3) Exploration of model behavior using a variety of perturbations. The perturbations considered include large fires leading to the destruction of the land plants (an internal redistribution of carbon already present in the model) and the burning of fossil fuels (the distribution of "new" carbon added to the model from the outside). The closing discussion will emphasize the importance of developing students' abilities to interpret graphical output in terms of the scenario being played out in the model.

ED31C-1180 0830h POSTER

Integrating Research and Education: A 3D Modeling and Data Visualization Package for Data Assimilation

Kathy Garvin-Doxas[1,2] ((303) 492 8362; garvindo@colorado.edu)

Isidoros Doxas[1] ((303) 492 7988; doxas@colorado.edu)

[1]CIPS, UCB 390, University of Colorado, Boulder, CO 80309

[2]JILA, UCB 440, University of Colorado, Boulder, CO 80309

Recent advances in the development of integrated models of the Sun-Earth environment are placing increasing emphasis on data assimilation schemes that can maximize the intelligence extracted from our sparse sampling of upwind conditions. One of the schemes proposed is Branch Prediction and Speculative Execution, which consists of making probabilistic estimates of current upstream conditions, and distribute among available machines simulations that assume each of the probabilistically estimated states as initial conditions. As the near-Earth space evolves and near-Earth satellite data are compared with the models, some of the speculatively executed simulations will be proved wrong. At that point the machines that were executing them will be reassigned either to new lines of speculative simulation, or to increase the processing power devoted to more promising simulations already executing. CALCHAS is a 3D visualization package that integrates models and data, and is used in the above data assimilation scheme. The package is written in Java 3D, and has a modular design, so that different models and datasets, both real-time and historical, can be seamlessly compared using a variety of goodness-of-fit measures. The package is used both in research and education at the undergraduate as well as secondary level. Teaching modules use the package to teach Nature of Science (NOS) concepts like modeling and uncertainty, that have been shown particularly difficult to teach with traditional expository instruction. Standard instruments, like the Views About Science Survey (VASS; Halloun and Hesteness, *Science and Education* 7, 1998) and the Views of Nature of Science questionnaire (VNOS; Lederman, Abd-El-Khalick, Bell, and Schwartz, *Journal of Research in Science Teaching*, 39, 2002) are used to track progress in student conceptions of science.

ED31D MCC: Level 2 Wednesday 0830h

The Digital Library for Earth System Education: Opportunities for Collaboration II Posters

Presiding: **R Pandya,** DLESE Program Center/University Corporation for Atmospheric Research**; T Ledley,** TERC

ED31D-1181 0830h POSTER

Immersive Earth: Teaching Earth and Space with inexpensive immersive technology

Patricia H. Reiff[1] (713 3484634; reiff@rice.edu)

Carolyn Sumners[2] (713 6394632; csumners@hmns.org)

Colin C. Law[1] (770 4332131; colinlaw@mac.com)

Kerry Handron[3] (713 6655825; handronk@CarnegieMuseums.Org)

[1]Rice University, 6100 Main St., Houston, TX 77005, United States

[2]Houston Museum of Natural Science, 1 Herman Circle Drive, Houston, TX 77030, United States

[3]Carnegie Museum of Natural History, 4400 Forbes Ave, Pittsburgh, PA 15213, United States

In 1995 we pioneered "Space Update", the Digital Library for the rest of us", software that was so simple that a child could use it without a keyboard and yet would allow one-click updating of the daily earth and space science images without the dangers of having an open web browser on display. Thanks to NASA support, it allowed museums and schools to have a powerful exhibit for a tiny price. Over 40,000 disks in our series have been distributed so far to educators and the public. In 2003, with our partners we are again revolutionizing educational technology with a low-cost hardware and software solution to creating and displaying immersive content. Recently selected for funding as part of the REASoN competition, Immersive Earth is a partnership of scientists, museums, educators, and content providers. The hardware consists of a modest projector with a special fisheye lens to be used in an inflatable dome which many schools already have. This, coupled with a modest personal computer, can now easily project images and movies of earth and space, allows training students in 3-D content at a tiny fraction of the cost of a cave or fullscale dome theater. Another low-cost solution is the "Imove" system, where spherical movies can play on a personal computer, with the user changing the viewing direction with a joystick. We were the first to create immersive earth science shows, remain the leader in creating educational content that people want to see. We encourage people with "allsky" images or movies to bring it and see what it looks like inside a dome! Your content could be in our next show!

