Table 5. Differences Between Coastal Ocean and Open Ocean Processes

Processes	Coastal Mixing and Optics	Open Ocean (e.g., Sargasso Sea)
Seasonal	very important	very important
Inertial	less important	more important
Tidal[1]	very important	important
Internal solitary waves	potentially important	less important
Storms, hurricanes, wind mixing	very important	very important
Eddies	important	more important
Water mass variability[2]	very important	less important (except eddies)
Advection	very important	less important
Bottom boundary layer	very important	no importance
Shear instabilities	little importance	very important
Nutrient availability	mixing, resuspension	recycling
Light levels	high particles and attenuation	low particles and attenuation

[1]Diurnal and semidiurnal.
[2]Includes meanders, jets, filaments, and fronts.

well as the physical time series signals. The inertial period appeared to have been important only following major storms and hurricanes. The bottom boundary layer processes had a great influence on particle movement in the water column and along the seafloor, affecting the inherent optical properties and, subsequently, the phytoplankton biomass distributions and primary productivity in the upper water column following storms and hurricanes (further discussed by *Chang and Dickey* [1999] and *Chang et al*. [this issue]).

This experiment also set the context for comparing our unique coastal ocean results with previous open ocean findings. Important differences arise because of coastal bottom boundary layer effects, large-scale water mass intrusions, and the relatively greater role of tides on the shelf. Timescales of optical variability are thus generally shorter for the coastal environment. Finally, these data are being used with interdisciplinary models (e.g., physical-bio-optical and sediment resuspension) to establish and possibly predict relationships between physical, optical, and biological processes in a coastal environment.

Appendix

Frequency autospectra were computed in order to quantify the variability of the current speed and bio-optical time series data described in section 3.0, and autospectra of temperature and salinity were computed to investigate water mass variability (e.g., Plate 2). The autospectra were calculated using 1024-point fast Fourier transforms (FFTs) tapered with a Hanning window, zero overlap, and $N \cong 15{,}000$ points (broadband data). The 95% confidence intervals were calculated for the autospectra, and are shown for the current speed only. Fluctuations in autospectra at frequencies higher than 10 cycles per day (cpd) seen in Plate 2 were due to noise.

Autocovariances were computed for [Chl a], beam c, temperature, and wind and current speed data at all depths available to determine the timescales of decorrelation of the various physical and bio-optical properties (data not shown). Salinity data were omitted from autocovariance calculations since they were unavailable at the depths of bio-optical data.

Coherence functions are used to quantify the relationship between two signals at a range of frequencies for specified phase lags. Coherence estimates were made between PAR and [Chl a] to assess the impact of light levels on primary productivity (data not shown). Temperature and [Chl a] and [Chl a]$^{-1}$ coherence (temperature and [Chl a]$^{-1}$ coherence data were insignificant) were calculated to investigate the impact of water mass movements on phytoplankton growth (data not shown). Upwelling favorable conditions were examined by computing wind and current speed and [Chl a] coherence (data not shown). Beam attenuation coefficient and [Chl a] coherence estimates were used to assess quantitatively the relation of biogenic material in the water column with total particle concentration at specific frequencies (data not shown). Three-hour filters were applied to the time series prior to computation of coherence functions to remove spikes in the data. Coherence functions at zero phase lag were calculated using 4096-point FFTs for periods with $N \geq 15{,}000$ data points (summer/fall and winter stratification) and 2048-point FFTs for periods with $N < 15{,}000$ data points (winter mixing and spring) for ~10 degrees of freedom. Time series were tapered with Hanning windows, with 72-point overlaps and removal of means. Statistical significance levels were calculated according to *Thompson* [1979].

Acknowledgments. This work was supported by the Office of Naval Research as part of the Coastal Mixing and Optics program (T.D. grant N00014-96-1-0669). We would also like to thank Heidi Sosik (WHOI) for her discrete bottle sample data; W. Scott Pegau (OSU) and Wilf Gardner (Texas A&M University) for their complementary profile data; David Porter and Donald Thompson (Johns Hopkins University) for their AVHRR data and site maps; Yogi Agrawal and Chuck Pottsmith (Sequoia Scientific, Inc.) for the use of their bottom tripod; Libe Washburn and Joe McNeil for their insights concerning data analysis; and Derek Manov, David Sigurdson, and Erin Lutrick for engineering and technical support.

References

Backus, R. G. (Ed.), *Georges Bank*, 593 pp., MIT Press, Cambridge, Mass., 1987.

Bacon, M. P., R. A. Belastock, and M. H. Bothner, ^{210}Pb balance and implications for particle transport on the continental shelf, U.S. Middle Atlantic Bight, *Deep Sea Res*., *Part II*, *41*, 511–535, 1994.

Barth, J. A., D. Bogucki, S. D. Pierce, and P. M. Kosro, Secondary circulation associated with a shelfbreak front, *Geophys. Res. Lett*., *25*, 2761–2764, 1998.

Bartz, R., J. R. V. Zaneveld, and H. Pak, A transmissometer for profiling and moored observations in water, in *Ocean Optics V*, edited by M. B. White, pp. 102–108, Int. Soc. for Opt. Eng., Bellingham, Wash., 1978.

Bartz, R., R. W. Spinrad, and J. C. Kitchen, A low power, high resolution, in situ fluorometer for profiling and moored applications in water, in *Ocean Optics IX*, edited by M. A. Blizard, pp. 157–170, Int. Soc. for Opt. Eng., Bellingham, Wash., 1988.

Biscaye, P. E., Preface: Shelf edge exchange processes in the southern Middle Atlantic Bight: SEEP-II, *Cont. Shelf Res*., *41*, 229–230, 1994.

Biscaye, P. E., R. F. Anderson, and B. L. Deck, Fluxes of particles and constituents to the eastern United States continental slope and rise: SEEP-I, *Cont. Shelf Res*., *8*, 855–904, 1988.

Bogucki, D., T. Dickey, and L. G. Redekopp, Sediment resuspension and mixing by resonantly generated internal solitary waves, *J. Phys. Oceanogr*., *27*, 1181–1196, 1997.

Booth, C. R., The design and evaluation of a measurement system for photosynthetically active quantum scalar irradiance, *Limnol. Oceanogr*., *19*, 326–335, 1976.

Bourne, D. W., and C. S. Yentsch, Phytoplankton, primary production, and microbiology, in *Georges Bank*, edited by R. H. Backus, pp. 210–212, MIT Press, Cambridge, Mass., 1987.

Boyd, T., M. D. Levine, and S. R. Grad, Mooring observations from