be observed using stationary, high temporal and vertical resolution measurement platforms (see Section X.3.1; Kerfoot et al., 2002; Figure X.5).

Figure X.5
Time series contour plot of (A) absorption coefficient and (B) attenuation coefficient at 676 nm, measured by an absorption-attenuation meter (ac-9) deployed on a moored vertical profiler. Vertical migration (positive phototaxis) of phytoplankton is nicely illustrated in these figures; phytoplankton swim toward the sunlight during the daylight hours and migrate toward the ocean bottom during nighttime. Water samples indicate that dinoflagellates were present. Figure courtesy of John Kerfoot and Oscar Schofield, Rutgers University.

Harmful algal species may out-compete other phytoplankton with their ability to adapt and compete for nutrients other than the macronutrients, nitrate, ammonium or phosphate. Dzurica et al. (1989) found that *Aureococcus anophagefferens* is capable of utilizing glutamic acid and glucose for carbon and energy sources. Maldonado et al. (2002) examined the influence of micronutrient (iron and copper) uptake on the toxicity of cultured diatoms, *Pseudo-nitzschia multiseries* and *Pseudo-nitzschia australis* (for more details see Section X.2.3). *In situ* observations of *P. australis* blooms in Monterey Bay, CA showed that this toxic species bloomed in waters low in iron, suggesting that *P. australis* may sequester iron from other species (data not yet published; see http://www.mbari.org/MUSE/intro.htm). These measurements were obtained using high spatial resolution platforms carrying interdisciplinary sampling devices (see Section X.3).

Interactions between phytoplankton species (toxic with non-toxic) and harmful algae with grazers (e.g., zooplankton) are situation-specific (e.g., Turner and Tester, 1997; Cullen et al., 2002). Attempts have been made to generalize phytoplankton species succession prior to and following HABs (the "Mandala" from Margalef et al., 1979; see Cullen, 2005) and grazing stresses on HABs. This type of broad overview, although by and large informative, is not applicable to all phytoplankton blooms or all HABs. Quantification of phytoplankton community composition variability must be accomplished using long-term, continuous monitoring efforts.

X.2.3 Chemical processes
Both physical and biological processes influence variability in ocean chemistry. Coastal ocean chemistry is primarily driven by input of "new" nutrients rather than recycling, as in the open ocean (e.g., Mann and Lazier, 1991). New nutrients are introduced to the system through physical forcing (upwelling, advection, resuspension, river outflows, etc.) that occurs on spatio-temporal scales of tens of meters to coast-wide and days to months. Recycled nutrients are generally contributed through biological means (exudation, "sloppy feeding", benthic regeneration, etc.), which occur on timescales of hours to months. For example, HABs of *Karenia brevis* may be triggered by nitrogen-fixing cyanophytes, which bloom during natural iron enrichment through Saharan dust deposition (Walsh and Steidinger, 2001).

Many attribute the occurrences of HABs to nutrient loading and coastal eutrophication (e.g., Parsons et al., 2002). The nutrient loading has been blamed on