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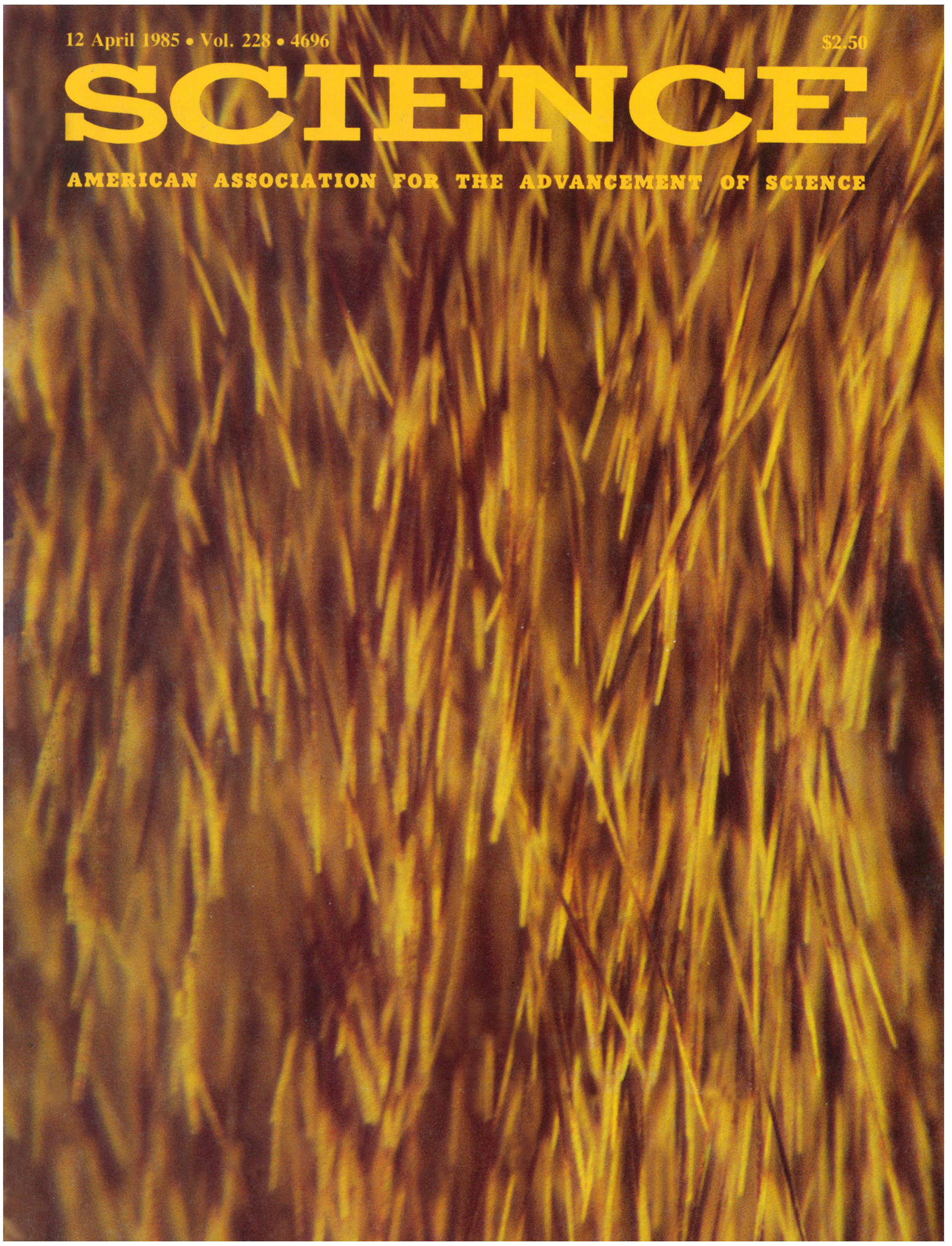

