

JOHN R. APEL, RICHARD F. GASPAROVIC, and CHARLES C. KILGUS

GUEST EDITORS' INTRODUCTION

This issue of the *Digest*, "APL Ocean Sciences—1989," is the sixth in a series of theme issues dedicated mainly to results from oceanographic research and engineering programs at the Laboratory. Previous issues* dealt in part with some wet-deck research into upper-ocean small-scale dynamics and with remote measurement oceanography using both radar altimeters and synthetic aperture radars (SAR's). This issue continues with those orientations but displays what is increasingly becoming the norm in ocean science: large, collaborative, multiorganizational research.

The articles have been collected into three groupings. The first group deals with internal waves and scattering of electromagnetic energy from their surface manifestations, a subject of continuing research interest at APL. Three papers treat results from a joint U.S.–Norway experiment in the Sognefjord (see the front cover) during which ship-generated internal-wave wakes were observed using multifrequency radars. Apel and Gjessing give an overview of the experiment and the concepts behind the so-called delta-k radar, an instrument in whose development Gjessing has played an important role. The hydrodynamics of the internal-wave wakes is treated by Norwegian colleagues Dysthe and Trulsen, who refine an analytic ship-wake theory and apply it successfully to the Sognefjord data. In an article that sheds considerable light on the attributes of delta-k radars, Jensen presents a theoretical analysis of the measurement process for a multifrequency radar.

In a slightly different vein, Gasparovic et al. present the results of a joint program between the United Kingdom and the United States in Loch Linnhe, Scotland, in which SAR is used to observe ship-generated internal waves. Their article shows how electromagnetic scattering theory may be successfully applied to simulating the intensity modulations of the internal waves in the SAR imagery. Thompson discusses microwave scattering from a moving ocean surface and applies a time-dependent scattering model to compute the Doppler spectrum of the radar returns from ocean waves. Watson, using field data from another multinational program, shows how large internal solitary waves in the Strait of Gibraltar are refracted by the bathymetry there. And Allen and Joseph discuss a statistical-mechanical theory for oceanic internal waves that produces the well-known Garrett–Munk spectrum from first principles.

*Previous ocean-oriented issues of the *Digest*: Vol. 3, No. 1 (1982); Vol. 6, No. 3 (1985); Vol. 6, No. 4 (1985); Vol. 8, No. 1 (1987); Vol. 8, No. 2 (1987).

The second set of articles offers an update on the continued flow of extraordinary results from the Navy's radar altimeter satellite, Geosat. An earlier issue of the *Technical Digest* described the Geosat system and gave an overview of the results of the 18-month geodesy mission (1985–1986). On 7 November 1986, Geosat began an Exact Repeat Mission (ERM), developed by the Naval Ocean Research and Development Activity (NORDA), acquiring data along a 17-day repeating ground track that follows the Seasat tracks laid down in 1978. The ERM data set has enabled NORDA to develop a unique system for merging Geosat sea-surface height data with satellite infrared sea-surface temperature data to map the Gulf Stream front and eddy system. These various data products are now routinely provided to the fleet by the Naval Oceanographic Office in support of Navy operations.

Data from the ERM have allowed Cheney et al. of NOAA to map the dynamics of sea level over the entire tropical Pacific on an operational basis. The Geosat altimeter mapping captured the propagation of a pulse of warm water across the Pacific during the 1986 El Niño and the subsequent redistribution of water in the cold phase of the cycle, La Niña. An understanding of the impact of this phenomenon on interannual climatic variability is the goal of the NOAA effort.

Research at APL and Harvard University (and independently at NORDA) has led to the development of a "synthetic" geoid, an important advance in our ability to measure the ocean from space, as Porter et al. discuss. The synthetic geoid allows the total dynamic topography of even small-amplitude (on the order of 15 cm) mesoscale features on the sea surface to be measured with a precision of a few centimeters. The technique avoids the signature distortion introduced by earlier processing techniques that attempted to remove the geoid from the altimeter data.

The synthetic geoid has been incorporated into an APL real-time ocean monitoring and forecasting system, as described by Calman and Manzi. The system demonstrates that the altimetric data can be processed on a workstation-class computer in near real-time. The ERM data provided to the oil exploration community have also made possible the tracking of large eddies that affect drilling operations in the Gulf of Mexico.

An analysis of radiometric measurements of satellite water vapor has shown that, at mesoscale wavelengths, water vapor causes a small residual uncorrected error in Geosat altimetric height measurements, corrupting at

most a few percent of data segments (see Monaldo in this issue). The impact on planetary-scale ocean wavelength measurements can be severe, however, requiring the merging of correction data from other satellites with the altimeter data.

