NEWS

New User Facility for Environmental Sensing

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Hydrologic instrumentation is undergoing a transformative shift in its ability to concurrently measure scales from centimeters to kilometers [e.g., *Selker et al.*, 2006]. To rapidly distribute and incorporate these advances in the Earth and hydrologic sciences, the U.S. National Science Foundation's Earth Sciences Instrumentation and Facilities Program launched in September 2009 a community-accessible instrument facility for distributed temperature sensing (DTS) and wireless networked environmental sensing.

DTS systems for the facility use laser-induced Raman backscatter (spectrally shifted scattered light whose intensity can be related to the thermal state of the optical fiber) to measure the distribution of temperatures along fiber-optic cables up to 30 kilometers long. The DTS systems can measure temperatures along fiber-optic cable with spatial resolution of less than 1 meter and with temperature resolution of ±0.01°C. In contrast to "single point in space" measurements of environmental temperatures or "single point in time" remote sensing of temperatures, DTS provides the opportunity to continuously monitor temperatures of air, water, soil, or snow at high spatial and temporal frequency without the need for a large network of measurement systems. The DTS techniques, first widely deployed in the past decade by the oil and electric power industries, have been applied to a wide variety of near-surface Earth observations, including stream and groundwater interaction, snowpack evolution and melting, mixing and energy budgets of lakes and streams, soil moisture sensing, atmospheric processes, and dam seepage.

The Center for Transformative Environmental Monitoring Programs (CTEMPs), jointly operated by Oregon State University and the University of Nevada, Reno, provides short- and intermediate-term project access to five field-deployable DTS systems that can be shipped directly to project sites. CTEMPs is operating as an instrumentation node of the Hydrologic Measurement Facility of the Consortium of Universities for the Advancement of Hydrologic Science, Inc. These DTS systems are available to the Earth science community and can be configured for a wide variety of environmental measurements, data storage/data transmission protocols, and operating conditions. CTEMPs also will provide—as part of the field-deployable systems—wireless autonomous meteorological stations to augment the thermal data collection, as well as advice, guidance, and logistical services to the user community. CTEMPs users will have access to instrumentation as well as technical support for experiment design, field deployment, and data interpretation.

CTEMPs, working with industry, also will make extended-resolution (spatial and temporal) DTS systems available to address the most demanding applications of this technology. CTEMPs anticipates that in early 2010 it will make available to the research community a DTS with 0.25-meter spatial-scale and 1-second temporal-scale capability, which will be 4 times better spatial resolution and 10 times better temporal resolution than currently available instruments. Additionally, CTEMPs is testing a suite of other sensing systems, including fiber-optic distributed strain and acoustic sensing, and a spectrum of low-cost and high-precision point sensors suitable for traditional and wireless networked sensing systems.

CTEMPs also is offering a series of 1-day introductory short courses and 4-day hands-on workshops to train researchers and students on the leading edge of distributed sensing.

For more information about the center and its short courses, and to apply to use the field-deployable DTS systems, visit http://www.ctemps.org or contact Susan Atkisson at susan.atkisson@oregonstate.edu.

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FORUM

A New Approach to Data Publication in Ocean Sciences

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Data are collected from ocean sciences activities that range from a single investigator working in a laboratory to large teams of scientists cooperating on big, multinational, global ocean research projects. What these activities have in common is that all result in data, some of which are used as the basis for publications in peer-reviewed journals.

However, two major problems regarding data remain. First, many data valuable for understanding ocean physics, chemistry, geology, biology, and how the oceans operate in the Earth system are never archived or made accessible to other scientists. Data underlying traditional journal articles are often difficult to obtain. Second, when scientists do contribute data to databases, their data become freely available, with little acknowledgment and no contribution to their career advancement. To address these problems, stronger ties must be made between data repositories and academic journals, and a "digital backbone" needs to be created for data related to journal publications.