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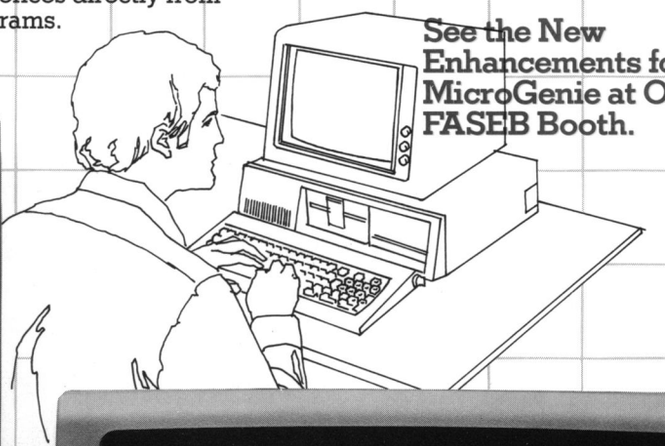

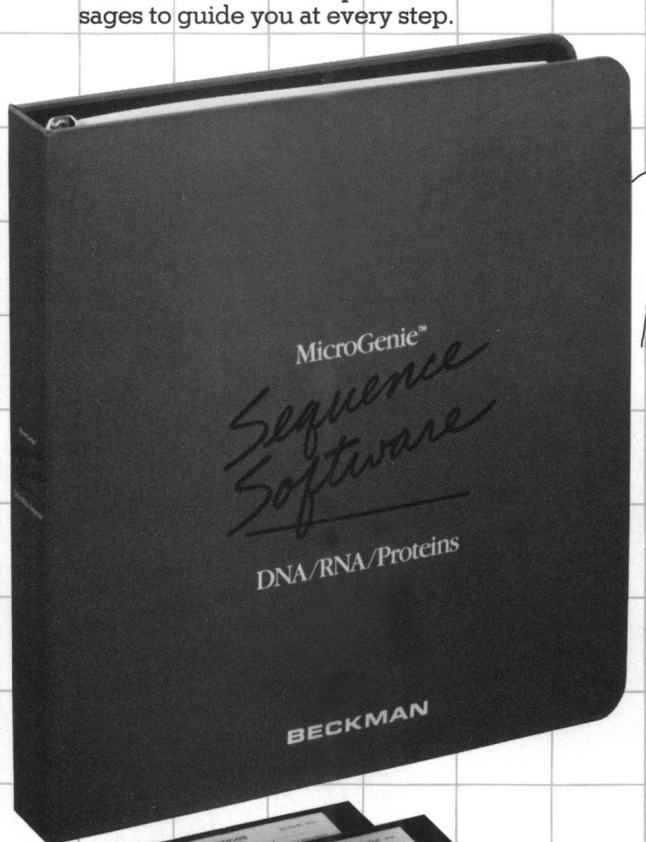

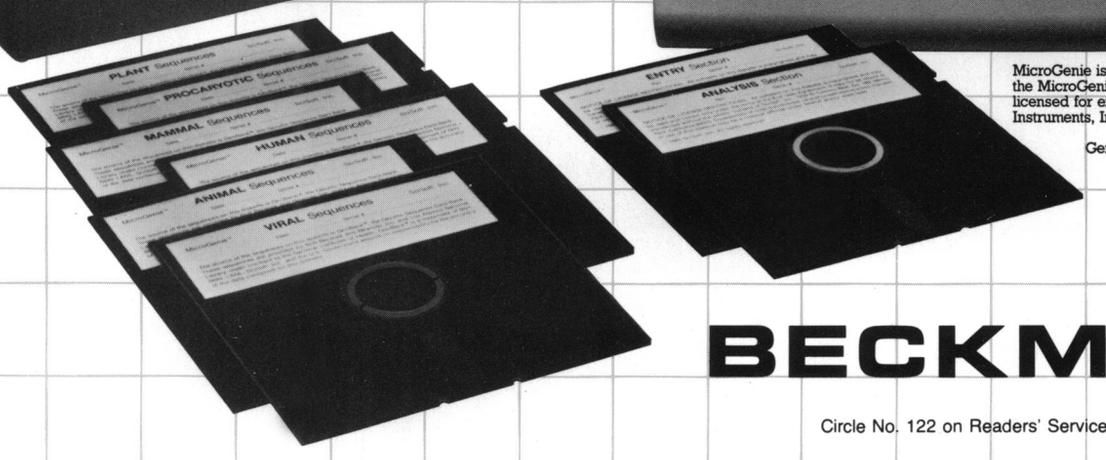

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COVER

"Fur" (technically pile) on thorax of moth, *Orthosia rubescens*. Such fur allows noctuid winter moths to maintain thoracic temperatures above 30°C during flight at near freezing temperatures in late winter. It consists of modified scales (that color Lepidoptera wings), elongated to near 2 millimeters to serve as insulation. See page 177. [Bernd Heinrich, University of Vermont, Burlington 05405]

