Additionally, grant funding was used to create an Earth and Space Science Resource Day at National Science Teachers Association (NSTA) annual conventions. NSTA conventions are composed of short workshops and presentations and lectures on science teaching or education research. Occasional science lectures such as the AGU lecture offer science content information. At the 2002 convention AGU's GIFT program joined with NESTA, NAGT, and AGI to coordinate a series of workshop events. Coupled with NESTA's guided learning field trip teachers were offered a suite of science content and science-teaching activities focused on the Earth and Space sciences.

Workshop evaluations revealed that the participants appreciated the opportunity to attend and participate in a scientific meeting. As a rule the science talks were held in high value, as teachers often do not have access to current science research. The curricular workshops were valued as an opportunity to bring new teaching materials into their classrooms.

ED61C-0037 0830h POSTER

A Systematic Approach at the Departmental Level to the Provision of Outreach Programs Aimed Towards Local Elementary and Secondary School Students and Teachers

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The School of Geography and Geology (SGG) at McMaster University has developed a set of opportunities to provide linkages between University geoscientists and local elementary and secondary school students and their teachers. These opportunities include an open invitation to all local secondary schools (> 200 schools) to bring their senior classes to attend an introductory environmental science lecture, and university geoscientists, both faculty and graduate students, teaching grade 4 "Rock & Mineral Detective" classes in local elementary schools. A regional atlas focusing on the Hamilton region is being created by a team consisting of university faculty, a university librarian, high school teachers, elementary school teachers and local government personnel. The atlas includes teaching modules and accompanying visual imagery. This atlas will allow students to connect what they observe in their local environment and the earth science concepts that they are learning through their course of instruction. SGG also hosts the GIS high school initiative in which high school students and teachers are invited to spend a half day in the university GIS labs learning about the various applications and uses of GIS. Students are also provided an opportunity to discuss with faculty about the University experience and what they can expect.

The intent of these outreach programs is to provide K-14 students with a broader understanding of the Earth Sciences, to increase interest in the discipline of Earth Sciences and to recruit a greater number of students in Earth Sciences programs at the University level. These university-based initiatives have been developed concurrently with substantial changes to the provincial elementary and high school curricula that require the inclusion of more Earth Science instruction. This has provided an impetus for local teachers to be particularly receptive to these outreach initiatives.

Success of these outreach programs is challenging to measure but subscription to the programs is increasing annually with many teachers subscribing to the programs in successive years.

ED61C-0038 0830h POSTER

What Every Scientist Should Know About Quality Professional Development Experiences for Teachers

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The ongoing professional development of science teachers is vital to the success of science education. The role of scientists in the professional development of teachers is also essential. Myriad workshops for teachers of space and Earth science are offered, and many of them involve the participation of scientists, but how many of them live up to the qualities articulated in the National Science Education Standards for the professional development of teachers? How many of them are informed by the notable books on professional development and the roles scientists can and should play in the professional development of teachers? Drawing on resources like these, this paper will summarize the key elements of exemplary professional development experiences for science teachers, with an emphasis on the role of space and Earth scientists. The paper will also present a useful spectrum that identifies the value and attributes of different types of professional development experiences, from the pervasive 1-hour workshop at a conference to programs of successively longer duration.

ED61C-0039 0830h POSTER

Teaching Teachers: Lessons Learned Conducting Workshops Associated with NASA Earth Science Missions

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Coordinators of NASA education and outreach (EPO) programs participate in a wide range of presentations and workshops for K-12 educators. Typical presentations include one-hour talks by NASA scientists and one to two hour hands-on activities conducted by EPO teams using NASA-produced education material. Teacher workshops can run from a half-day to several weeks depending on the program. As an EPO team for several NASA Earth Science missions, we have a variety of roles in the development and implementation of workshops for educators such as providing scientists as presenters, overseeing the development of education materials, creating the agenda, teaching in the workshops, and providing follow-up support for participants. Over time our workshop approach has evolved as we have learned to focus on specific outcomes and have improved our ability to meet the needs of our participants. We encourage participants to come as teacher teams from the same district or school. Most workshops combine scientist presentations, opportunities for hands-on exploration and teacher reflection. We now are working to create support networks for participants during the school year. This paper will highlight the lessons learned by the Landsat 7 and EOS Aura EPO teams as a result of our workshop experience and feedback from our workshop participants. We will offer some recommendations for developing workshops and suggest some next steps for assessing the effectiveness of teacher workshops.

ED62A MCC: 130 Saturday 1330h
Teaching the Teachers: What Have We (They) Learned? II (joint with OS, GC, PA)

Presiding: J Thieman, NASA Goddard Space Flight Center; **S Stockman**, Science Systems and Applications, Inc.; **F Ireton**, Science Systems and Applications, Inc.

ED62A-01 1330h INVITED

NSF Programs that Support Faculty Development: An Overview of Opportunities in the Geosciences

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The National Science Foundation, Division of Undergraduate Education administers a number of programs that support faculty development in the geosciences. The National Dissemination (ND) track in the CCLI (Course, Curriculum and Laboratory Improvement) Program supports projects that promote the development of opportunities for professional development for faculty through national offering of workshops, short courses, or related activities. These projects involve extensive outreach activities and large numbers of faculty from across the country. An overview of the CCLI-ND program will be given and current ND projects in the geosciences will be highlighted. Some strategies for implementing effective faculty development activities will also be given.

