REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)* 1/8/2002	**2. REPORT TYPE** Final Report	**3. DATES COVERED** *(From – To)* 08/01/1998-12/31/2000

4. TITLE AND SUBTITLE

Observation and Modeling of Spatial Wave Coherence

5a. CONTRACT NUMBERS

5b. GRANT NUMBER
N00014-98-1-0793

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Drs. Eugene A. Terray and Mark A. Donelan

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Woods Hole Oceanographic Institution
Applied Ocean Physics and Engineering Department
98 Water Street, MS #12
Woods Hole, Massachusetts 02543-1053

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Office of Naval Research
Code 321CD
Ballston Centre Tower One
800 N. Quincy Street
Arlington, VA 22217-5660

10. SPONSORING/MONITORING ACRONYM(S)

11. SPONSORING/MONITORING AGENCY REPORT NUMBER

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

The work reported here was undertaken as part of the Mobile Offshore Base (MOB) study. We used field observations taken from a fixed tower using arrays of surface elevation gages to estimate the along-crest coherence of wind generated water waves. The coherence scale was found to depend linearly on wavenumber.

20020805 094

15. SUBJECT TERMS

Wind waves, Spatial coherence, Crest length statistics

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			
Unclassified	Unclassified	Unclassified	Unlimited	3	**19 b. TELEPHONE NUMBER** *(Include are code)*

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI-Std. Z39-18

Final Report
OBSERVATION AND MODELING OF SPATIAL WAVE COHERENCE

E.A. Terray
Department of Applied Ocean Physics and Engineering
MS-11, 217 Bigelow
Woods Hole Oceanographic Institution
Woods Hole, MA 02543
(508) 289-2438 (Voice), (508) 457-2194 (Fax)
eterray@whoi.edu

M.A. Donelan
Rosenstiel School of Marine and Atmospheric Sciences
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149
(305) 361-4717 (voice)
mdonelan@rsmas.miami.edu

Award Number: N00014-98-0793

GOALS AND OBJECTIVES

The Mobile Offshore Base (MOB) program was tasked with addressing the feasibility of building large floating structures, with scales of order a kilometer, that would serve as forward supply and staging facilities in support of remote naval operations. An important design issue for a structure of this size is the coherence of the forcing by long-period ocean waves. The study reported here is a component of the MOB program aimed at developing an improved understanding of the along-crest coherence and group statistics of long period waves. The specific objectives of this work are to provide:

- statistics of crest lengths and "runs" of high waves
- estimates of the array covariance $<\eta(x,y,t)\eta(0,0,0)>$
- software for time-frequency analysis of wave measurements
- software for the time-frequency synthesis of wave fields.

APPROACH

We investigated these issues using data collected by one of the co-PIs using an extended 14-element array, and a compact 6-element array of capacitance wavestaffs deployed from a tower in a large lake (Donelan *et al.,* 1986, 2000). The fetch at this site varied from 1 to roughly 300 km, thus providing a wide range of wave development. Our proposed analysis was based on the "Wavelet Decomposition Method" (WDM) of Donelan *et al.* (1996), which permits the identification of individual waves of a given scale and direction passing through the array at each instant of time.

RESULTS

[1] The estimator proposed by Donelan *et al.* (1996) is based on the assumption that the directional spread of individual wavetrains is much smaller that the statistical spread of the wave field as a whole, and that only a single wavetrain (which itself may be composed of waves of many scales) is incident on the array at any instant. We have relaxed this constraint to permit several wavetrains to be present at once. The new estimator reduces to that of Donelan *et al.* (1996) for a single wave and infinite signal-to-noise ratio. Applying it to data suggests that their assumption is satisfied roughly 90% of the time.

[2] We have studied "crest lengths" (*i.e.* the along-crest correlation of high waves) in two ways. In the first, we use both the WDM and conventional Fourier transform techniques to estimate the temporally-averaged lateral correlation of the waves. A typical example using data from the large 14-element array is given in Figure 1. In the second approach we introduce a model of the lateral crest profile, which we take to be approximately Gaussian, so that

$$\eta(y) = \eta_o e^{-(\beta y)^2},$$

where the waves are assumed to be propagating in the x-direction, and the parameter β is a measure of the lateral sharpness of the crest. Wavelet decomposition was applied to data from the compact array (Donelan *et al.*, 2000) in order to identify the propagation directions of packets of waves, and assess their crest lengths by comparison of observed amplitudes across the propagation direction. Figure 2 shows that the dependence of β on the mean wavenumber of the crests in various frequency bands is approximately linear. In this case $\beta = 0.55\,k$, and therefore the total average width of the crests to the half amplitude point is about half the wavelength. We were not successful in applying this approach to the extended array because of its sparseness.