URL: http://earth.rice.edu

ED31D-1182 0830h POSTER

THREDDS Second Generation (THematic Real-time Environmental Distributed Data Services): Engaging the GIS Community and Tools

Ben Domenico[1] (ben@unidata.ucar.edu); John Caron[1] (caron@unidata.ucar.edu); Ethan Davis[1] (edavis@unidata.ucar.edu); Daniel Edelson[4] (d-edelson@northwestern.edu); Robb Kambic[1] (rkambic@unidata.ucar.edu); Rajul Pandya[2] (pandya@ucar.edu); Stefano Nativi[3] (stefano.nativi@pin.unifi.it)

[1]Unidata Program Center, UCAR P.O. Box 3000, Boulder, CO 80307-3000, United States

[2]DLESE Program Center, UCAR P.O. Box 3000, Boulder, CO 80307-3000, United States

[3]University of Florence -sede di Prato, Piazza Ciardi, 25, Prato 59100, Italy

[4]Northwestern University, Learning Sciences Program School of Education & Social Policy 2120 Campus Drive, Evanston, IL 60208, United States

The central mission of the THREDDS (THematic Real-time Environmental Distributed Data Services) project is to make it possible for educators and researchers to publish, locate, analyze, and visualize data in a wide variety educational settings. In the initial phase THREDDS established a solid, working prototype of services and tools to enable data providers to create inventory catalogs of the data holdings at their site and educational module builders to author compound documents with embedded pointers to environmental datasets and analysis tools. These catalogs and data-interactive documents can then be harvested into digital libraries using standard protocols. THREDDS Second Generation (THREDDS2G) will further enhance collaborations among data providers, toolbuilders, researchers and educators. It will do so by expanding the team of contributors and the breadth of data in the collections, taking advantage of recent technological advancements, and integrating THREDDS technologies with emerging standards and related environmental data systems. Since much of this expansion will involve Geographic Information Systems (GIS), THREDDS will actively engage the GIS community with the disciplines and tools that make the end products more useful at all educational levels, for decision makers and for the general public.

URL: http://my.unidata.ucar.edu/content/software/thredds/index.html

ED31D-1183 0830h POSTER

The Earth Exploration Toolbook: An Opportunity to Bring Earth Science Data to the Educational Community

Tamara S Ledley[1] (617-873-9658; Tamara_Ledley@terc.edu); LuAnn Dahlman[1] (480-357-8864; LuAnn_Dahlman@terc.edu); Carla McAuliffe[1] (480-945-6563; Carla_McAuliffe@terc.edu); Nick Haddad[1] (617-873-9643; Nick_Haddad@terc.edu); Cathy Manduca[2] (507-252-8658; cmanduca@carleton.edu); Sean Fox[2] (507-646-4365; sfox@carleton.edu); Denise Blaha[3] (603-862-1792; denise.blaha@unh.edu); Rita Freuder[3] (603-862-1792; rita.freuder@unh.edu); Robert Downs[4] (845-365-8985; rdowns@ciesin@columbia.edu)

[1]TERC, 2067 Massachusetts Ave., Cambridge, MA 02140, United States

[2]SERC Carleton College, 1 North College Street, Northfield, MN 55057, United States

[3]Complex Systems Research Center University of New Hampshire, 39 College Road, Durham, NH 03824, United States

[4]CIESIN Columbia University, 61 Rt. 9W, Palisades, NY 10964, United States

The Earth Exploration Toolbook (EET) presents step-by-step examples of using Earth science datasets and data analysis tools in educational settings. Each chapter in the EET walks users through a compelling case study in which they use data and analysis tools to explore issues and concepts in Earth system science. Designed for use by K-12 teachers, undergraduate faculty, and their students, each chapter provides enough experience and in-depth knowledge of the resource to enable an educator to use it, apply it to other teaching contexts, or help students use the resource to explore and investigate aspects of the Earth system of interest to them. Using our experience in developing the initial five chapters of the EET we are developing a template for the structure of a chapter. This web-based template will allow those outside the project, who have Earth science datasets and data analysis tools that they would like to be used by the educational community, to contribute a new chapter to the EET. In this presentation we will discuss the currently available chapters and EET chapter template, and describe the opportunities for others to help contribute a chapter to the EET.

