

MOORED TIME SERIES MEASUREMENTS OF THE VERTICAL STRUCTURE OF OPTICAL PROPERTIES IN THE COASTAL OCEAN

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Award #: N00014-96-1-0669/N00014-95-1-0813 (AASERT)

LONG-TERM GOALS

The present study concerns the investigation of physical and particle relationships via optical properties as part of the ONR Coastal Mixing and Optics (CMO) program. Goals of our research are: 1) to better understand the problem of vertical mixing and transport of particles, momentum, and heat, 2) to obtain new observations which will enable us to examine and model important processes (both periodic and episodic) that affect the vertical distributions of optical properties and particle concentrations, and 3) to improve the interpretation and facilitate the utilization of emerging optical measurements taken in coastal waters.

SCIENTIFIC OBJECTIVES

The overall objective of our research is to determine how particles and optical properties respond to physical forcing under various oceanic conditions on a broad continental shelf off the east coast of the U.S. Specific objectives are:

- 1) To quantify the variability of optical and physical properties at time scales as short as a few minutes. Our data sets allow us to compute: power spectra, coherence, and phase functions of time series as well as wavelet transforms of spectral beam attenuation coefficient, spectral scattering coefficient, and spectral absorption coefficient, estimated particle concentration, chlorophyll fluorescence, temperature, salinity, and horizontal currents. Again, the physical data will be integrated with those of other groups for joint analysis directed toward physical aspects,
- 2) To relate physical processes (e.g., wind forced inertial and surface wave breaking mixing activity, internal and inertial waves, solitary waves, tides, advection, etc.) to observed optical variability,
- 3) To determine the relationships between vertical fluxes of particles and optical properties with respect to physical environmental conditions such as shear, stratification, and gradient Richardson number,
- 4) To examine the importance of particulate matter for diurnal cycling of the mixed layer, especially through the modulation of the penetrative component of solar radiation,
- 5) To distinguish the difference between optical variability associated with waves opposed to mixing events,

Report Documentation Page

Form Approved
OMB No. 0704-0188

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1. REPORT DATE 30 SEP 1997		2. REPORT TYPE		3. DATES COVERED 00-00-1997 to 00-00-1997	
4. TITLE AND SUBTITLE Moored Time Series Measurements of the Vertical Structure of Optical Properties in the Coastal ocean				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) University of California at Santa Barbara, Institute of Computational Earth System Science, Santa Barbara, CA, 93106				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a REPORT unclassified	b ABSTRACT unclassified	c THIS PAGE unclassified			

- 6) To make general distinctions among particle types and to partition their origin (e.g., biogenic from euphotic layer versus resuspended sediment),
- 7) To relate optical and particle variability near the ocean bottom to physical processes affecting sediment resuspension,
- 8) To provide time series (at several depths) of physical and optical properties to complement vertical microstructure measurements (optical and physical) to set the context for these observations and model development.

APPROACH

Our approach has been to simultaneously collect time series of optical and physical data from several depths using a variety of newly developed optical (e.g., spectral capability) and physical instruments placed on a mooring at a mid-shelf location (Mid-Atlantic Bight, roughly 40.5N, 70.5W). Our choice of optical parameters enables the interpretation of the data in terms of different optically important components of seawater (biogenic particles and non-biogenic particles). We deployed 3 moored instrument packages (approximately 10, 30, and 50m) on a mid-shelf mooring (water depth of roughly 70m) and a fourth on a bottom tripod (within about 2m of the bottom) being deployed by collaborators. A total of 4 deployments were conducted between July 8, 1996 and June 7, 1997.

WORK COMPLETED

Our component of the field program was coordinated with other CMO investigators through workshops and email correspondence. We completed the design, engineering, and fabrication of instrument systems for the field program. In addition to the BIOPS (AC-9 plus other optical and physical sensors), we purchased (using UCSB funds) and setup other complementary sampling systems including an ADCP, conductivity-temperature systems and a CTD/rosette system for use in the experiment.

All four deployments of the mooring, preliminary data analyses, and data reports have been completed (Chang et al., 1997a,b,c,d). Our results are shown on the cover of *SeaTechnology*, February, 1997 (Dickey et al., 1997). Highlight data may be viewed on our web site (<http://www.icess.ucsb.edu/opl/cmo.html>).

RESULTS

We have collected a remarkable data set with a very high percentage of data return. The eye of Hurricane passed within roughly 80km of our mooring (site is on 70m isobath) on September 1-2, 1996 and soon after Hurricane Hortense passed within roughly 250km of our mooring on September 14, 1996. With the passage of Edouard, the mixed layer deepened very rapidly with temperature differences from the top to bottom (68m) decreasing from 12degC to about 2 degC. Sediment resuspension was dramatic as well and is easily seen in all optical data, including the AC-9 data. The resuspension event is evident from 68m clear up to the 10m depth! Surprisingly, Hortense's passage resulted in significant sediment resuspension despite its relatively great distance from the mooring site. (please see web site <http://www.icess.ucsb.edu/opl/cmo.html> and references below).

IMPACT/APPLICATION

It is evident that the data collected during the two hurricanes are very unique and will be most valuable for understanding major episodic perturbation of the optical properties of the coastal ocean. Sediment resuspension, modification of biomass constituents, and productivity will all be topics of intense study and modeling using this rich data set along with complementary data collected by CMO/PRIMER colleagues.

TRANSITIONS

The results of our work (see impacts above) should be of interest to several levels of Navy interest.

RELATED PROJECTS

Our study is highly complementary to other CMO/PRIMER activities. Several other moorings and another bottom tripod sampled in the vicinity of our mooring. A variety of shipboard observations (profile and SeaSoar) also complement our measurements. Our high resolution time series will be beneficial for the vertical and horizontal mixing efforts along with remote sensing activities and vice versa.

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