deployed. Also, since 1992, several mooring deployments have been conducted in Monterey Bay, California, as part of Monterey Bay Aquarium Research Institute's (MBARI) Ocean Acquisition System for Interdisciplinary Science (OASIS) to: 1) make long-term continuous observations of physical, chemical, and biological processes in an eastern boundary current, coastal upwelling environment; 2) test real-time data access and two-way telemetry; and 3) test new oceanographic sensors (Chavez et al., 1997). Bio-optical instruments have included: spectroradiometers, irradiance (PAR) sensors, light-scattering sensors, fluorometers, and other optical instruments (HydroRad, HydroScat, a-beta, and c-beta). Results show the evolution of coastal upwelling and its effect on hydrography, physics, chemistry, and bio-optics of the water column (Chavez et al., 1997).

...many envision the use of hyperspectral optical data for identification of phytoplankton species...

A Vision of Future Studies of Temporal Variability of Optical Properties

There has been a phenomenal increase in optical measurement capabilities, especially with the development of high spectral resolution sensors for both *in situ* and remote (satellite and airplane) platforms. Yet, there remains a need for better understanding and interpretation of our present optical measurements and for measuring additional optical parameters *in situ*. Several new systems are being developed for moored optical measurements (see Dickey, 2001a; Maffione, this issue), including: flow cytometers, particle cameras using holographic and other methods, and spectral fluorometers. Optical instrumentation has been shown to be especially effective for biological studies and expansion to others is likely. For example, many envision the use of hyperspectral optical data for identification of phytoplankton species, at least by groups. This would lead to improved understanding of community succession and perhaps allow prediction of harmful algal blooms. It is anticipated that optical measurements may prove valuable for other disciplines as well. Optical measurements have already been demonstrated to be important for upper ocean heating rates and heat budgets. In the future, it may be possible to use optical signatures and measurements for remotely estimating mixed layer depth in some oceanic regions. In addition, increasing numbers of chemical variables will be measured from moorings (e.g. Tokar and Dickey, 2000; Dickey et al., 2000) and will be useful for understanding and modeling biological processes like primary and new production.

The temporal range of *in situ* measurements of several of the fundamental spectral optical variables (irradiance, radiance, absorption, scattering, etc.) can in principal capture most of the processes of interest. Spectral and coherence analyses are certainly powerful analytical methods. However, the processes of interest are often non-stationary, nonlinear, and out of equilibrium and thus not strictly amenable to conventional statistical methods. However, new techniques such as wavelets and fractals may well prove to be valuable analytical tools (e.g. Emery and Thomson, 1997). The development of optical time series programs, akin to the Mauna Loa CO_2 program, in key oceanic regions is feasible because we can now use well-calibrated radiometers deployed from dedicated and moorings-of-opportunity (e.g. shared use of moorings with programs such as CLIVAR, Global Ocean Observation System, etc.). The temporal resolution of both airplane and satellite platforms are still rather coarse and suffer from cloud obscuration. However, there are plans for multiple ocean color satellite missions, which should improve both temporal and spatial coverage (C. Davis, personal communication). In particular, some hyperspectral color satellites with spatial resolutions on order of tens of meters are being planned for coastal observations; some color systems with similar resolutions are already being flown from aircraft. These capabilities will provide improved opportunities for comparing and synthesizing optical time-series obtained from moorings and satellites.

A new thrust for time series observations will be toward fully three-dimensional observations, which will increase the spatial sampling domain (see Figure 2 in Dickey, 2001a). Moorings with fixed depth and profiling instrumentation will remain important and platforms such as AUVS, gliders, drifters, offshore platforms, and profiling floats will become important components complementing moorings and satellites. Recently, bio-optical measurements have been made from AUVs at the BTM site in both Massachusetts Bay and Monterey Bay (e.g. Griffiths et al., 1999a; Yu et al., 2001). Increasingly, there is interest in utilization of optical data in near real-time and for data assimilation models (Bissett, this issue). Prediction of optical and bio-optical variables has become a realistic goal.

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