planners from their local communities. The pilot curriculum will be both *interdisciplinary*—combining science, social studies, mathematics and other subjects—and *intergenerational*—involving students of all ages and adult community members.

Satellite imagery provides a natural focus for integrating academic disciplines. The physical sciences and mathematics are required to understand the technology of remote sensing; earth and environmental sciences, geography and local history are involved in interpreting the images. Students will develop decision-making and communicative skills by working in teams to "ground truth" images, organize the information and report to their local town planners. They will experience computers as valuable tools and science as a quest for answers rather than a collection of known facts.

The program will begin in two neighboring coastal towns in Maine—Boothbay Harbor and Wiscasset—and later be offered to other towns in Maine. Through a grant from Apple Computer, Inc., each school will receive a Macintosh IIci computer equipped with a color monitor. Image analysis software and satellite images of the land and oceans will be furnished by the Bigelow Laboratory and the Island Institute.

In the first year, each participating school will receive a satellite image of their local area and image analysis software developed by the Island Institute. All students in these towns will be introduced to the technology. Interested primary- and middle-school students will participate with high school science classes to produce a thematic map of their communities. Teams of students and adults will conduct field trips to "ground truth" images, thereby identifying the various types of land cover (wetlands, forests, fields, paved surfaces, etc.) seen as spectrally distinct pixels in the images. New satellite images acquired at intervals of three to five years will be used to study temporal changes in natural habitats and land-use patterns and to build a valuable historical record for the town.

In the second and third years, the curriculum will be expanded to include imagery of the Gulf of Maine, North Atlantic and other regions of the world's oceans. As the spatial scale of their images increases, focus will move from local to regional and finally to global environments over a three-year period. Other schools entering the program in the second year will begin with a local "mapping project" and will draw on the experiences of the pilot-year teachers and students. A summer workshop for teachers will be conducted each year, and instructional materials will be developed for the widest possible distribution.

The global perspective of remote sensing promises to provide answers to some of the perplexing global ecological problems humans now face. This perspective has given rise to a new science—Earth Systems Science—that views the atmosphere, oceans and land as one interconnected whole. The curriculum goal is not to inspire students to become future scientists, though this may happen in some cases. Instead, our goal is to enable students to become effective citizens of local, regional and global communities by empowering them with the tools and knowledge to make decisions and effect change. Our aim is to engage students in learning about and preserving their environment. Whether students become scientists or not, it is important to provide them with an understanding of the technologies that will affect their lives.

To achieve these goals requires three critical steps: (1) schools must be equipped with the appropriate tools; (2) technical knowledge presently residing in the research community must be translated into a language understood by teachers and students; and (3) a curriculum must be developed, tested and the resultant instructional materials published.

A grant of equipment from Apple Computer, Inc., affords us the opportunity to take the first step. Apple will provide the necessary computer equipment for six schools in the first year (1990-91). There is the possibility to expand the program to twenty schools in the second and third years. Thousands of students in Maine stand to benefit from this program over the next three years.

In 1990, the computers (Macintosh IIci's) donated by Apple are still rather expensive for most public school budgets. Within the next five years, the computer equipment needed should become more affordable if present trends continue. By that time, we hope to have made progress with steps two and three. Our long-range goal is to produce textbooks and other instructional materials that will enable teachers to bring satellite imagery and remote sensing technology into classrooms anywhere in the world. If we can afford to take all three critical steps, we have an opportunity to affect education in a major way. ❑

CMOS CONGRESS

THE WINNIPEG CENTRE of the Canadian Meteorological and Oceanography Society (CMOS) will host the Twenty-Fifth Annual CMOS Congress at the Delta Hotel, Winnipeg, Manitoba, Canada, from June 4-7, 1991.

The general theme will be Northern Meteorology and Oceanography. All papers related to physical, chemical and biological aspects of the above theme are especially welcome. Within the general theme, sessions will be held on physical, chemical and biological properties of the Arctic Ocean, ice in the north, the climate and weather of the north, climatic change and northern impacts, Arctic air pollution and northern hydrology. Papers on any topic of interest to CMOS members will also be considered.

Special sessions will be held on prairie storms and applications of chaos theory in meteorology and oceanography. CMOS Committees and Council will meet on June 3, 1991, at the Delta Winnipeg Hotel.

When submitting an abstract, please indicate whether you wish to present your paper orally or have a poster presentation. The Scientific Committee reserves the right to transfer some papers to poster sessions if an excess number of papers have been submitted for oral presentations.