Concluding this second group of articles, Haines et al. discuss the development of new gravity models as part of the NASA TOPEX program, which is allowing orbits with unprecedented precision (on the order of 35 cm) to be computed for the ERM. This development will enable Geosat oceanographic measurements to be made on time scales and space scales that have hitherto been corrupted by long-wavelength orbit errors.

By any measure, the Geosat oceanographic mission has been a highly successful program, reinforcing the value of altimetric satellites. The World Ocean Circulation Experiment (WOCE), to be conducted in the 1990s, will have as its central objective the establishment of the general circulation of the ocean and, as such, will involve oceanographic institutions around the world. It will require not only extensive ship and buoy observations, but satellite measurements as well. A centerpiece for WOCE observation systems will be the joint U.S.-French satellite, TOPEX/Poseidon, which will carry the APL-built radar altimeter.

The third group of articles deals with the continued evolution of the radar altimeter beyond Geosat (see MacArthur et al. in this issue). The TOPEX altimeter will make precise measurements of satellite heights above the sea at two frequencies, thereby allowing the correction of long-wavelength ionospheric error, as required for basin-scale circulation measurements.

Innovations in solid-state RF electronics and in digital-processing technology have produced reductions in instrument size and weight by a factor of 2, as discussed by von Mehlem and Wallis and by Perschy et al. These developments have resulted in a next-generation altimeter that is compatible with the Navy's radar altimeter spacecraft, Lightsat.

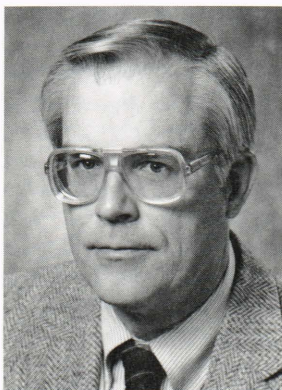
Subjects missing from this issue but prominent in the past are dynamics of ocean surface waves and imaging of waves with SAR. The Spring 1990 issue of the *Digest* will be dedicated to papers from a 1989 conference at APL that included those subjects, thereby rounding out the historical dimensions of ocean research at the Laboratory. Robert C. Beal will be the guest editor of that issue.

Recent organizational changes at APL have consolidated and strengthened the Laboratory's efforts in ocean physics. We trust that even more science will flow from those management changes, and we expect that the science will manifest itself in future issue of the *Johns Hopkins APL Technical Digest*.

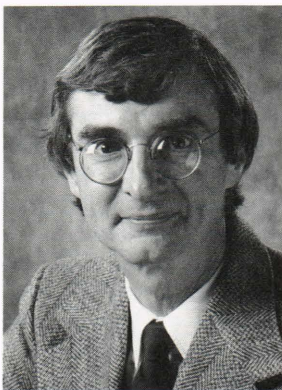
THE AUTHORS



JOHN R. APEL is a physicist/oceanographer and chief scientist of the Milton S. Eisenhower Research Center at APL. For the past three years, he has served as editor-in-chief of the *Johns Hopkins APL Technical Digest*; for this Ocean Sciences issue, he was guest editor, along with Richard F. Gasparovic and Charles C. Kilgus. Apel, who grew up in a boat-building family two blocks from the sea, has been a major contributor to the science of remote measurements of the ocean. He holds several awards from the federal government, including a gold medal, and publication awards from APL for his work in the ocean sciences. He is an editor of *Review of Geophysics* and teaches physics of the sea in the Johns Hopkins Continuing Professional Programs.



RICHARD F. GASPAROVIC is the assistant supervisor of the Space Geophysics Group in APL's Space Department. He received a B.S. degree from Fordham University in 1963, an M.S. degree from the University of Pennsylvania in 1964, and a Ph.D. from Rutgers University in 1969. He was employed by RCA briefly before joining APL in 1971. Dr. Gasparovic has been associated with numerous research activities involving remote sensing of the ocean surface using microwave, infrared, and optical sensors. He also lectures on satellite oceanography in the G.W.C. Whiting School of Engineering's Continuing Professional Programs.



CHARLES C. KILGUS received a B.S. degree in electrical engineering from Drexel Institute of Technology in 1964 and M.S.E. and Ph.D. degrees from The Johns Hopkins University in 1968 and 1970, respectively, specializing in communications theory. Since joining APL in 1964, he has worked in the Space Department on various antenna, communications, and system design projects including Transit, Dodge, Geos-B and -C, Seasat, and Geosat. Dr. Kilgus is currently a principal staff engineer and program manager in the Space Department.