

can otherwise look as a graphical exercise. Dealing with research aimed at the study of dangerous, explosive volcanoes, improving the general understanding of these scientific results plays an important role as far as risk perception is concerned. An educated population has better chances to follow an appropriate behavior, i.e.: one that could lead, on the long period, to a reduction of the potential risk. In this sense, a correct divulgation of scientific results, while improving the confidence of the population in the scientific community, should belong to the strategies adopted to mitigate volcanic risk. Due to the relevance of the long term final goal of such divulgation experiment, this work represents an interdisciplinary effort, combining scientific expertise and specific competence from the modern communication science and risk perception studies.

ED41A MC: 303 Thursday 0830h
AGU Scientists' Roles and Partnerships in Support of K-14 Education and Public Outreach: Part Two I (joint with PA)

Presiding: R Johnson, UCAR/NCAR; C A Morrow, Space Science Institute

ED41A-01 0840h

Entering a New ERA: Education Resources and AGU

Jill L Karsten¹ (202-777-7508; jkarsten@agu.org)

Roberta M Johnson² (303-497-2951; rmjohnsa@ucar.edu)

¹American Geophysical Union, 2000 Florida Ave., NW, Washington, DC 20009, United States

²UCAR, P.O. Box 3000, Boulder, CO 80307-3000, United States

Professional societies play a unique role in the ongoing battle to improve public education in the Earth and space sciences. With guidance from its Committee on Education and Human Resources (CEHR), AGU has traditionally sponsored strong programs that provide mechanisms for linking its research membership with the formal/informal science education communities. Among the most successful of these are tutorials for K-12 teachers taught by AGU members during national meetings (e.g., GIFT - Geophysical Information For Teachers) and internships that allow teachers to experience geophysical science research first-hand (e.g., STARS - Science Teacher and Research Scientist). AGU also co-sponsors major symposia to discuss and develop strategies for Earth science education reform (e.g., the NSF-sponsored Shaping the Future workshop) and provides an annual forum for the Heads and Chairs of undergraduate geoscience departments to discuss common problems and share solutions. In the fall of 2001, AGU expects to unveil a major new education and outreach website that will provide enhanced opportunities for communicating to students, teachers and the public about AGU members' research and new directions in geophysical science education. The most important contribution that AGU makes, however, is to validate and prominently endorse the education and outreach efforts of its members, both by sponsoring well-attended, education-related special sessions at AGU national meetings and by annually honoring individuals or groups with the Excellence in Geoscience Education award. Recent staff changes at AGU headquarters have brought new opportunities to expand upon these successful existing programs and move in other directions that capitalize on the strengths of the organization. Among new initiatives being considered are programs that partner education efforts with those being developed as part of several large research programs, curriculum modules that will promote teaching earth sciences-related materials within core physics, chemistry, and math curricula, and more sophisticated informal science education programs. Efforts to better coordinate AGU's education programs with those being developed by other professional geoscience organizations are also underway.

ED41A-02 0855h INVITED

Supporting Geoscientists in Partnerships for K-12 Education at NSF

Margaret Leinen (703-292-8500; mleinen@nsf.gov)
 National Science Foundation, 4201 Wilson Blvd., Room 705, Arlington, VA 22230, United States

NSF Directorate for Geosciences (GEO) education activities have evolved over the last decade based on

advice from a broad segment of the geosciences community. These activities gained momentum when a Geosciences Education Working Group (GEWG, 1996) recognized the shift from traditional priorities that emphasized only research, to those that support education in geosciences as well. The GEWG report embraced this increased emphasis on education as a component of NSF's role in assuring the long-term health of the geosciences and endorsed the principle that research and education should be well integrated.

While many geosciences education activities are funded by the Education and Human Resources Directorate (EHR) of NSF, the GEWG report highlighted the need to have more active participation by research geoscientists in K-12 education activities, and the need to train them to be able to do so. While some roles in education are clearly best left to educational professionals (e.g. large-scale systemic reform projects, pedagogical development at the K-12 level, and many teacher enhancement projects), activities such as undergraduate research, technology advancement, curriculum content development and informal science are ones in which GEO should actively seek to collaborate with programs in EHR.