URL: http://serc.carleton.edu/eet

ED31D-1184 0830h POSTER

Using Data in the Classroom: Resources for Undergraduate Faculty

Cathryn A Manduca (cmanduca@carleton.edu)

Science Education Resource Center, Carleton College, Northfield, MN 55057

On-line access to geoscience data and tools for data visualization and analysis are creating exciting new opportunities for engaging undergraduate students with data. The National Science Digital Library (NSDL) and DLESE both include access to data and tools as fundamental aspects of their vision and are currently striving to support faculty in using data in their courses. The Using Data in the College/University Classroom Workgroup at the 2003 DLESE Annual meeting brought together data providers, resource developers, and faculty to discuss issues surrounding data access and use in the undergraduate classroom. In order to improve understanding among these diverse viewpoints, workgroup participants created concept maps showing the relationships between data and education. These maps and other highlights of the working group discussion are available at http://swiki.dlese.org/ReportOut2003/26. The working group discussions built on substantial existing resources including: 2001 Report of the DLESE Data Access Working Group bringing together data providers and tool developers (www.dlese.org/documents/reports/meeting/Feb_01/dawg20801_outcomes.html); 2002 Using Data in the Classroom workshop bringing together faculty from across the disciplines (serc.carleton.edu/research_education/usingdata/workshop02/); 2003 Using Data in the Classroom report describing current uses of data in undergraduate science courses and faculty needs for data access and tools (serc.carleton.edu/ research_education/usingdata/report.html); NSDL Using Data in the Classroom Portal providing access to data, tools, teaching materials, and a discussion of pedagogic and development issues and opportunites for community contribution to these collections (serc.carleton.edu/research_education/usingdata/); Starting Point "Teaching with Models" site supporting faculty teaching at the entry level in using mathematical, statistical, and other types of models in their courses (serc.carleton.edu/introgeo/);

Earth Exploration Toolbook providing step-by-step instructions for using Earth science datasets and software tools in educational settings. (serc.carleton.edu/eet/); and NSDL projects developing data access and tools including THREDDS (www.unidata.ucar.edu /projects/THREDDS/); Data Discovery Toolkit and Foundry (www.newmediastudio.org/DataDiscovery/index.html); Collection and Distribution of Geoscience (Solid Earth) Data Sets (atlas.geo.cornell.edu/nsdl/nsdl.html); and Atmospheric Visualization Collection (www.nsdl.arm.gov/index.shtml) These resources will be available for exploration at our poster.

URL: http://serc.carleton.edu

ED31D-1185 0830h POSTER

Support and Dissemination of Teacher-Authored Lesson Plans: a Digital Library for Earth System Education (DLESE) and Geological Society of America (GSA) Collaboration

Holly Devaul[1] (303-497-2653; devaul@ucar.edu)

Rajul E. Pandya[1] (303-497-2650; pandya@ucar.edu)

Christine V. McLelland[2] (303 357-1082; cmclelland@geosociety.org)

[1]University Corporation for Atmospheric Research (UCAR), DLESE Program Center PO Box 3000, Boulder, CO 80303, United States

[2]Geological Society of America, P.O. Box 9140, Boulder, CO 80301-9140, United States

The Digital Library for Earth System Education (www.dlese.org) and the Geological Society of America (www.geosociety.org) are working together to publish and disseminate teacher-authored Earth science lesson plans. DLESE is a community-based effort involving teachers, students, and scientists working together to create a library of educational resources and services to support Earth system science education. DLESE offers free access to electronic resources including lesson plans, maps, images, data sets, visualizations, and assessment activities. A number of thematic collections have recently been accessioned, which has substantially increased library holdings. Working in concert with GSA, a non-profit organization dedicated to the advancement of the geosciences, small-scale resource creators such as classroom teachers without access to a web server can also share educational resources of their own design. Following a two-step process, lesson plans are submitted to the GSA website, reviewed and posted to the K-12 resource area: http://www.geosociety.org/educate/resources.htm. These resources are also submitted to the DLESE Community Collection using a simple cataloging tool. In this way resources are available to other teachers via the GSA website as well as via the DLESE collection. GSA provides a template for lesson plan developers which assists in providing the necessary information to help users find and understand the intent of the activity when searching in DLESE. This initial effort can serve as a prototype for important services allowing individual community members to contribute their work to DLESE with little technical overhead.

