

clearly with clients and other team members. Professional development is supported through encouragement of continuing education, as well as publication and presentation of professional work. An overview of the earth science staff and work at SwRI can be found at <http://www.swri.edu/4org/d20/d20home.htm>  
 URL: <http://www.swri.edu/4org/d20/d20home.htm>

ED22B-07 1635h

Mapping the Globe with C & C Technologies

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C & C Technologies is an international survey and mapping company with an entrepreneurial spirit that is evident throughout. C & C was recently awarded the MTS (Marine Technology Society) ROV Committee Corporate Excellence Award in recognition of their pioneering spirit displayed by the introduction of the HUGIN 3000 Autonomous Underwater Vehicle (AUV) to the offshore industry. This presentation will outline the wide variety of global mapping projects that C & C has performed for government, private sector, and academia. These include high-resolution mapping of Cater Lake, the Panama Canal, Antarctica, Lake Tahoe, and the HUGIN 3000's discovery of the German submarine U-166 in 5000 feet of water in the Gulf of Mexico. Academic disciplines required to support these technical challenges will be characterized and job opportunities in this emerging field will be addressed.  
 URL: <http://www.cctechnol.com>

ED22B-08 1650h

What Are Faculty Advisors To Do When Their Own Career Path Does Not Satisfy Their Students?

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As graduate students seek advice on broad career options, many faculty advisors do not know what to do. It is easy for them to do nothing. They may do nothing because they assume that their own students are interested only in an academic research career like theirs. The mistake here can be that the advisors' verbal and non-verbal communication deters students from mentioning their interests in the first place or pursuing those interests, if mentioned. Or advisors may do nothing by assuming that it is not their responsibility to advise students about career options other than being an academic researcher. The advisors' lack of knowledge about other careers may lead them to avoid the issue. The mistake here is obvious. So what are advisors to do?

They can encourage students to think of their graduate study as part of their career preparation, not just a task to obtain a research degree. Creating a risk-free environment for career discussion will enable faculty advisors to learn each student's career priorities and validate exploration of broad career options. Advisors should not feel inadequate by being unable to advise about everything. No one expects them to. They can encourage their students to meet together, on their own if necessary, to discuss common career concerns, even to invite speakers, including alums, to talk about different careers and the preparation required. They can encourage their students to seek additional mentors, people more knowledgeable about careers of interest to the students. They can encourage students to take courses for career preparation, particularly courses outside of science, even though these courses "take them away from their research." And advisors should not hold students at fault if they change their minds about career paths. More information often changes minds. These are a few of the many things that advisors can do.

It is essential that faculty advisors not resent students' decisions to follow a career path different from the advisors' or, for students wanting a faculty position, decisions to prepare themselves for teaching as well as research. Conflicts that do arise can at least be alleviated if these differences of opinion or goals are taken to be like the conflicts between offspring and parents, a normal part of maturing into one's own person.

ED32A MC: 122 Wednesday 1330h

Informal Education: A Powerful Tool in Science Literacy I (joint with PA)

Presiding: J Thieman, NASA/GSFC; D Alexander, Lockheed-Martin Solar Astrophysics Lab

ED32A-01 1330h

Bridging the Gap Between Formal and Informal Science Education

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Formal learning skills are enhanced throughout our daily lives through the public media, (television, newspapers, radio); while hiking our favorite park; or by visiting a museum or science center.

Over the past few years the informal science community has started to bridge the gap with the formal education community. Although few informal education organizations have established set curriculum guidelines, many have adapted the use of the National Science Standards. In so doing, these organizations have raised their level of professionalism. Many formal school programs are now actively seeking collaborative science education programs to enhance and expand their hands-on, inquiry based curricula through informal science organizations.

This paper/presentation will address my current research within this field. I will discuss selected federal science agencies education and outreach efforts. Key points will include media usage, age of target audiences, credentials of interpretation staff, and level(s) of collaboration with formal schools.