The GEO education program has expanded over the last decade. Our first education activity, Awards to Facilitate Geoscience Education (AFGE), was very successful in attracting some of the leading researchers in geosciences. This program evolved to become the Geoscience Education Program. An important program funded by GEO that developed from community activity is the Digital Library for Earth System Education (DLESE). This program grew out of a joint EHR/GEO award and a series of community workshops. The program will establish an Internet portal for geoscience curricular materials and other teacher resources that will enable further collaboration between the research and education communities in geoscience.

ED41A-03 0915h INVITED

Implementing the NSF Geosciences Education Vision: A University Perspective

Richard C. J. Somerville (1-858-534-4644; rsomerville@ucsd.edu)

Scripps Institution of Oceanography, University of California, San Diego, 9500 Gilman Drive, Mail Code 0224, La Jolla, CA 92093-0224, United States

Geosciences Education: A Recommended Strategy (NSF97-171) is a report which laid out an ambitious vision for promoting education and public outreach (EPO) activities in the Earth sciences. A key to making this vision a reality is bringing members of the academic research community more fully into the EPO domain. Many university scientists enthusiastically embrace EPO goals and have taken steps to participate personally in a broad spectrum of EPO activities, ranging from working with K-12 teachers to briefing Congress. Other researchers in academia, however, have encountered severe barriers to entering the EPO world, including peer disapproval and administrative discouragement at their universities. A common experience for both researchers and educators is to find that the two communities are separated by a cultural chasm, with naivete and distrust in evidence on both sides. This talk draws on the personal experience of the author, a professor at a research university who is himself heavily involved in EPO, and who chaired the working group that wrote the NSF report.

URL: http://www.geo.nsf.gov/adgeo/geoedu/97_171.htm

ED41A-04 0935h

A Young Scientist's Experiences with Education and Public Outreach

Mary L Urquhart (650-604-1794; murquhart@mail.arc.nasa.gov)

NASA Ames/NRC, MS 239-20 NASA Ames Research Center, Moffett Field, CA 94035

Scientists can play a multitude of roles in support of K-14 education and public outreach, and these roles are not limited to established researchers with their own sources of funding. For young scientists just beginning their career and those still in graduate school, participation in E/PO can provide a wealth of opportunities for interaction with students, educators and the public. However, it can also present unique challenges.

While in graduate school at the University of Colorado at Boulder, several of my classmates and I became heavily involved in K-14 education and public outreach. Our participation included long-term scientist-teacher partnerships, curriculum development, organizing and presenting in educator workshops, public events, writing shows for the University planetarium, and providing content advice or reviews for curriculum projects and museum displays. Whether our E/PO work was paid or volunteer, we were able to apply our knowledge and enthusiasm to projects that directly impacted students, educators, and the public. Some products of our E/PO activities, such as the

standards-based curricular materials and the planetarium shows, have had a continuing impact. Unfortunately, not all aspects of our E/PO activities were positive. Vigorous participation in educational outreach can have a significant negative impact on the career of a scientist who is not yet an established researcher. Challenges a young researcher may face include time and energy taken away from research, a decreased technical publication rate, and a perception by senior colleagues that E/PO is not a valid use of time for "real" scientists. Although several of my classmates surrendered their roles in E/PO as they approached graduation, a few of us have remained active participants despite the risks to our science careers. For me, E/PO has brought an enhanced sense of passion, fulfillment and understanding of "the big picture" to my work as a scientist. It has also required significant time and energy. In this presentation, I will summarize my own roles and partnerships in K-14 education and public outreach, as well as the challenges created by such involvement. I will also offer advice to other young scientists interested in E/PO from the lessons I have learned along the way.