Links Between Data Repositories and Academic Journals

The Scientific Committee on Oceanic Research (SCOR) and the International Oceanographic Data and Information Exchange (IODE) of the United Nations Educational, Scientific and Cultural Organization's Intergovernmental Oceanographic Commission (IOC) are discussing how to provide better access to ocean data through increased submission to approved, open, online resources. Such new infrastructure and new approaches to data publication could help scientists who observe the ocean and model its processes. Most important, it is now timely to

- increase the availability of data used to create figures, tables, and statistical analyses in traditional journal articles;
- reinforce linkages between data lodged in data centers and science publications, particularly "data briefs"; and
- encourage the publishing of journals that specialize in "data publications" or "data briefs."

Data publications are short descriptions (as short as a few paragraphs of text), not interpretations, of data sets. They provide persistent pointers to the data in an approved data repository as well as references citable in papers that use the data, and in authors' curricula vitae.

Getting Journals on Board

Several journals in the ocean sciences already welcome the publication of data briefs. They include *Marine Micropaleontology*; *Geochemistry, Geophysics, Geosystems; Ecological Archives;* and *Earth System Science Data.*

Other journals also acknowledge the benefits of submitting the data underlying traditional publications to approved databases. In 1993, AGU first established its "Policy on Referencing Data in and Archiving Data for AGU Publications" (see http://www.agu.org/pubs/policies/data_policy.shtml). The policy emphasizes the importance for authors to submit data that are the basis for their papers to a recognized data archive. It also states AGU's commitment to ensuring the long-term archiving and protection of data. Data sets associated with articles are available at http://www.agu.org/pubs/esupp_browse.html, and access to these data does not require membership in AGU or subscription to an AGU journal.

Submission of data associated with journal publications is a standard practice in other domains, such as molecular biology, in which the gene sequences that are described in peer-reviewed publications must be submitted to GenBank or related archives. To help make such submissions standard in the ocean sciences, SCOR and IODE are working with editors and publishers of journals to discuss how to implement greater use of data publication.

Building a Digital Backbone

To archive and administer data related to journal publications, additional infrastructure in data management systems is required. Such infrastructure must be implemented with minimal costs to avoid impeding the publication process (see Figure 1). The "eRepository" technology developed by the digital library community delivers some of the functionality needed for this infrastructure. However, it does not provide added value—in terms of harmonization with other data in the system, quality control, and metadata enhancement—associated with the IODE network of national data centers.

A workable compromise would be to use eRepository technology as "front-end" processes of data centers that serve ingested data sets "as is" in the short term, as well as providing added value to data sets through existing data management infrastructure in the medium and long terms. This new infrastructure should improve the data publication review process through closer collaboration between data centers and journal editors.

SCOR and IODE are working with existing data centers, libraries, and journals to promote the development of the infrastructure required to provide ocean sciences publications with an effective "digital backbone." Other groups are also spearheading efforts to link academic journals to data repositories. Ongoing cooperative activities are along three lines:

1. SCOR and IODE are continuing to work with editors of ocean science journals to establish pilot projects along the lines described in Figure 1.

2. The Marine Biological Laboratory/Woods Hole Oceanographic Institution (WHOI) library is working with the U.S. Biological and Chemical Oceanography Data Management Office (BCO/DMO) at WHOI on a pilot project on how libraries and data centers could work together to provide the digital backbone for traditional journal publications, ensuring that data sets have appropriate associated metadata and are easily accessible.

3. The British Oceanographic Data Centre is working on a pilot project to repackage existing data holdings into data sets appropriate for assignment of persistent identifiers to provide a mechanism for concrete links to scientific publications.

The work flow diagram in Figure 1 will be revised as scientists, data managers, and journal editors gain experience from the pilot projects. Important questions raised by the ocean science community include the following:

- What should be the details of quality control in data centers? A simple action would be to ensure that submitted data are machine readable. Other actions might be to ensure that data sets include a minimal set of metadata.

