Recent Advances in Interdisciplinary Technologies and Their Potential Utilization in Ocean Observing Systems

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1. INTRODUCTION

During the past decade, there has been a major thrust forward in sensors, which are capable of providing important chemical, optical, biological, and acoustical as well as physical data. Interdisciplinary sensor suites are important for studying problems such as carbon cycling and variability, the role of biology in upper ocean heating, phytoplankton productivity, upper ocean ecology, population dynamics, and sediment resuspension. Many of the new sensors are relatively small and have modest power requirements. Thus, the deployment of an increasing number of these sensors from autonomous platforms is becoming practical (e.g., Dickey, 1991). The Bermuda Testbed Mooring program is devoted to the testing of new interdisciplinary sensors and systems as well as to groundtruthing satellite sensors and fundamental oceanographic studies including modeling (Dickey et al., 1998).

2. INTERDISCIPLINARY TECHNOLOGIES

Moorings have been used to obtain chemical, optical, biological, and acoustical data in addition to the more common physical data (e.g., temperature, salinity, and currents) and have proven to be excellent platforms for testing and developing new sensors (Dickey et al., 1998). A few examples of variables which can now be sampled from moorings include: nitrate concentration, dissolved oxygen, partial pressure of carbon dioxide, scalar irradiance, spectral inherent and apparent optical properties, chlorophyll fluorescence, and size distributions of particles and zooplankton. Most variables can be sampled every few minutes.

Already, new scientific insights into interdisciplinary processes have resulted from concurrent, multi-sensor measurements from moorings. Examples include: the roles of seasonal and episodic forcing and eddies in increasing upper ocean nitrate and levels of primary productivity at mid- and high-latitudes; monsoonal atmospheric and eddy forcing of productivity in the Arabian Sea; modulation of productivity in the equatorial Pacific through tropical instability waves, Kelvin waves, and El Nino/La Nina sequences; sediment resuspension via internal solitary waves and hurricanes; and variability in upper ocean heating caused by phytoplankton. Moorings are also being used to groundtruth ocean color data collected from satellites. Durations of interdisciplinary moorings have typically been a few months to a year. The major constraint remains biofouling. However, new anti-biofouling methods are being developed and tested; encouraging results suggest that this impediment will be considerably less limiting in the future.

Drifters, and most recently autonomous underwater vehicles (AUVs), have also been used to collect limited interdisciplinary data sets. Size and power are more constraining parameters for drifters, AUVs, floats, and gliders than for moorings. Nonetheless, some optical and chemical sensors have been successfully deployed from drifters and plans are underway for float and glider applications. AUVs have already carried similar sensor suites as well as ADCPs and turbulence probes. Again, biofouling will be problematic for long-term measurements from these various platforms.

In the future, it is likely that continued expansion will occur in the areas of small, energy efficient, interdisciplinary sensors. In particular, sensors will likely be capable of measuring a much wider range of chemical compounds and trace elements, higher spectral resolution inherent and apparent optical properties and spectral fluorescence, and multi-frequency acoustical systems for better resolution of zooplankton size classes. Cost per sensor is an important issue and may be a major limiting factor, especially for expendable platforms. Commercialization of key sensors will be essential for this reason. Telemetry of data from the various platforms is critical for many, if not most, new applications. The sensor and telemetry technologies mentioned here will be important for maximum utilization of the various platforms.

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