URL: <http://lyra.colorado.edu/sbo/mary/>

ED41A-05 0950h

Involving Research Scientists in Education and Public Outreach

Susan Buhr¹ (303-492-5657; susan.buhr@colorado.edu)

Elisabeth Andrews² (bandrews@cmdl.noaa.gov)

Sandra Laursen¹ (sandra.laursen@colorado.edu)

¹CIRES/University of Colorado, CIRES CB 216 University of Colorado, Boulder, CO 80309-0216, United States

²Climate Monitoring and Diagnostics Laboratory/NOAA, 325 S. Broadway, Boulder, CO, United States

A recurring question arises when discussing scientist roles in K-14 education: "How can we encourage scientists to engage in these opportunities?" The Outreach Program of the Cooperative Institute for Research in Environmental Sciences (CIRES) is very concerned with this question as we strive to involve CIRES research scientists and science in education. Lessons learned through NSF-supported social science research conducted at CIRES will be described, such as factors that are important in recruiting and retaining scientist involvement, factors that hinder scientist involvement, and implications for project design. Examples will be drawn from diverse CIRES projects, including education projects initiated through sponsored geoscience research.

URL: <http://cires.colorado.edu/~k12>

ED41A-06 1005h

An Oceanographer's Journey into the World of Education

Robert H Stewart (979-845-2995; stewart@ocean.tamu.edu)

Texas AM University, Oceanography Department, College Station, TX 77843-3146, United States

For most of my career, I was a research oceanographer. For the past eleven years, I have been a professor, and for the past four years I have been working to improve teaching of the geosciences, especially oceanography at all levels from elementary school through graduate school. My work has centered primarily on improving middle- and high-school curriculum, and on improving teaching at the upper undergraduate and beginning graduate levels. I wish to share the lessons I have learned about improving K-12 education: 1) Teach interesting subjects which build on student interest—this may seem obvious, but few textbooks are built around themes such as global warming, hurricanes, tornadoes, whales, or earthquakes. 2) Don't limit your work to your particular specialty—think of the geosciences first in their broadest context—after all, global warming involves far more than meteorology or oceanography. 3) Work on a team with educators and students—we may be experts in science, but how much do we know about teaching K-12 students, their vocabulary, and their ability to understand each topic? 4) Work on projects that reach the most teachers and students—this is perhaps best done through NSF-funded, statewide systemic initiatives. 5) Be aware of national and state standards, including but not limited to math and science—the AAAS Project 2061 has published much useful material. 6) Teach special sections of science courses for preservice teachers—teach the way they will teach after they graduate. 7) Build assessment into your work—we think we have good ideas, but we need to prove we are really improving education. 8) Get to know your state education agency—they often seek expert help, and they have great influence on education. Have I made a difference? I think so—10,000 students and teachers visit our web site each month; I have been asked to help review questions on the certification test given all middle-school teachers in the state;

and a graduate student who worked with me for three years is now teaching four sections of science methods each semester to preservice teachers. I am assured all her students will be learning about the geosciences.

URL: <http://oceanworld.tamu.edu>

ED41A-07 1020h

Engaging AGU Scientists in the Development of Multimedia Education Products

Catherine Gautier (805-895-1731; gautier@PlanetEarthScience.com)

Planet Earth Science, 30 West Mission Street Suite 8, Santa Barbara, CA 93101, United States

Planet Earth Science Inc. was established by an AGU scientist with the specific purpose of bringing Earth System Science education to the secondary education level. Through the development of its multimedia education products it has engaged a number of AGU scientists, engineers, instructional designers and educators at every level of the development chain from instructional design to content writing, media development and class-room testing. This has allowed diverse communities to better understand each other and work at finding ways to collaborate more efficiently.

Specific experiences acquired through the development of the CODIE award winning instructional CD "Ocean Expeditions: El Nio," jointly funded by the Department of Energy and NASA, will be presented and lessons learned will be discussed with emphasis on scientists engagements.

ED41A-08 1055h INVITED

Project ASTRO: A Program to Link Astronomers with Teachers in Grades 4-9 and Families

Andrew Fraknoi (415-869-2905; fraknoi@fhda.edu)

Astronomical Society of the Pacific, 390 Ashton Ave., San Francisco, CA 94112, United States

As a concrete example of how scientists can have a major local effect on science education, I report on a program at the Astronomical Society of the Pacific to link professional and amateur astronomers with teachers and families in their area. Begun in 1993, Project ASTRO is now operating in 12 regional sites around the U.S. and has trained over 1000 astronomer-teacher partnerships. Graduate students and recent PhD's seeking experience in education have been some of our most effective partners.