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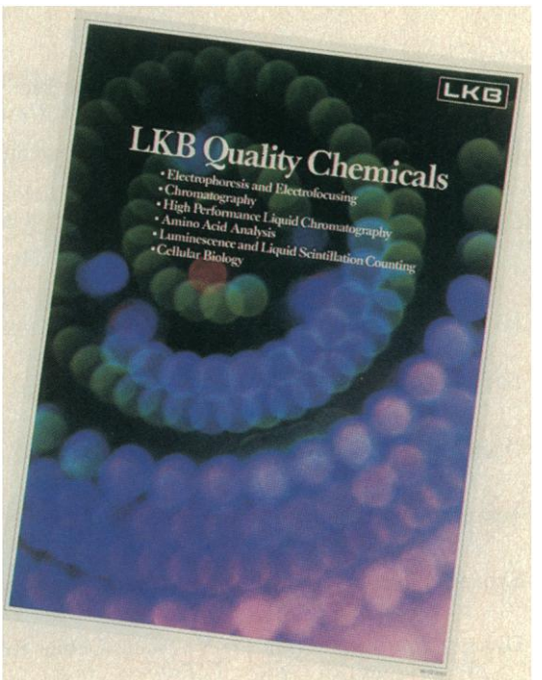

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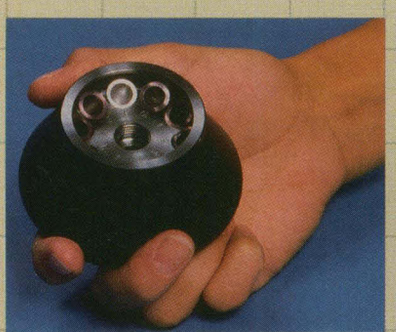

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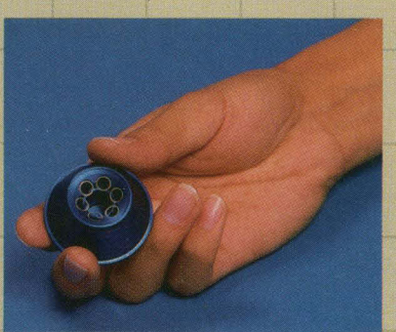

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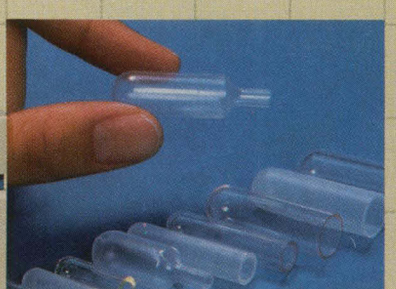
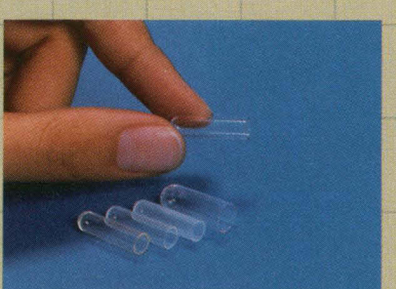


TL-100 milliliter-sized tubes. A choice of 10.



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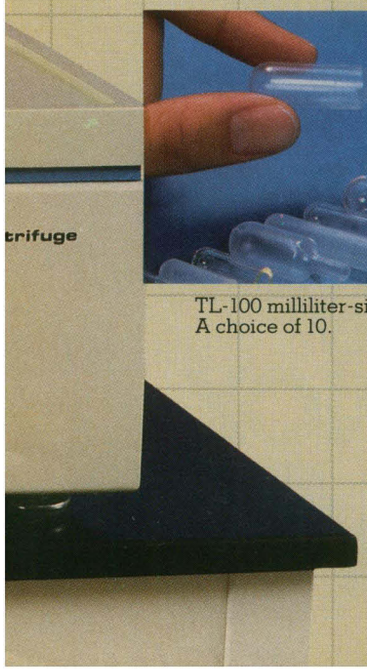

