days to weeks, covering much of the eastern Gulf of Mexico. Stumpf et al. (2003) utilize ocean color imagery to monitor the occurrence and presence of these blooms. These HABs tend to accumulate and grow at a persistent mid-shelf convergence front that is maintained by seasonal winds along the west Florida coast. Gulf of Mexico eddy circulation affects bloom retention and distribution, and the Florida Current and Gulf Stream act to transport the *K. brevis* blooms out of WFS region. It is thought that decreasing water temperatures may also contribute to cessation of blooms of the warm-water species, *K. brevis*.

Coastal buoyant plumes have been found to be responsible for the transport of *Alexandrium tamarense* in the southwestern Gulf of Maine (Keafer and Anderson, 1991). *A. tamarense* is a toxic dinoflagellate, found to produce biotoxins and result in paralytic shellfish poisoning syndrome (e.g., Anderson, 1995). Keafer and Anderson (1991) utilized sea surface temperature (SST), estimated from remotely sensed imagery, to track a warm coastal plume that formed from spring runoff. This buoyant plume was found to be responsible for the southerly transport of *A. tamarense* along the east coast of the U.S. Springtime coastal upwelling then shifted the plume of warmer water containing *A. tamarense* offshore. This study by Keafer and Anderson (1991) demonstrates the utility of large-scale, remotely sensed SST data for HAB characterization and monitoring (see Section X.3.2).

Lindahl (1986) found a correlation between high salinity plumes of Skagerrak (northern European) waters and blooms of the toxic dinoflagellate *Gymnodinium mikimotoi* (formerly *Gyrodinium aureolum*) on the west coast of Scandinavia. Lindahl (1986) hypothesized that *G. mikimotoi* blooms offshore and is transported toward the coast by wind-induced currents and convergent flows. These examples illustrate the need for high temporal and spatial resolution and judiciously placed physical instrumentation for understanding HAB dynamics in a coastal region.

X.2.2 Biological processes

The growth of harmful algae generally has two principal requirements: nutrients and light. Nutrient uptake and light adaptation in phytoplankton take place on timescales of hours to days and are generally more spatially important in the vertical direction, i.e. with depth of the water column. The observations and sampling of biological parameters are focused on phytoplankton behavior (e.g., motility), physiology (nutrient uptake), and grazing pressures. Some examples are described here.

Many harmful algae are dinoflagellates, which have been observed to be adapted to decaying turbulence and thus tend to bloom during well-stratified, quiescent waters. However, dinoflagellates are biophysically adapted for swimming, allowing this particular phytoplankton group to perhaps avoid or dampen turbulence and vertically migrate (Smayda, 1997; 2002). Also, some toxic dinoflagellates species form from a resting state (a cyst) that falls to the ocean floor (Anderson et al., 1984; Marasovic, 1989; Nagai et al., 2003). This allows the dinoflagellates to lay dormant when chemical conditions are not optimal for their growth. When nutrients are in abundance or when triggered by internal biorhythms, the algae return to the water column as phytoplankton (Burkholder and Glasgow, 1997; Donaghay and Osborn, 1997). Cysts can also be resuspended off of the ocean floor through physical forcing (high currents and/or waves; Figure X.3). The vertical movement of phytoplankton, e.g., diel vertical migration, can