Astronomers receive training (together with their teachers) in a 2-day workshop that provides them with a wide range of effective teaching techniques, age-appropriate hands-on activities, and useful resources. They commit to making at least four visits to "their" classroom each year and work with their teacher to tailor a plan appropriate for their interests and the students' needs. A wide range of resource materials (including a video and a thick resource and activity notebook) is available from the project.

The 12 ASTRO sites have formed a national network for exchanging ideas and approaches, and helping to train new sites. A kit of training materials is available to help any institution that would like to start a site. Contact the author, or see: www.astrosociety.org/project-astro.html

The project is currently engaged in a new enterprise, creating a series of workshops and take-home activity kits to engage families in doing astronomy and space science in evenings or weekends.

URL: http://www.astrosociety.org/project_astro.html

ED41A-09 1115h

Maryland Summer Center for Space Science - A Collaboration Between Scientists and Maryland Teachers

Kerri B Beisser¹ (240-228-6050; kerri.beisser@jhuapl.edu)

Nicola J Fox¹ (240-228-3529; nicola.fox@jhuapl.edu)

¹ Johns Hopkins University/Applied Physics Laboratory, Space Department 11100 Johns Hopkins Road, Laurel, MD 20723, United States

JHU/APL hosts the Maryland Summer Center for Space Science for 6th and 7th graders. Students learned to harness the power of technology and keep pace with the expanding knowledge of space science. Students experienced the process involved in planning/launching a simulated space mission, including design/fabrication of instrumentation for a spacecraft. They were part of a Mission Team that built a spacecraft scale model complete with instrumentation as a NASA Discovery Program mission. Students also created logos, poster sessions, budgets, E/PO plans, and even gave a full mission overview oral presentation to

their peers. JHU/APL offered an exciting environment for this study of applications in space. Students interacted with scientists, engineers, and program management. They examined instruments, visited test facilities, mission operations and clean room facilities. Two week program, G/T students, Maryland State Department of Education.

ED41A-10 1130h INVITED

From Laboratories to Classrooms: Involving Scientists in Science Education

Edna K. DeVore (650-960-4538; edevore@seti.org)

SETI Institute, 2035 Landings Dr., Mountain View, CA 94043, United States

Scientists play a key role in science education: the adventure of making new discoveries excites and motivates students. Yet, American science education test scores lag behind those of other industrial countries, and the call for better science, math and technology education is widespread. Thus, improving American science, math and technological literacy is a major educational goal for the NSF and NASA. Today, funding for research often carries a requirement that the scientist be actively involved in education and public outreach (E/PO) to enhance the science literacy of students, teachers and citizens. How can scientists contribute effectively to E/PO? What roles can scientists take in E/PO? And, how can this be balanced with research requirements and timelines? This talk will focus on these questions, with examples drawn from the author's projects that involve scientists in working with K-12 teacher professional development and with K-12 curriculum development and implementation. Experiences and strategies for teacher professional development in the research environment will be discussed in the context of NASA's airborne astronomy education and outreach projects: the *Flight Opportunities for Science Teacher EnRichment* project and the future *Airborne Ambassadors Program* for NASA's *Stratospheric Observatory for Infrared Astronomy (SOFIA)*. Effective partnerships with scientists as content experts in the development of new classroom materials will be described with examples from the SETI Institute's *Life in the Universe* curriculum series for grades 3-9, and *Voyages Through Time*, an integrated high school science course. The author and the SETI Institute wish to acknowledge funding as well as scientific and technical support from the National Science Foundation, the National Aeronautics and Space Administration, the Hewlett Packard Company, the Foundation for Microbiology, and the Combined Federated Charities.

URL: <http://www.seti.org/education>

ED41A-11 1150h INVITED

The Role of Scientists in the Education Program of JPL's Astrobiology Institutes: A PI's Perspective.