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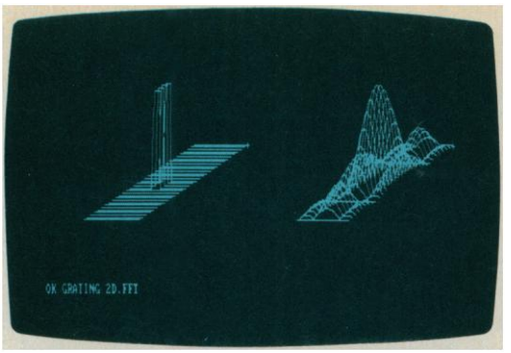
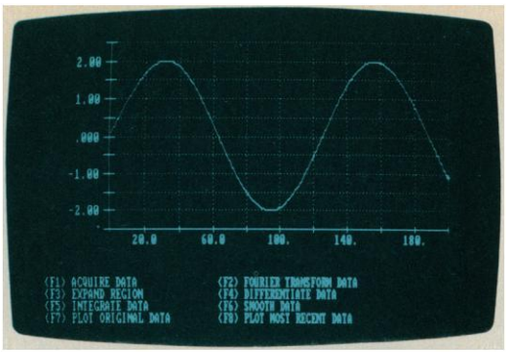


ASYST multiple windows permit side-by-side comparisons. The two-dimensional FFT routine, shown, is one of the many built-in functions.



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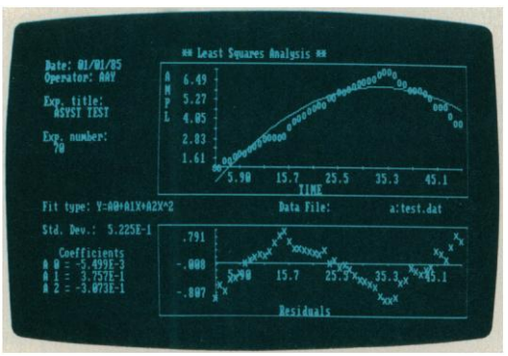

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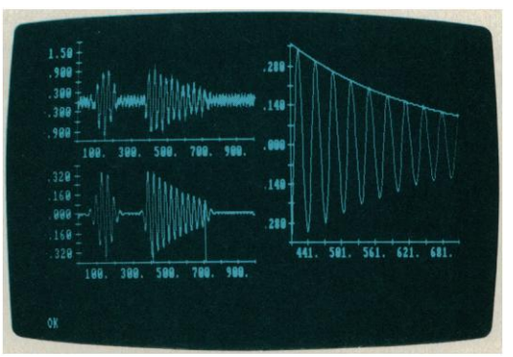

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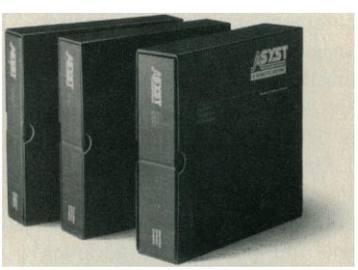

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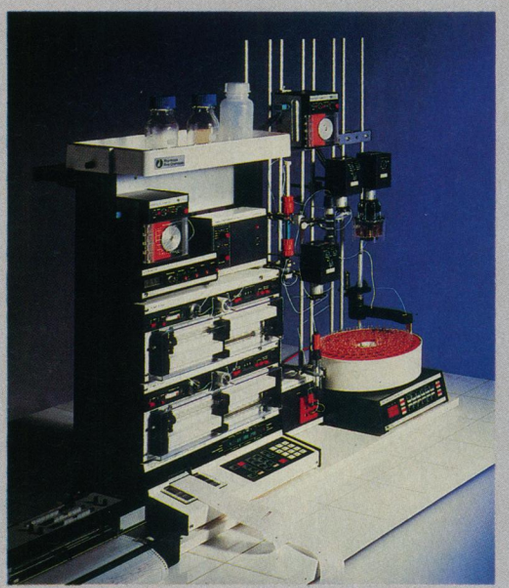