URL: <http://www.nsf.gov>

ED62A-02 1345h

Workshop Formats and Teacher Transformation: the TLRBSE Experience

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The main objective of most workshops aimed at teachers is to transform how they teach science in the classroom to the hands-on, inquiry-based model advocated by national and state education standards. Many different workshop formats have been tried to achieve this objective, ranging from half-day training sessions

on site at the teachers schools to multi-month total immersion experiences at research centers followed by in-depth support during the school year. Some of the issues involved in the choice of format include, teachers time, potential for replication, and effectiveness in actually changing teachers teaching habits that are often deeply ingrained. The authors have had personal experience with a wide variety of workshop formats. We find that teacher transformation requires gaining a fair amount of specific content knowledge, confidence in using software and data, and hands-on experience in using the inquiry approach. One-day workshops have very little effect. Longer workshops from a week to a whole summer - are better. Still better are longish workshops with the same teachers returning for several consecutive summers with individual teacher support during the school year. The additional workshops allow the teachers to share their experiences with the new materials and gain additional training in content and pedagogy. Problems with such programs include the high cost and relatively small number of teachers affected. Continued contact during the school year can also be a challenge. We are currently running a program called Teacher Leaders in Research Based Science Education (TLRBSE) which includes a distance learning course to provide content and pedagogy, a two-week summer workshop at a major observatory to provide hands-on experience and direct contact with scientists, and an online community for school year support. We will describe our experience to date with this new format and compare our results with other format we have tried in other programs. This work is supported by NSF ESI 0101982.

URL: <http://www.noao.edu/outreach/tlrbse/>

ED62A-03 1400h INVITED

Lessons Learned in Professional Development

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Successful professional development has many essential elements. It must deliver rich content in the context of supporting instruction. It is best done in an environment where teachers can reflect on the pedagogy and how it supports learning the content. Implementation of new knowledge or curriculum in the school classroom has greater success when teams of teachers participate in professional development and have a mechanism to support one another when they return to the classroom. Support of the school administrators or lack of it has a tremendous impact on a teachers ability to implement changes as an outcome of professional growth. Research shows that professional development has greater impact when there is a requirement for action by the participants after the training. However, our experience shows that when all of these structures are in place, the most critical element for professional development to ensure long term impact on teaching and learning in the classroom is the teacher support provided after the program.

We have conducted professional development lasting from half-days to four weeks. While each has their own place, the impact is strongly determined by the level of assistance provided to the teacher when making changes in the classroom. Support can range from electronic communications to personal assistance in the classroom. One of the essential components is rapid response so problems are addressed before they become obstacles to change. For the past three years, we have used graduate and undergraduate students to provide classroom assistance following professional development. We will report on the different types of programs supported and the impact on curriculum and teaching methods in the classrooms.

ED62A-04 1415h

Exploring Earth Science with Middle School Teachers: Collaboration between Scientists and Educators

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A series of earth science courses for middle school teachers has been designed to investigate physical geology, oceanography and meteorology, historical geology, and participant-selected topics. These courses have been offered during the academic semester in a weekly class format. They also can be "bundled" into two to three week-long intensive summer workshops.

The introductory, historical, and oceanography/meteorology courses are content-driven and designed to meet the teaching standards requirements of participants. Each class, facilitated by a geoscientist, concentrates on a specific topic, involving observation and analysis of data related to the topic, discussion, content presentation, and the incorporation of local resources (e.g., museum exhibits, natural settings, etc.) where ever possible. Each class closes with an extensive participant-driven discussion of where the topic fits within the educational standards/expectations (with emphasis on skills, content knowledge, and science as a human endeavor). Participants are provided with a variety of existing content-accurate classroom materials and resources appropriate to middle school students. The "topics" course is a participant-driven investigative class in which participants select two to three earth science subjects of interest to explore in detail. With the assistance of a geoscientist-facilitator, groups research the topics and select classroom resources and activities. Classroom implementation, conducted by the participants, is similar to that of the content courses (above).

Collaborative and individual pre- and post-tests (as traditional "tests," essays, flow charts, diagrams, etc.) are increasingly being used to help the facilitator and participants assess starting points and development of understanding. Concept maps and journals are used to follow progress as well. Content and data, while presented at an adult-learner level, are discussed with the participants in light of subject material appropriate for the classroom, and paths to use the information in the classroom. The geoscientist serves in two roles, facilitator and scientist, with a primary goal of helping the participating teachers to develop a depth of understanding of the content. The teachers bring their strengths as educators to the collaboration; armed with accurate content knowledge, data, and understanding of the process of science, they help identify best teaching practices and transfer the information to students.

ED62A-05 1430h

SECTRA - A novel approach to teacher workshops for Sun-Earth science

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The Sun-Earth Connection Teacher Resource Agent (SECTRA) program was an attempt by the scientists and outreach specialists of ISTP and SECEF to both "teach the teachers" and then assist those participants in teaching their colleagues. In designing our program, we put special emphasis on partnering with education offices and groups, evaluating the needs of the teachers before, during, and after the workshop, and providing the best educational resources - even if it meant asking others to partner with us. We integrated hands-on activities for participants with sequential, themed science presentations, tours and field trips to science facilities, and discussions of pedagogy and educational issues. We also built time into the workshop for planning and material/lesson-plan evaluation. The culmination of SECTRA was a grant program by which participants applied for funding to conduct workshops in their own communities. We will discuss the rationale and logistics of this multi-year SECTRA program, as well as the evaluation of those workshops.

URL: <http://www-istp.gsfc.nasa.gov/istp/outreach/workshop/>

ED62A-06 1445h

A Novel Approach to Teaching and Learning Biogeoscience

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