ED32A-02 1345h

Space Mysteries: Making Science and Astronomy Learning Fun

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How do you get and keep a student's attention during class? Make learning fun! Using a game to teach students ensures that they have fun, enjoy the lesson and remember it. We have developed a series of interactive web and CD based games called "Space Mysteries" to teach students math, physics and astronomy. Using real NASA data, the students must find out Who (or What) dunit in an engaging astronomy mystery. The games include video interviews with famous scientists, actors playing roles who give clues to the solution, and even a few blind alleys and red herrings. The first three games are currently online in beta release at <http://mystery.sonoma.edu>.

URL: <http://mystery.sonoma.edu>

ED32A-03 1400h INVITED

Expanding Public Outreach: The Solar System Ambassadors Program

Kay Ferrari (818-354-7581; [kay.a.ferrari@jpl.nasa.gov](mailto:kay.a.ferrari@jpl.nasa.gov))

Solar System Ambassadors Program, Jet Propulsion Laboratory 4800 Oak Grove Drive MS: 264-788, Pasadena, CA 91109-8099, United States

The Solar System Ambassadors Program is a public outreach program designed to work with motivated volunteers across the nation. These competitively selected volunteers organize and conduct public events that communicate exciting discoveries and plans in Solar System research, exploration and technology through non-traditional forums. In 2001, 206 Ambassadors from almost all 50 states bring the excitement of space to the public. Ambassadors are space enthusiasts, who come from all walks of life. Last year, Ambassadors conducted almost 600 events that reached more than one-half million people in communities across the United States. The Solar System Ambassadors Program is sponsored by the Jet Propulsion Laboratory (JPL) in

Pasadena, California, an operating division of the California Institute of Technology (Caltech) and a lead research and development center for the National Aeronautics and Space Administration (NASA). Participating JPL organizations include Cassini, Galileo, STARDUST, Outer Planets mission, Genesis, Ulysses, Voyager, Mars missions, Discovery missions NEAR and Deep Impact, Deep Space Network, Solar System Exploration Forum and the Education and Public Outreach Office. Each Ambassador participates in on-line (web-based) training sessions that provide interaction with NASA scientists, engineers and project team members. As such, each Ambassador's experience with the space program becomes personalized. Training sessions provide Ambassadors with general background on each mission and educate them concerning specific mission milestones, such as launches, planetary flybys, first image returns, arrivals, and ongoing key discoveries. Additionally, projects provide limited supplies of materials, online resource links and information. Integrating volunteers across the country in a public-engagement program helps optimize project funding set aside for education and outreach purposes, establishing a nationwide network of regional contacts. At the same time, members of communities across the country become an extended part of each mission's team and an important interface between the space exploration community and the general public at large.

URL: <http://www.jpl.nasa.gov/ambassador/front.html>

ED32A-04 1420h INVITED

The AGU and Planetariums: Effective Ways of Interacting With Planetariums As Informal Learning Centers.

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Today's planetariums are informal, science learning centers focusing on space/earth sciences, astronomy and the humanities. This paper shares creative ways on how planetariums reach their audiences effectively, and how professional scientists can be part of the planetarium education.

ED32A-05 1440h INVITED

Dive and Discover: Bringing Oceanographic Research into the Classroom and to the General Public

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We have developed the "Dive and Discover" web site for use in classrooms and for the general public to provide near real-time, daily access to oceanographic research expeditions, particularly those using deep submergence vehicles operated by Woods Hole Oceanographic Institution. The site was one of five science sites nominated for a 2001 Webby Award, was selected by Scientific American as one of the top five sites in the category of earth and environmental science, and was one of Eisenhower National Clearinghouse's "digital dozen" for science resources.

The web site consists of two major components. A series of educational modules provide both general educational information about the oceans and the people that study them, as well as cruise-specific information about the natural systems being studied, the participating scientists, and the data and sample-collecting methodologies and technologies being used. The second component consists of modules that allow access to near real-time updates of the progress of the cruise, images of seafloor features and animals, samples of data being collected and used on board, and general information about life on board. In addition, a Mail Buoy provides e-mail access for students to ask questions of the scientists on board the ship during the course of the expedition.

COSI Toledo have a linked Educators Companion that gives access to COSI project management tips, background information, activities, correlations to national science education standards, assessment tools, and a vast array of resources to assist educators in using the web site.