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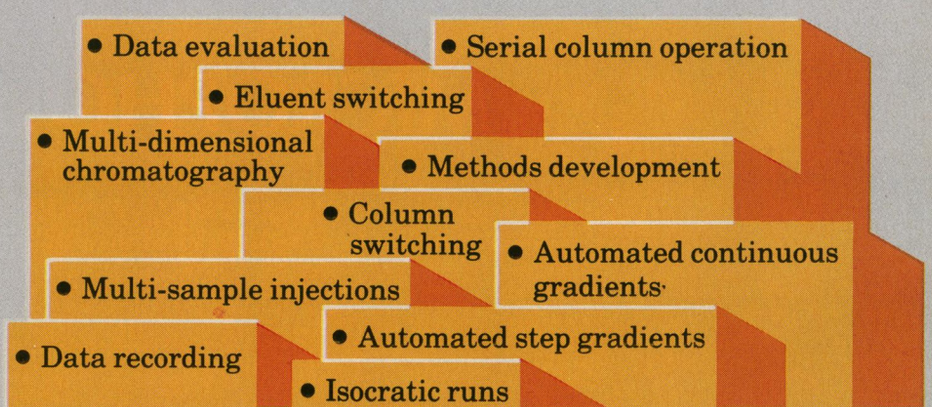

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12 April 1985, Volume 228, Number 4696 **SCIENCE**

Oceanography from Space

Climate variability affects large segments of our economy from the Florida citrus grower and the Kansas farmer to the utility and construction industries. Our nation would benefit in several ways from better climate prediction capabilities.*

The possibility of improved prediction depends critically on understanding the role of the oceans in the climate system. It is fortunate that new space technology promises to provide the necessary global synoptic descriptions of the upper oceans and their interaction with the atmosphere and that new computer resources are ready to help analyze and model the data.

The currents, the eddies, and the driving forces—winds, radiation, and mass flux at the ocean surface—must all be measured simultaneously and globally if we are to understand air-sea interaction processes and to construct accurate predictive models. Such measurements can be obtained only by satellite-borne instrumentation, appropriately complemented by in situ data. Satellite measurements of global biological processes, particularly near-surface ocean biology, are also an essential key to understanding the biogeochemical cycles of carbon dioxide.

The ocean science community has recognized the special role of satellites by developing a phased plan for oceanography from space, a series of four satellite missions for ocean physics, biology, and geodesy. The first of these is the Navy's Remote Ocean Sensing System (NROSS), scheduled for 1989; it will provide operational information on ocean waves and eddies and research data on surface winds.

The second of the series is proposed as a joint United States–French mission, TOPEX/POSEIDON, that will carry a high-precision altimeter to measure the topography of the ocean surface. This topography results from the combined effects of winds, currents, and gravity. Together with the ocean surface winds measured by NROSS, the global data on ocean currents revealed by TOPEX/POSEIDON will provide for the first time a synoptic global description of ocean circulation. Mission studies for TOPEX/POSEIDON have been conducted during the past 5 years, and the satellite design studies have been completed, emphasizing low-risk, flight-proven technology. Participation by the French will not only provide a significant savings in cost from a solely U.S. mission but will also continue a valuable international cooperative effort. Current planning is aimed for flight in 1990 depending on budgetary approval. Launch of TOPEX/POSEIDON in 1990 is deemed critical by oceanographers because, without simultaneous measurements of currents and winds, we cannot hope to understand the physics of large-scale and long-term air-sea interaction.

The third and fourth steps in the satellite series focus on biology and geodesy. NASA is currently investigating flight opportunities for ocean color measurements that allow determination of chlorophyll content of the surface layers and provide flow visualization. This mission has been recommended by the ocean science community for launch in 1990. For measurements of the earth's gravity and magnetic field, a geopotential research mission is proposed for launch in 1991. Measurements of the earth's gravity will enable us to determine the effect of gravity on the topography of the ocean surface—the geoid—and thus in combination with the altimeter measurements to determine absolute currents.

By coming to a general consensus, oceanographers have put together a plan that opens the door to a quantum jump in description and understanding. The data will be central to predictive systems for protection and control of our exclusive economic zone, fisheries conservation and management, offshore oil and gas production, and mineral extraction. This new program should have high priority in the nation's overall science effort.—ROGER REVELLE, *Professor of Science and Public Policy, University of California, San Diego, La Jolla 92093*

*B. I. Edelson, "Mission to planet earth," *Science* **227**, 367 (1985).

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