ROBERT C. BEAL

GUEST EDITOR'S INTRODUCTION

Nearly thirty years ago, the National Academy of Sciences and the U.S. Navy sponsored a conference in Easton, Maryland, on ocean wave spectra. At that conference, many of the leading theoreticians and practitioners of the day came together to share ideas about the behavior of wind-driven ocean surface waves. Reading the conference record[1] today is a sobering experience because, even after thirty years, some of the fundamental problems remain. For example, the spatial and temporal structure of the vector wind field over the ocean is not much better modeled today than it was then.

On the other hand, progress has been substantial along two other fronts. Thirty years ago, temporal wave height records had just yielded to one-dimensional height spectra, but full two-dimensional (directional) spectral plots were still rare. Since then, numerical wind–wave modeling techniques have progressed through three generations of development, and several institutions routinely produce complete basin or global-scale spatial arrays of temporally evolving directional wave-height spectra.

Roughly in parallel with the model development, various instrumental techniques for estimating the directional spectrum have been developed and refined. Most of the advances have come with radar remote sensing techniques, some of which give the promise for global monitoring of the directional spectrum from satellites. Although certainly not the only technique practical from space, synthetic aperture radar (SAR) has been the one most thoroughly explored during the past decade. With the expectation of several spaceborne SAR missions in the 1990s (at least one each from Canada, Europe, Japan, and the United States), this exploration will continue.

The specific role of spaceborne SAR in practical global wave forecasting, however, has yet to be precisely defined and demonstrated, partly because of continuing uncertainty about the ability of the SAR with any specified geometry to give a useful measure of the directional wave spectrum. Assuming that this issue is eventually resolved in favor of the SAR, there remains the question of how best to assimilate sparsely sampled SAR-derived spectra along sets of single satellite passes into global numerical wave models that, themselves, may be guided by a similar sparsely sampled estimate of the wind field from a satellite scatterometer.

Fundamentally, however, one thing seems clear: the directional wave spectrum can be estimated in the future only to the extent that it can be measured in the present. Furthermore, because typical seas are not described adequately by a single parameter such as significant wave height, global estimates of only significant wave height will not be sufficient. If global wave forecasting skill is to improve, we must measure what we are attempting to predict over global scales.

In April 1989, APL hosted a symposium entitled "Measuring, Modeling, Predicting, and Applying Directional Ocean Wave Spectra." The symposium was based largely on results from an international waves experiment conducted in the Labrador Sea during March 1987. The Labrador Sea Extreme Waves Experiment, known as LEWEX, involved participants from eight countries (Canada, Federal Republic of Germany, France, the Netherlands, Norway, Spain, the United Kingdom, and the United States) and produced a unique and unprecedented set of more than 2000 estimates of the directional wave spectrum, all displayed in a common format.

That symposium led to a set of thirty-three papers covering four complementary topics in wind–wave theory, shipboard measurements, aircraft and spacecraft measurements, and wave model performance. The subset of ten articles that follows is a sampling, offered here to show both the flavor of the experiment and some of the lively debate that such an experiment invariably renews. The subset is not totally representative, however, in the sense that only a few spectral intercomparisons are included. The reader interested in pursuing that level of detail should consult Ref. 2.

LEWEX was possible only because of the splendid degree of cooperation among all of its participants. No single sponsor and no single country or organization dominated. It was, in many respects, a "grass roots" affair, made possible by many individual efforts. The results of most of those efforts are given either in the following ten articles or in Ref. 2, and need no elaboration here. In addition, Nelson Freeman of the Canada Department of Fisheries and Oceans negotiated the aircraft arrangements at Gander; Susan Bales, then of the David Taylor Research Center, coordinated the NATO participation; Susan Argus, then of the Canadian Radarsat Office, smoothed many potential resource conflicts with the Labrador Ice Margin Experiment; Ken Asmus of the Canada Atmospheric Environmental Service provided vital land/sea communications support at Gander; Chuck Livingston of the Canada Centre for Remote Sensing labored to have the "shuttle-substitute" CV-580 SAR ready; and the crews of the two research vessels

(HNLMS *Tydeman* and CFAV *Quest*) and the two research aircraft (the Canadian CV-580 and the NASA P-3) mustered all the resources to the right place at the right time, in spite of the weather.

The LEWEX participants have been magnanimous in sharing data and in allowing their results to be displayed and distributed in common formats, without restriction. This open philosophy did much to foster and sustain the cooperative spirit that was necessary for LEWEX to succeed.

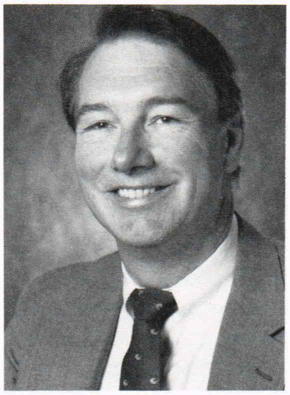
For LEWEX financial support over the past five years, I am indebted to the Office of the Oceanographer of the Navy, NASA Headquarters, the Office of Naval Research, and the APL Independent Research and Development fund.

REFERENCES

[1] *Ocean Wave Spectra*, National Academy of Sciences, Prentice-Hall, Englewood Cliffs, N.J. (1963).

[2] Beal, R. C., ed., *Directional Ocean Wave Spectra,* The Johns Hopkins University Press, Baltimore (in press, 1991).

THE AUTHOR



ROBERT C. BEAL is an APL principal staff physicist. He leads SAR ocean wave research efforts at APL, and he served as the LEWEX science coordinator.