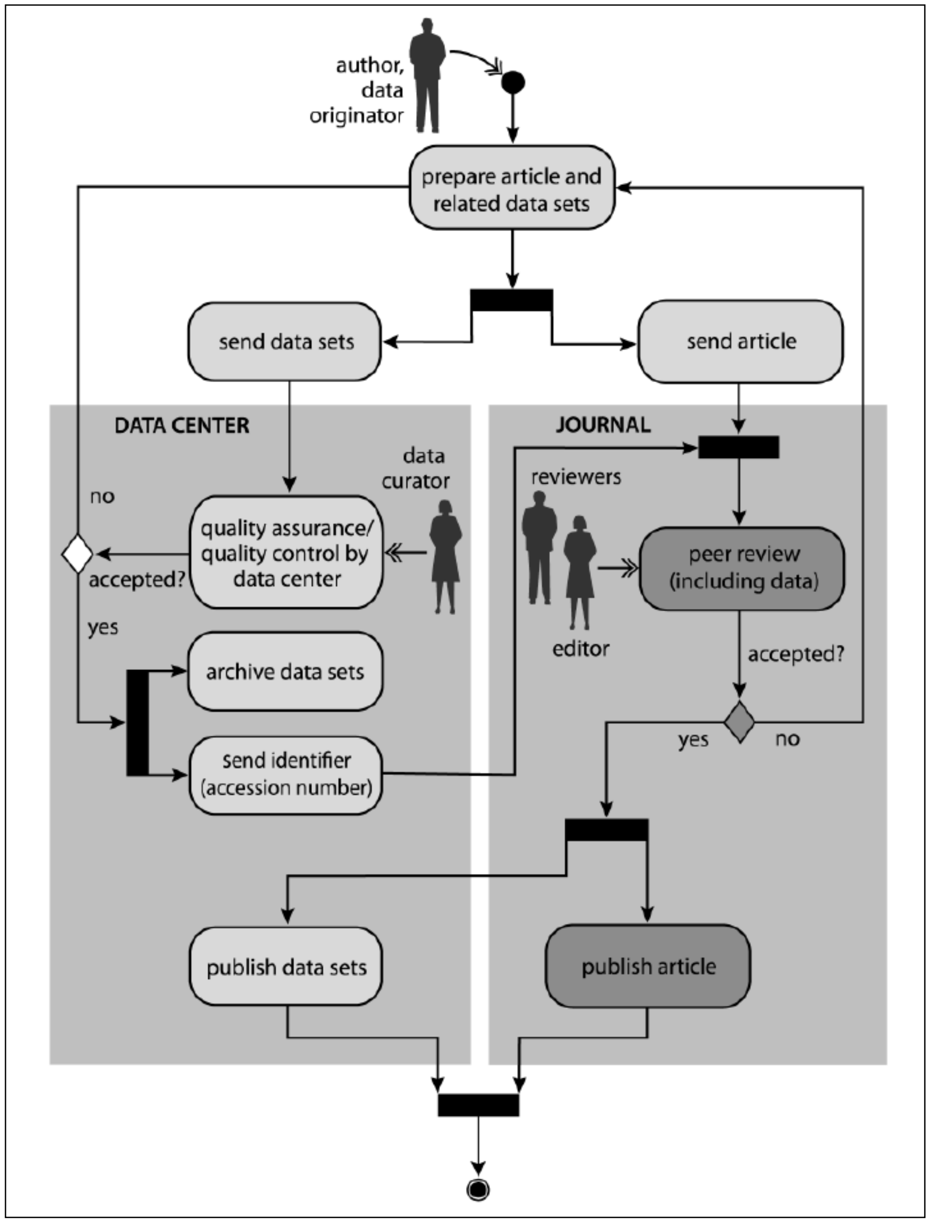

Fig. 1. Suggested work flow for peer-reviewed data publications in the ocean sciences. Image modified from Scientific Committee on Oceanic Research/International Oceanographic Data and Information Exchange *[2008]. At the end point of this flowchart are freely available peer-reviewed papers and data sets.*

• What happens to data associated with articles that are not published? Such data may still be valuable to other scientists, and archiving should ensure that the data originator receives appropriate credit.