URL: http://www.dlese.org

ED31D-1186 0830h POSTER

You Can't Always Get What You Want, But You Can Create What You Need: The Promise of DLESE for Pre-service Teacher Education

Russanne Low (612-626-0205; rlow@cce.umn.edu)

University of Minnesota, 107 Armory Hall 15 Church St. SE, Minneapolis, MN 55455, United States

DLESE provides a practical and valuable alternative to conventional introductory Earth Science textbooks for college instructors teaching pre-service teachers. A review of commonly used introductory Earth science textbooks reveals a course of study that highlights topics not addressed in the K-8 National Science Education Standards, and misses others that are stressed in K-8 curriculum. Using DLESE objects, we created an on-line digital course supplement that replaces the traditional textbook and introduces a pre-service Earth science curriculum aligned to National and MN State Science Standards. There are some distinct advantages to a textbook-less approach: out-of-class study includes a variety of learning objects including scientific visualizations, diagrams, primary text sources, and video-clips, accommodating all learning styles. In addition, familiarity with the on-line environment facilitates the engagement of students in the application of real data to discover scientific concepts. One of the unexpected benefits of the DLESE-based curriculum is the increased motivation observed among members of the pre-service teacher cohort. The practical relevance of the curriculum is especially important to elementary teachers, many of whom are uncertain about their knowledge and ability to teach science. By the end of the course, the students know they have been exposed to every topic they are expected to teach. Importantly, they will also be skilled in the use of DLESE for their own lesson planning, curriculum development and ongoing personal professional development.

ED31D-1187 0830h POSTER

COMET Multimedia modules and objects in the digital library system

Timothy C. Spangler[1] (303-497-8473; spangler@comet.ucar.edu)

Joseph P. Lamos[1] (303-497-8465; lamos@comet.ucar.edu)

[1]University Corporation for Atmospheric Research, P.O. Box 3000, Boulder, CO 80307-3000, United States

Over the past ten years of developing Web- and CD-ROM-based training materials, the Cooperative Program for Operational Meteorology, Education and Training (COMET) has created a unique archive of almost 10,000 multimedia objects and some 50 web based interactive multimedia modules on various aspects of weather and weather forecasting. These objects and modules, containing illustrations, photographs, animations,video sequences, audio files, are potentially a valuable resource for university faculty and students, forecasters, emergency managers, public school educators, and other individuals and groups needing such materials for educational use. The COMET Modules are available on the COMET educational web site http://www.meted.ucar.edu, and the COMET Multimedia Database (MMDB) makes a collection of the multimedia objects available in a searchable online database for viewing and download over the Internet. Some 3200 objects are already available at the MMDB Website: http://archive.comet.ucar.edu/moria/

ED31D-1188 0830h POSTER

Libraries and Information Science: the Profession. Alternative Career Opportunities for Atmospheric, Earth, and Geo-scientists.

April M Love (949-824-7237; amlove@uci.edu)

University of California, Irvine, Science Library, P. O. Box 19557, Irvine, CA 92623-9557, United States

Many graduate students, researchers and scientists may not be aware that there are other career opportunities available to them as scientists besides the traditional academic, government, industrial and private sector tracks. Subject specialists with science backgrounds are in great demand. Knowledge management and information services affiliated with science and research is an exciting and creative profession. Contributing to, finding and delivering the range of information now emerging from new and established disciplines in all formats defines Information Science and Librarianship with a multitude of opportunities. This poster will offer information to encourage students and researchers with these skills and backgrounds to consider Information and Library Science as an exciting career path.

ED31E MCC: 3012 Wednesday 1020h

The GeoWall in the Earth Science Classroom II *(joint with P, SM)*

Presiding: **P J Morin,** University of Minnesota**; P van Keken,** University of Michigan

ED31E-01 1020h

Visualizing seismic wave propagation

Peter van Keken[1] (keken@umich.edu); Jeroen Tromp[2] (jtromp@gps.caltech.edu); Dimitri Komatitsch[2] (komatitsch@yahoo.com); Shalini Venkataraman[3] (shalini@evl.uic.edu); Nicholas Schwarz[3] (schwarz@evl.uic.edu); Luc Renambot[3] (luc@evl.uic.edu); Jason Leigh[3] (spiff@evl.uic.edu)

