Ships have served the oceanographic community well, but their limitations in terms of cost, availability, limited synoptic sampling capability, and sample degradation and contamination have necessitated development of other complementary platforms as described below.

## 2.3 MOORINGS

Moorings have been used for physical and meteorological measurements for several decades. However the use of moorings, some with data telemetry capabilities, for interdisciplinary studies including bio-optics and biogeochemistry began relatively recently. Moorings are especially well suited for observing high frequency, episodic, and slowly varying phenomena (see Dickey et al., 1998a,b, 2000, 2001; Dickey and Falkowski, 2002). They are also valuable for testing of new sensors and systems that can later be used on other platforms that are either difficult or impossible to retrieve (e.g., drifters, profiling floats, and autonomous underwater vehicles). Some of the more relevant time series measurements that can now be made from moorings include: nitrate, trace elements, partial pressure of carbon dioxide ($pCO_2$), dissolved oxygen (DO), primary production (via time series samplers and the $^{14}C$ method), particle fluxes (time series sampling sediment traps; Berelson, 2001), and a broad range of relevant optical variables for spectral light fields for estimating primary production and other carbon parameters (e.g., POC; Bishop, 1999). These have enabled the oceanographic community to gain new insights into a variety of biogeochemical processes (examples are given in the next section). Several diverse, and often adverse, oceanic regions have been studied using interdisciplinary moored systems. These range from the equatorial Pacific to high latitude areas south of Iceland and in the Southern Ocean (see Dickey and Falkowski, 2002). Because of biofouling of sensors, useful data from moorings have often been limited to 3-6 months in the open ocean; however, work is advancing to extend useful deployment periods for biogeochemical and bio-optical sensors and systems (e.g., Dickey et al., 2000). High temporal resolution will continue to be needed to minimize sampling induced uncertainties (via undersampling and aliasing).

Time series observations at selected sites of expected high environmental consequence (e.g., equatorial Pacific, high latitude sites of water formation and/or $CO_2$ uptake; Follows and Williams, this volume) and special long-term monitoring value (e.g., oligotrophic areas of the gyres of the Pacific and Atlantic Oceans, the Arctic region, the Southern Ocean, and near Antarctica; Follows and Williams, this volume) will require mooring platforms (Send et al., 2001; Dickey et al., 2002). Optimal selections of locations will be essential because of costs and return on investment. There is also need for