• What processes will be needed to ensure that data are archived, assigned a persistent identifier, and accessible before the associated paper is published? The timing surrounding the implementation of this process is especially important as publication times become faster and review drafts of papers become available through electronic publishing.

• What are the rights and responsibilities of data archives during the review process, in terms of data release, data protection, timing, etc.?

• What existing persistent identifier should be assigned to data referenced in journal articles? Digital object identifiers (DOIs) have become an almost de facto standard in journal publishing, but other options exist. Whichever identifier is used, the issue of the “least publishable unit” for assignment of an identifier must be tackled.

More details about the SCOR/IODE activity are available at http://www.iode.org/datapublishing. The authors welcome input on this topic from the geosciences community.

Reference

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MEETINGS

Earth Sciences Push Radiative Transfer Theory

2009 International Conference on Advances in Mathematics, Computational Methods, and Reactor Physics; Saratoga Springs, New York, 4–7 May 2009

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The theories of radiative transfer and particle—particularly neutron—transport are grounded in distinctive microscale physics that deals with either optics or particle dynamics. However, it is not practical to track every wave or particle in macroscopic systems, nor do all of these details matter. That is why Newton’s laws, which describe individual particles, are replaced by those of Euler, Navier-Stokes, Maxwell, Boltzmann, Gibbs, and others, which describe the collective behavior of vast numbers of particles. And that is why the radiative transfer (RT) equation is used to describe the flow of radiation through geophysical-scale systems, leaving to Maxwell’s wave equations only the task of providing the optical properties of the medium, be it air, water, snow, ice, or biomass. Interestingly, particle transport is determined by the linear transport equation, which is mathematically identical to the RT equation, so geophysicists and nuclear scientists are interested in the same mathematics and computational techniques.

In nuclear science and engineering, transport theory holds a very high profile. Clearly, it is important to know that reactor criticality or radiation medicine dosage is computed to as many decimal places as possible. Accordingly, particle transport theoreticians regroup every 2 years at the American Nuclear Society’s Mathematics and Computation (M&C) Conference series. At M&C 2009, there were two cross-disciplinary sessions of immediate interest to the geophysics community: “Radiation transport in the Earth sciences” and “Transport in stochastic media.”

The former session was composed almost entirely of invited papers by RT experts in various aspects of geophysics, especially the cloudy atmosphere. The speakers showcased progress, often at the fundamental level, capitalizing on the common mathematical language. Extensions from steady state to time-dependent problems, from intensity/scalar-RT to polarized/vector-RT, and from one- to three-dimensional geometries were covered, as was the modeling of intricate RT processes in vegetated surfaces and at interfaces between distinct media. The results presented were timely and important for remote sensing of the environment, as well as for radiation energy budget estimation in global climate models, using innovative deterministic and Monte Carlo numerical methods.

The latter session is a regular feature at M&C events, but this year it was almost half populated by speakers originally invited for the special Earth science session. These speakers reported on large-scale RT effects from unresolved random spatial variability. This merged scheduling demonstrates the ease with which transport theoreticians can cross huge disciplinary divides.

By all accounts, these sessions were a very successful outreach effort by the American Nuclear Society. Several of the “Earth science” invitees attended the full meeting, running from session to session to hear the latest on the daunting technicalities of the RT equation, with its six or seven independent variables. A special issue of the *Journal of Quantitative Spectroscopy and Radiative Transfer* will be dedicated to the breadth of topics covered at these sessions.

In summary, Earth science challenges RT at its core, thus justifying deep dives into the foundations of the theory. The meeting highlighted the possibility that new ideas—and maybe collaborations from the world of nuclear science and engineering—will enable scientists to resurface from those dives with the potential for breakthrough in the applications.

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