diverse set of emerging observing platforms, and well-integrated observational and modeling efforts. Some of the promising observational tools include: (1) hyperspectral optical instrumentation that can be deployed from aircraft, satellites, and *in situ* platforms; (2) new biological, chemical, and optical sensors, many of which have (or soon will have) the capacity to measure on virtually the same time and space scales as physical sensors (e.g., temperature, conductivity, currents); (3) several new observing platforms including AUVs, profiling floats and moorings, drifters, and gliders, and (4) real-time two-way data communication techniques. Interdisciplinary models are also critical for developing new parameterizations and algorithms that can be applied to complex ecosystems with special focus on HABs. They will also be needed to design optimal sampling arrays. Data assimilation models will be especially important for directing adaptive sampling assets.

Presently, most HAB research is response oriented and is not useful for studying the critical problem of pre-conditioning of HAB events. Therefore, future focused process studies devoted to HABs need to be done in the context of high frequency, long time series observations as the full evolution of a particular HAB event needs to be observed and documented. This concept may soon be possible by instrumenting coastal global observing system platforms with key instrumentation to measure variables relevant to the HAB problem and by utilizing emerging color satellites including those with hyperspectral sensors and high spatial resolution capabilities. Using data assimilation models along with these complementary data sets, it should be possible to quantify ecosystem and HAB variability on time and space scales down to hours and meters and to make plausible predictions of HAB conditions that are useful for environmental management.

Acknowledgments

Much of this work was supported by the U.S. ONR, NOPP, and NSF. We would like to thank John Kerfoot, Josh Kohut, Richard Gould, and Robert Arnone for the vertical migration data, HF-radar image, MODIS satellite image, and associated satellite-derived products. We express appreciation to Frank Spada, who provided illustrations for several figures, and Derek Manov, who supplied photographs. Marcel Babin, John Cullen, Christy Herren, Cristina Orrico, and Oscar Schofield provided valuable insights for this chapter.

References

Abbott, M. R., Brink, K. H., Booth, C. R., Blasco, D., Codispoti, L. A., Niiler, P. P., and Ramp, S. R. (1990). Observations of phytoplankton and nutrients from a Lagrangian drifter off northern California. *Journal of Geophysical Research*. 95: 9393-9409.

Abbott, M. R., Brink, K. H., Booth, C. R., Blasco, D., Swenson, M. S., Davis, C. O., and Condispoti, L. A. (1995). Scales of variability of bio-optical properties as observed from near-surface drifters. *Journal of Geophysical Research*. 100: 13,345-13,367.

Abbott, M. R. and Letelier, R. M. (1998). Decorrelation scales of chlorophyll as observed from bio-optical drifters in the California Current. *Deep-Sea Research II*. 45: 1639-1667.

Agrawal, Y. C. and Pottsmith, H. C. (1994). Laser diffraction particle sizing in STRESS. *Continental Shelf Research*. 14: 1101-1121.