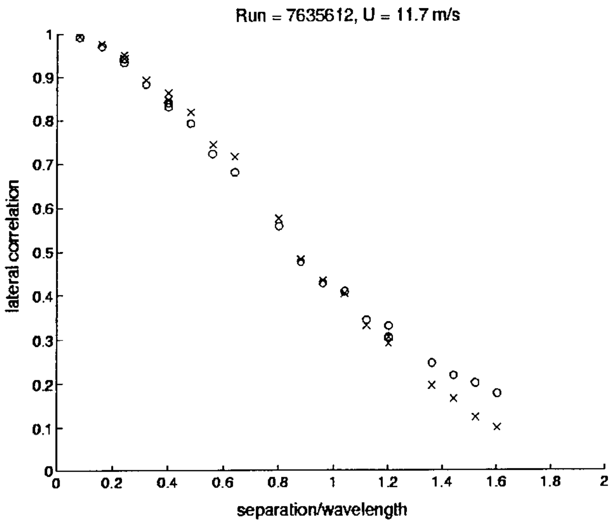

Figure 1. Lateral correlation function computed using wavelets (o) *and Fourier transform techniques* (x) *for data from the 14-gage array. The center frequency was 0.35Hz.*

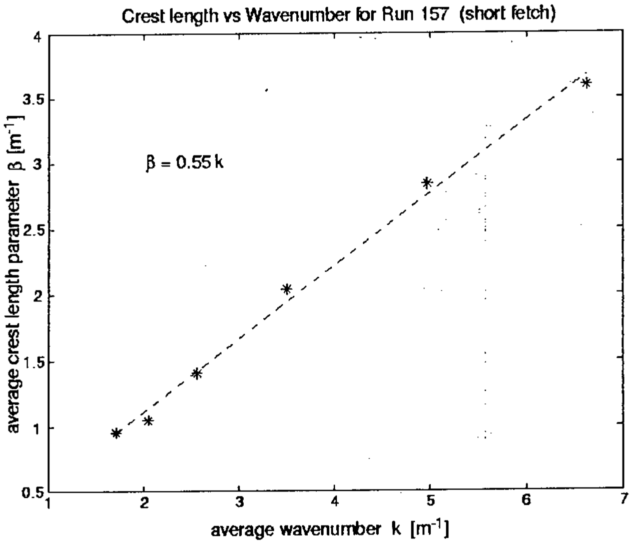

Figure 2. Dependence of the lateral crest shape parameter on the wavenumber of the waves for a case of wind waves at short fetch using data from the compact array.

REFERENCES

Donelan, M.A. J. Hamilton, and W.H. Hui (1986): Directional spectra of wind-generated waves. *Phil. Trans. Roy. Soc.*, **A315**, 509-562.

Donelan, M.A., W.M. Drennan and A.K. Magnusson (1996): Nonstationary analysis of the directional properties of propagating waves. *J. Phys. Oceanogr.*, **26**(9), 1901-1914.

SUPPORTED PUBLICATIONS AND PRESENTATIONS

Donelan, M.A., W.M. Drennan and E.A. Terray (2000): Wavenumber spectra of wind waves in the range of 1m to 50m. *The Wind--Driven Air-Sea Interface: Electromagnetic and Acoustic Sensing, Wave Dynamics and Turbulent Fluxes*, M. Banner (*ed.*), School of Mathematics, The University of New South Wales, Sydney, Australia, pp. 35-42.

Donelan, M.A. (2000): Wave propagation and wind-wave interaction. Abstract and presentation at the NCAR Geophysical Turbulence Program Workshop: *Turbulence and the Air-Sea Interface*. Boulder, Colorado, August 15-17, 2000.

Additional manuscripts are in preparation.