A System for In-Situ Characterization of the Composition and Size Distribution of Particles in the Coastal Ocean and Their Effect on Ocean Color.

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LONG-TERM GOALS

(i) Quantify and understand the effects of aggregation dynamics on the distribution of particles in the bottom boundary layer;
(ii) Understand how the properties of particles (composition, shape, and internal structure) affect their optical and acoustical properties.

SCIENTIFIC OBJECTIVES

Instrumentation is requested to study the dynamics of suspended particles and their effects on the optical and acoustical characteristics of the water column. The instrument will supplement a funded project that will be carried out at the Martha's Vineyard Coastal Observatory, and they will capitalize on routinely gathered fluid dynamical measurements at that site. These instrument will be used both on bottom-mounted and profiling platforms designed to determine the particle concentration and size distribution and the effect of particles on optics and acoustics. The measurements will be used to evaluate a state-of-the-art model of particle dynamics, and will lead ultimately to model improvements and enhanced capabilities for predictions and interpretations of suspended sediments and the associated acoustical and optical fields.

APPROACH

A novel underwater system integrating both optical and acoustical sensors is proposed to characterize the concentration, bulk composition and size distribution of particles in a region of the ocean and to study the effects of these particles on light and sound propagation. Optical sensors operating in the visible part of the spectrum are most sensitive (in terms of signal per volume or mass) to particles ranging from submicrometer (backscattering) through micrometer (attenuation) to hundreds of micrometer (near forward scattering) sizes. High-frequency acoustic backscatter is most sensitive to particles from tens of micrometers to millimeters. Combining commercially available acoustical and optical sensors provides information on all size ranges of oceanic particles.
A problem in sediment dynamics is that the distribution as function of depth of sediment concentration derived from a single optical measurement cannot be explained as a function of the underlying

resuspension and sinking dynamics. This inadequacy arises because particle aggregation and dis-aggregation contribute significantly to the particulate mass balance and settling dynamics. In order to constrain aggregation dynamics, concentration of particles over all relevant size ranges needs to be measured (from submicrometer to millimeter scales). High-frequency acoustics, in combination with optical measurements, can span the whole size range relevant to study of particle dynamics, with sufficient overlap to test assumptions inherent to the different inversion methods.

Optical and acoustical properties of oceanic waters determine the degree to which acoustical and optical signals can be transmitted within them and the color of the water as observed remotely. Thus, once sediment dynamics are well understood and constrained, knowledge of bottom type, physical forcing, and the concentration of material within the water should be sufficient to predict optical and acoustical transmission and ocean color. These predictions are crucial to assess the utility of naval systems within the water before deploying valuable assets.

WORK COMPLETED

The project has started in April of 2004. We have elected to purchase an AQUAscat mutlifrequency acoustic scattering sensor rather than three Sontek ADVs of different frequency after we tested an ADV in the fall of 2003 and found its dynamic range to be to small to provide the sensitivity we wanted. In addition the AQUAscat provides 128 depth bins instead of a single one provided by the ADV. We have also elected to purchase a WHOI in-house mini-node rather than the WETLabs DH-4, as we found out that it will more easily integrate to the existing observatory at MVCO.
Most of the instrumentation requested (The HyperPro, LISST-Floc, datalogger, computer, ac-s, bb-9, and AQUAscat have been purchased, tested (in the summer Optic Classes) and a subset of it was deployed at the MVCO in Sep., 2004 (including the AQUAScat, the mini-logger and the LISST-Floc).

RESULTS

This instrumentation package is greatly enhancing our data collection at MVCO as we speak. We are able to log into the mini-logger from our office in Maine, adjust gains and parameter to instruments and debug observed problem (such as send divers to replace a clogging filter).
We are planning on using the ac-s, bb9 and the radiometers in next year's deployment. The ac-s and bb9 are back at WETLabs for repair following problems we discovered when using them last summer.

IMPACT/APPLICATIONS

Many of the instruments purchased through this grant were used in the Optics Classes though at the Darling Marine Center this summer, exposing students to the latest optical technology.

RELATED PROJECTS

Optics, acoustics, and stress in a nearshore bottom nepheloid layer- an ONR funded proposal to E. Boss, J. Trowbridge, P. Hill and T. Milligan. Equipment from this DURIP grant is providing instrumentation used in that proposal.

Summer Courses in Ocean Optics and Biogeochemistry: “Monitoring the Oceans with Coastal Observatories” and “Radiative Transfer and Remote Sensing” at the University of Maine Darling Marine Center. Equipment from this DURIP grant is providing instrumentation used in that proposal.