We have worked with teachers and students from all over the United States to test, evaluate, and refine the web site during five cruises in the Pacific and Indian Oceans over the last two years. These cruises focused on various problems associated with mid-ocean ridge volcanism, and the chemical, physical and biological processes associated with seafloor hydrothermal activity. Our intention is that the conceptual approach we have developed will have broad application for marine scientists to promote ocean science education and public outreach in the future.

URL: <http://www.divediscover.whoii.edu>

## ED32A-06 1520h

### Science@NASA: Direct to People via the Internet

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NASA's founding charter includes the requirement for reporting all research results to the public. This requirement is based on the principle that the exploration of space results in real benefits to humanity and that those benefits are to be shared as widely as practical. When NASA was founded, the traditional education and outreach methods were through the news media and the formal and informal (museums, planetariums, exhibits, etc.) educational communities. With the nearly ubiquitous availability of the Internet, a third choice presents itself: communicating directly with individuals in their homes. This powerful approach offers benefits and pitfalls that must be addressed to be effective. This paper covers an integrated approach to providing high quality NASA research information to multiple audiences via a family of websites. The paper will discuss the content generation, review, and production process and provide metrics on evaluating the results.

URL: <http://science.nasa.gov>

## ED32A-07 1535h

### The Media as an Invaluable Tool for Informal Earth System Science Education

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One of the most widely utilized avenues for educating the general public about the Earth's environment is the media, be it print, radio or broadcast. Accurate and effective communication of issues in Earth System Science (ESS), however, is significantly hindered by the public's relative scientific illiteracy. Discussion of ESS concepts requires the laying down of a foundation of complex scientific information, which must first be conveyed to an incognizant audience before any strata of sophisticated social context can be appropriately considered. Despite such a substantial obstacle to be negotiated, the environmental journalist is afforded the unique opportunity of providing a broad-reaching informal scientific education to a largely scientifically uninformed population base.

This paper will review the tools used by various environmental journalists to address ESS issues and consider how successful each of these approaches has been at conveying complex scientific messages to a general audience lacking sufficient scientific sophistication. Different kinds of media materials used to this effect will be analyzed for their ideas and concepts conveyed, as well as their effectiveness in reaching the public at large.

## ED32A-08 1550h

### Enhancing Nontraditional Informal Programs Using Exhibitions: a case study of MarsQuest

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The Space Science Institute (SSI) of Boulder, Colorado has recently developed a large traveling exhibition called MarsQuest. The 5,000 square foot exhibition will enable millions of Americans to share in the

excitement of the scientific exploration of Mars and learn more about their own planet in the process. A large exhibition, like MarsQuest, can provide a memorable experience for visitors, but it does not have to end there. A variety of nontraditional informal activities can tie into such informal science education projects to enhance and extend their impact. I will first discuss the MarsQuest exhibition that features compelling hands-on displays, updateable computer stations, and models that offer memorable experiences for visitors of all ages. The MarsQuest Education Program includes a professional development workshop for teachers, a museum staff orientation, web resources, and a public talk by a Mars scientist. By surrounding visitors with vivid Mars images, the planetarium show, narrated by Patrick Stewart, expands on the exhibitions main themes and allows visitors to delve deeper into the mysteries of Mars. The MarsQuest exhibition is proving to be extraordinarily successful. The exhibits three-year tour is already fully booked (a second 3-year tour is planned), and the exhibit has been met with tremendous amounts of publicity and press coverage at its venues to date. The MarsQuest experience will be used to explore how a large exhibition can enhance non-traditional informal programs such as public talks by scientists, mall science events, camp-ins, public demonstrations, interactive web events, and the creation of mini versions that can travel to smaller venues in underserved regions of the country. I will then discuss how these activities can best piggyback on the media attention and public awareness that is generated by a large exhibition.

URL: <http://www.spacescience.org>

## ED32A-09 1605h

### From SuperClusters to Browsers: Using Research Simulations in Informal Education

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As research fields push forward, continually creating more sophisticated and computationally intensive simulations, it can be forgotten that older modeling approaches can play a valuable role in educating the public. The bleeding edge simulation of a decade ago that ran only on supercomputers can now run from a browser window, giving non-scientists insights into physical systems as well as insights into how science is done. This translation from research to education is not always practical: many approaches are too abstract or not sufficiently "bullet proof" to be used in this way. But at their best, simulations can help create inquiry-based environments that allow the public to "do science" without needing to mastering the underlying mathematics.