Victoria Suzanne Meadows (626-395-8680; vsm@feisty.jpl.nasa.gov)

Jet Propulsion Laboratory/California Institute of Technology, MS183-900 4800 Oak Grove Drive, Pasadena, CA 91109, United States

Astrobiology is the study of life in the universe, a topic which has enormous public appeal. The NASA Astrobiology Institute consists of a geographically diverse but scientifically interconnected set of 15 research teams which promote, conduct and lead integrated multidisciplinary research in astrobiology. The Jet Propulsion Laboratory in Pasadena, CA now hosts two of the NAI research teams: one focused on in situ detection of life in our own Solar System, and the other, led by the author, focused on remote-sensing detection of life in extrasolar planetary systems. These two research efforts use very different techniques and expertise to address the overarching theme of the search for life elsewhere in the Universe. This research theme offers a compelling context and rich source of examples for learning fundamental concepts in earth and space science, physical science and life sciences. This talk will briefly describe the wide range of EPO products implemented and planned by the JPL astrobiology groups, and will concentrate on the diversity of roles the research scientists play in the EPO activities. This talk will also provide a Principal Investigator's perspective on the importance of EPO programs for astrobiology research, and the difficulties and triumphs encountered in implementing these EPO programs.

ED42A MC: Hall D Thursday 1330h

Showcase on Undergraduate Research in the Geophysical Sciences (joint with PA)

Presiding: K Grove, San Francisco State University; J Singer, Buffalo State College; R Johnson, UCAR/NCAR

ED42A-0163 1330h POSTER

Designing Undergraduate Research Experiences: A Multiplicity of Options

Cathryn A Manduca (507 252-8658; cmanduca@carleton.edu)

Carleton College, 1 North College Street, Northfield, MN 55057

Research experiences for undergraduate students can serve many goals including: developing student understanding of the process of science; providing opportunities for students to develop professional skills or test career plans; completing publishable research; enabling faculty professional development; or enhancing the visibility of a science program. The large range of choices made in the design of an undergraduate research program or opportunity must reflect the goals of the program, the needs and abilities of the students and faculty, and the available resources including both time and money. Effective program design, execution, and evaluation can all be enhanced if the goals of the program are clearly articulated.

Student research experiences can be divided into four components: 1) defining the research problem; 2) developing the research plan or experiment design; 3) collecting and interpreting data, and 4) communicating results. In each of these components, the program can be structured in a wide variety of ways and students can be given more or less guidance or freedom. While a feeling of ownership of the research project appears to be very important, examples of successful projects displaying a wide range of design decisions are available. Work with the Keck Geology Consortium suggests that four strategies can enhance the likelihood of successful student experiences: 1) students are well-prepared for research experience (project design must match student preparation); 2) timelines and events are structured to move students through intermediate goals to project completion; 3) support for the emotional, financial, academic and technical challenges of a research project is in place; 4) strong communications between students and faculty set clear expectations and enable mid-course corrections in the program or project design. Creating a research culture for the participants or embedding a project in an existing research culture can also assist students in completing a successful research experience. Outstanding undergraduate research experiences can take place in a wide variety of settings and serve a wide variety of student and faculty needs if projects are designed with these goals in mind.

ED42A-0164 1330h POSTER

Preparing Students for Geologic Research with a Junior-level Course

R. Heather Macdonald¹ (757-221-2443; rhmacd@wm.edu)

Christopher M. Bailey¹ (cmbail@wm.edu)

Gregory S. Hancock¹ (gshanc@wm.edu)

Gerald H. Johnson¹ (ghjohn@wm.edu)

Brent E. Owens¹ (beowen@wm.edu)

¹Department of Geology, College of William and Mary, P.O. Box 8795, Williamsburg, VA 23187, United States

A required research project for all seniors is a cornerstone of the undergraduate geology program at the College of William and Mary. To help prepare students for this experience, junior geology majors take a required one-credit course, Introduction to Geologic Research. The main goals of the course are to help students define their individual research project and to develop basic research and presentation skills. Specific objectives are to introduce the process of geologic research and to have students discuss and defend geologic research with peers and faculty and give formal oral and written presentations of the research proposal. The major products of the course include a research bibliography, a 10-15 page proposal and an oral presentation and defense of the proposed research. The