Abstracts should be delivered by February 1, 1991, to: Mr. Rick Lawford; Chairman, Scientific Programme Committee; National Hydrology Research Centre; 11 Innovation Blvd.; Saskatoon, Saskatchewan, Canada, S7N 3H5; Telephone: (306) 975-5756; Fax (306) 975-5143.

For additional information about the location, contact: Mr. Bevan Lawson; Chairman, Local Arrangements Committee; Prairie Weather Centre; 266 Graham Ave., Room 900; Winnipeg, Manitoba, Canada, R3C 3V4; Telephone: (204) 983-4513; Fax: (204) 983-0109. ❑

CALENDAR OF MEETINGS

**Denotes co-sponsorship by The Oceanography Society*

*The Second Scientific Meeting of The Oceanography Society

Date: March 24-28, 1991
Location: Bayfront Center's Mahaffey Theater and the St. Petersburg Hilton and Towers, St. Petersburg, Florida
Sponsor: The Oceanography Society
Abstract Deadline: January 11, 1991
Contact: Judi Powell, Executive Director,The Oceanography Society, 1755 Massachusetts Ave. N.W., Suite 700, Washington, D.C. 20036; Telephone: (202) 234-2109; Fax: (202) 234-9538; Telemail Omnet: OCEANOGRAPHY.SOCIETY.

Hazards '91—International Symposium on Geophysical Hazards in Developing Countries and Their Environmental Impacts

Date: April 21-27, 1991
Location: Cairo, Egypt
Sponsors: The International Society for the Prevention and Mitigation of Natural Hazards; The Tsunami Society; The International Association for the Physical Sciences of the Oceans (IAPSO); IAPSO Commission on Marine Natural Hazards; Academy of Scientific Research and Technology, Egypt; International Tsunami Information Center
Abstract Deadline: Past
Contact: Dr. T.S. Murty, Chairman, International Scientific Committee, Hazards-91, c/o Institute of Ocean Sciences, P.O. Box 6000, Sidney, B.C., Canada V8L 4B2; Telephone: (604) 356-6311; Fax (604) 356-6390; Telex: 04-97281.

37th Brookhaven Symposium in Biology

Date: June 2-6, 1991
Location: Brookhaven National Laboratory, Upton, New York
Sponsor: Brookhaven National Laboratory, Associated Universities, Inc.
Contacts: Dr. Paul Falkowski, Department of Applied Science, or Dr. Avril Woodhead, Biology Department, Brookhaven National Laboratory, Upton, NY 11973; Telephone: (516) 282-2961; Fax (516) 282-3000; Telex: 6852516 BNL DOE.

Twenty-Fifth Annual Canadian Meteorological and Oceanography Society Congress

Date: June 4-7, 1991
Location: Delta Hotel, Winnipeg, Manitoba, Canada
Sponsor: The Winnipeg Centre of CMOS
Abstract Deadline: February 1, 1991
Contact: Mr. Rick Lawford; Chairman, Scientific Programme Committee; National Hydrology Research Centre; 11 Innovation Blvd.; Saskatoon, Saskatchewan, Canada, S7N 3H5; Telephone: (306) 975-5756; Fax (306) 975-5143.

5th International Conference on Toxic Marine Phytoplankton

Date: October 28-November 1, 1991
Location: Newport, Rhode Island
Sponsor: University of Rhode Island Graduate School of Oceanography
Pre-registration Deadline: Past
Contact: Dr. Theodore J. Smayda, University of Rhode Island, Graduate School of Oceanography, Narragansett, Rhode Island 02881-1197; Telephone: (401) 792-6171; Fax (401) 792-6160.

*Aquatic Sciences Meeting

Date: February 10-14, 1992
Location: Sweeney Convention Center, Santa Fe, New Mexico
Sponsor: The American Society of Limnology and Oceanography
Abstract Deadline: Forthcoming
Contact: Dr. Polly A. Penhale, ASLO Secretary, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA 23062; Telemail/Omnet: P.PENHALE.

Fourth International Conference on Paleoceanography

Date: September 21-25, 1992
Location: Kiel, Federal Republic of Germany
Sponsor: GEOMAR
Abstract Deadline: Forthcoming
Contact: ICP IV Organizing Committee; c/o GEOMAR; Wischhofstrasse 1-3/Bldg. 4; D-2300 Kiel 14, FRG; Telephone: (49) 4 31/72 02(0)-, Ext. 7202-115; Fax: (49) 4 31/72 53 91.