This approach is illustrated by a project funded by a small grant from NSF ISE through a program that provides education supplements to existing research awards. The project is a cooperative one that includes research scientists as well as professional educators. Using techniques adapted from a magnetospheric research program, applets are being built that allow web site visitors to explore the motion of particles in the Earth's magnetosphere. In order to maximize the impact of the program, the web pages will be linked to the Space Science Institute's Space Weather Center, a larger Space Weather outreach program that can provide background and context for the simulations. The scientists provide the technical expertise to re-implement the simulation in Java, so that it can be run over the web. The educators provide insight into how to identify specific learning goals, and how to accomplish those goals in an inquiry-based way using the web. We will describe some of the learning goals for the applets, as well as the approximations and compromises that need to be made to balance simulation accuracy with general public accessibility.

## ED32A-10 1620h

### "All About the Sun" A Webcast With Audience Participation

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The NASA-funded Solar Oscillations Investigation (SOI) Team at Stanford University has developed a unique webcast series as part of our educational outreach program. This series addresses solar science through a dialog between scientists and the viewing

audience. Not only does the audience learn scientific principles, they get to know the scientists and can participate in the show.

The shows are hosted at NASA-Ames through the NASA XOS project and have been broadcast from off-site locations such as classrooms of local schools. Videos shot on location are also included in shows.

What makes this webcast particularly effective is the interaction between scientists and viewers. Viewers can participate in the discussion of the topic through a chatroom. Supplemental materials, including lesson plans and suggested activities are available in advance for the audience. Viewers can perform the activities, record their results and submit video, images, or data for inclusion in the show. The level of audience interaction is increased beyond simple question and answer with experts. Audience members can contribute to the substance of the show. We strive to bring Scientists and the public closer through the show up to the limits of the technology and imagination.

## ED32A-11 1635h

### Scientist Involvement in High Visibility Education and Public Outreach: Eclipse 2001, A View from Zambia

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Our dynamic Sun offers exciting opportunities to share research discoveries of NASA's Sun-Earth Connection with the pre-college education and public outreach communities. NASA's Sun-Earth Connection Education Forum (SECEF), a partnership between UC Berkeley Space Sciences Laboratory and NASA/Goddard Space Flight Center, coordinates national programs for broad audiences that highlight solar and geospace missions and research programs. One of SECEF's primary goals is to facilitate scientist involvement in education and public outreach. We will show results of the high-visibility Eclipse 2001 event. This event involved more than 30 space scientists in schools, museums, and other venues in and out of this world, including members of minority professional societies, i.e. the National Society of Black Physicists and the International Space Station. We will discuss lessons learned and future opportunities for scientist participation.

URL: <http://sunearth.ssl.berkeley.edu>

## ED32A-12 1650h

### Presenting Numerical Modelling of Explosive Volcanic Eruption to a General Public

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Numerical modeling of explosive volcanic eruptions has been widely applied, during the last decades, to study pyroclastic flows dispersion along volcano's flanks and to evaluate their impact on urban areas. Results from these transient multi-phase and multi-component simulations are often reproduced in form of computer animations, representing the spatial and temporal evolution of relevant flow variables (such as temperature, or particle concentration). Despite being a sophisticated, technical tool to analyze and share modeling results within the scientific community, these animations truly look like colorful cartoons showing an erupting volcano and are especially suited to be shown to a general public. Thanks to their particular appeal, and to the large interest usually risen by exploding volcanoes, these animations have been presented several times on television and magazines and are currently displayed in a permanent exposition, at the Vesuvius Observatory in Naples.

This work represents an effort to produce an accompanying tool for these animations, capable of explaining to a large audience the scientific meaning of what

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**

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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**

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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)

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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](http://www.geo.nsf.gov/adgeo/geoedu/97_171.htm)

**ED41A-04 0935h**

**A Young Scientist's Experiences with Education and Public Outreach**

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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**

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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>

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**An Oceanographer's Journey into the World of Education**

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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, tornados, 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;