Below, brief summaries of capabilities and future directions using different platforms are presented.

Ships and Submarines

PRESENT AND NEAR-FUTURE CAPABILITIES

Ships have played important roles in providing access to ocean observations since early expeditionary voyages beginning several centuries ago. Today they are important for:

- direct observations and data collection and
- deployment of other sampling platforms, such as moorings, drifters, and others described below (e.g., Knox and Wallace 1999).

One of the advantages of ships is that advanced analytical instrumentation, which cannot presently be routinely deployed in situ from other platforms, can be utilized, often with real-time data analysis. Examples of such instrumentation include flow cytometers, mass spectrometers, radioactivity measurement systems, and turbulence sampling systems. In addition, large volumes of water and net towing are still required for some applications.

Four useful modes of ship sampling include:

- on-station profiling of instruments;
- underway sampling of surface waters using flow-through systems;
- underway sampling using towed undulating or fixed depth bodies or chains, which act as platforms for sensor suites; and
- underway acoustical measurements (e.g., using acoustic Doppler current profilers [ADCPs], hydrophone arrays, and side-scan sonar).

These various modes of sampling are especially useful for regional process-oriented studies and for long transect sampling programs designed to provide important spatial maps. It should also be noted that commercially operated VOSs or ships-of-opportunity observational programs (e.g., Smith et al. 2001) are especially valuable, particularly for obtaining data in remote oceanic regions where few dedicated research sampling programs can be routinely executed.

Some interesting examples of data collection from submarines have been reported. In particular, they have been used for making various physical measurements (sometimes including turbulence probes and biological samplers as well) and bubble measurements (using acoustics). Nuclear submarines have been used by civilian scientists under Arctic ice since 1993.