[1]University of Michigan, Geological Sciences 2534 CC Little Building, Ann Arbor, MI 48109, United States

[2]California Institute of Technology, Division of Geological and Planetary Sciences, Pasadena, CA 91125, United States

[3]University of Illinois at Chicago, Electronic Visualization Lab 851 S. Morgan St. Room 1120 SEO, Chicago, IL 60607, United States

An accurate understanding of the propagation of seismic waves in the Earth is of fundamental importance for Earth Scientists at any level. Wave propagation is generally difficult to understand due to the spherical geometry and strong compositional layering in the Earth. 3D heterogeneity, anisotropy and attenuation create further complexities. Several tools exists, including those developed by Alan Jones (www.geol.binghamton.edu/faculty/jones/jones.html) or Michael Wysession (epsc.wustl.edu), that help beginning and advanced geoscientists by visualizing wave propagation in the Earth for 1D velocity models. A recently developed spectral element method (SPECFEM3D; Komatitsch et al., Science, 298, 1737, 2002) solves the full wave equation in a 3D spherical Earth which allows the inclusion of more realistic effects such as 3D heterogeneity and anisotropy. Accurate models require high spatial and temporal resolution and the use of this code is therefore restricted to moderately large PC clusters or other parallel platforms. The high resolution presents also difficulties when attempting to visualize the wave propagation since the presence of high frequency information requires high spatial resolution in the visualization. We have developed various approaches to visualizing the realistic wave propagation, using both 2D slices and 3D volumes, at high resolution. The visualization tools will benefit researchers that use SPECFEM3D since it provides mechanisms of quality control, data querying and dissemination, while also allowing to share new computational results with students and the media. We will demonstrate and compare visualizations for a number of historical earthquakes and provide a preliminary report on how students in introductory and advanced geophysics courses appreciated the use of these tools.

URL: http://www.geowall.org/waves

ED31E-02 1035h INVITED

High-Resolution Multibeam Sonar Survey and Interactive 3-D Exploration of the D-Day Wrecks off Normandy

Larry A Mayer[1] (603 862-2615; lmayer@unh.edu)

Brian Calder[1] (603 862-3433; bcalder@ccom.unh.edu)

James S Schmidt[2]

[1]Center for Coastal and Ocean Mapping, University of New Hampshire, Durham, NH 03824, United States

[2]Naval Historical Center, Dept. of the Navy, Washington, DC 20009, United States

Historically, archaeological investigations use sidescan sonar and marine magnetometers as initial search tools. Targets are then examined through direct observation by divers, video, or photographs. Magnetometers can demonstrate the presence, absence, and relative susceptibility of ferrous objects but provide little indication of the nature of the target. Sidescan sonar can present a clear image of the overall nature of a target and its surrounding environment, but the sidescan image is often distorted and contains little information about the true 3-D shape of the object. Optical techniques allow precise identification of objects but suffer from very limited range, even in the best of situations. Modern high-resolution multibeam sonar offers an opportunity to cover a relatively large area from a safe distance above the target, while resolving the true three-dimensional (3-D) shape of the object with centimeter-level resolution. The combination of 3-D mapping and interactive 3-D visualization techniques provides a powerful new means to explore underwater artifacts. A clear demonstration of the applicability of high-resolution multibeam sonar to wreck and artifact investigations occurred when the Naval Historical Center (NHC), the Center for Coastal and Ocean Mapping (CCOM) at the University of New Hampshire, and Reson Inc., collaborated to explore the state of preservation and impact on the surrounding environment of a series of wrecks located off the coast of Normandy, France, adjacent to the American landing sectors The survey augmented previously collected magnetometer and high-resolution sidescan sonar data using a Reson 8125 high-resolution focused multibeam sonar with 240, 0.5° (at nadir) beams distributed over a 120° swath. The team investigated 21 areas in water depths ranging from about three -to 30 meters (m); some areas contained individual targets such as landing craft, barges, a destroyer, troop carrier, etc., while others contained multiple smaller targets such as tanks and trucks. Of particular interest were the well-preserved caissons and blockships of the artificial Mulberry Harbor deployed off Omaha Beach. The near-field beam-forming capability of the Reson 8125 combined with 3-D visualization techniques provided an unprecedented level of detail including the ability to recognize individual components of the wrecks (ramps, gun turrets, hatches, etc.),