

illustrate a variety of platforms, several of which can utilize physical, chemical, bio-optical, acoustical, and geophysical sensors or systems and the types of data sets that can be obtained (examples come from the Sargasso Sea off Bermuda). The time-space diagram shown in Figure 3 provides a rough means of estimating the utility of different platforms in space (horizontal aspect depicted in this figure) and time. It also re-emphasizes the need for deploying sensors from both *in situ* and remote platforms. Nesting of platforms and various modeling approaches can be used to optimize utilization of these observational assets as discussed in the final section. Below, brief summaries of capabilities and future directions for a few platforms are presented.

2.2 SHIPS

Ships have provided access to ocean observations since early expeditionary voyages. Ships are important for manned on-site observations and data collection and for deployment of other sampling platforms such as remotely operated vehicles (ROVs), autonomous underwater vehicles (AUVs), moorings, drifters, floats, and others described below. Common modes of ship sampling include: 1) on-station profiling of instruments, 2) underway sampling of meteorological and optical variables and surface waters using flow-through systems, 3) underway sampling to provide data in the horizontal and vertical dimensions using towed undulating or fixed depth bodies with sampling chains, which act as platforms for sensor suites, and 4) underway acoustical measurements (e.g. for acoustic Doppler current profilers (ADCPs), hydrophone arrays, and sidescan sonar). These various modes of sampling are useful for regional process-oriented studies and for long transect sampling programs designed to provide important spatial maps. Research ships can be used to deploy advanced analytical instrumentation, which presently cannot be easily deployed from other platforms, can be utilized, often with real-time data analysis. In addition, large volumes of water and net towing are still required for some research efforts. Commercially operated voluntary observing ship (VOS) or ships-of-opportunity observational programs are especially valuable, particularly for obtaining data in remote oceanic regions where few dedicated research sampling programs can be routinely executed or where ferries or ships transit regularly (essentially enable spatial time series). Dedicated research ships as well as VOSs have also played important roles in calibrating and validating ocean color satellite data.