COMPARISON OF TERRESTRIAL AND MARINE ECOLOGICAL SYSTEMS

A WORKSHOP on this subject was held in 1989 with partial National Science Foundation support. The report (copies available from J. Steele) discusses the various problems, logistic and conceptual, in making such comparisons, but its main conclusion is that we should have workshops or summer schools that focus on specific topics where interactions between the different sectors would be most fruitful. A recent meeting of the Steering Committee (J. Cohen, P. Dayton, T. Kratz, S. Levin, R. Ricklefs and J. Steele) proposed that three topics be selected from the report—patch dynamics, long-term data sets and analysis of community structure. Each of these would be the focus of a workshop/school lasting four weeks, with about twenty-five to thirty participants. The intent would be to compare data sets and methods of analysis across the terrestrial, freshwater and marine sectors. The output would be research methods, ideas and applications. The present tentative plan is to hold the first of these workshops on patch dynamics in summer 1991 with S. Levin, T. Powell and J. Steele as the organizers. We wish to learn the level of interest, especially at the graduate student and post-doctoral level. Please contact any of the organizers with your ideas and opinions: S. Levin, Center for Environmental Research, 345 Corson Hall, Cornell University, Ithaca, NY 14853-2701, (607) 255-4617; T. Powell, Division of Environmental Science, University of California, Davis, CA 95616, (916) 752-3026; J. Steele, Woods Hole Oceanographic Institution, Woods Hole, MA 02543, (508) 548-1400. ❑

BIOLOGICAL OCEANOGRAPHY: AN EARLY HISTORY, 1870 TO 1960

By Eric L. Mills

1989, 378 pp., $42.50, Cloth, Cornell University Press, Ithaca, NY.

Reviewed by David J. Carlson

In the mid-nineteenth century, biologists studying the oceans were mostly interested in discovering deep-sea organisms. Today biological oceanographers pay most attention to processes in the surface ocean. In his latest volume of oceanographic history, published by Cornell University Press in its History of Science Series, Eric Mills describes the period from 1870 to 1960 during which focus shifted from deep-sea natural history to upper ocean plankton dynamics and when, as a result, biological oceanography evolved and separated from marine biology. Although the history is titled *Biological Oceanography*, the book's primary topic is the progressive understanding of plankton dynamics in relation to chemical and physical oceanographic factors, a topic relevant, perhaps instructive, to many present-day oceanographers. Dr. Mills also touches on historical patterns of promotion and remuneration of oceanographers, of ship availability, and of private, federal and institutional support for oceanography, issues that provoke and perplex us still.

The inception and evolution of biological oceanography—distinct from marine biology by its attention to process rather than organism and destined eventually to separate from general ecology because of its attention to fisheries, its early need to invent and apply mathematical models, and its operation largely at institutes dedicated to oceanography—occurred mostly in northern Europe. There, increased populations, diminished agricultural resources, and improved fishing technology had most affected fisheries, and trained observers and experimenters were available from non-marine disciplines in the European university system. Because most instructors and students in that system were men (and severely well dressed if photographs of sea-going attire are accurate evidence), the initial biological oceanographers were male (Sheina Marshall of the Scottish Marine Biological Association laboratory and Penelope Jenkin and Marie Lebour of the Plymouth Laboratory are notable exceptions). Mills introduces us first to Victor Hensen, a German biochemist, anatomist and physiologist who turned his attention to marine subjects when nascent Germany formed a commission for the study of its seas. Hensen recognized that small planktonic organisms were important components of marine systems but more importantly felt that their abundance could be determined systematically and accurately. He eventually developed and calibrated plankton nets to be lifted vertically through the water column. Hensen was followed by Karl Brandt who, with colleagues of the so-called Kiel School (after Kiel University), first determined that nitrogen and other nutrients could limit phytoplankton growth and recognized geographical patterns evident in plankton abundance data collected by Hensen. (One of Brandt's colleagues, Hans Lohmann, also showed that Hensen's nets failed to collect nanoplankton and developed centrifugation and filtration techniques to improve collections.) The work of the Kiel School was extended in Norway by H.H. Gran. Gran described spring blooms in Norwegian coastal waters (the Kiel group had not recognized or not emphasized blooms in their data), documented vertical inhomogeneity (which had been obscured by Hensen's vertical tows), understood (with the help of A. Nathansohn, a German physicist) the importance of vertical mixing in supplying nutrients and controlling phytoplankton growth and described and then measured (using light and dark bottles) the compensation depth—that depth where energy gained by photosynthesis balances the energy spent in respiration. These and other efforts led eventually to the work of G. Atkins and H.W. Harvey at the Plymouth (England) Laboratory who improved meth-

[CONTINUED ON LOWER PAGE 62]

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