absorption of light was developed using high-temporal resolution data from the site in order to partition contributions by phytoplankton, detritus, and colored dissolved material (CDM) (Chang and Dickey, 1999). Besides the obvious effects of Hurricane Edouard and a later hurricane (Hortense), bloom conditions were also evident.

In the central Arabian Sea, the seasonal physical cycle associated with the northeast (NE) and southwest (SW) monsoons is correlated with bio-optical properties of the ocean (Dickey et al., 1998b). The seasonal physical forcing features two mixed layer deepening and shoaling cycles per year (Fig. 10.8). The NE monsoon is characterized by steady northeasterly winds of moderate intensity (about 6 m s^{-1}), surface cooling, and convection, whereas the SW monsoon features strong, persistent southwesterly winds with greater intensity (up to 15 m s^{-1}). The NE monsoon drives deeper mixed layers (about 110 m depth) than the SW monsoon (about 80 m depth) because of the convective forcing. A half-yearly cycle in chlorophyll *a* (Fig. 10.8) is an important feature with seasonal blooms occurring late in each monsoon season and into the respective intermonsoon periods; the depth-integrated chlorophyll *a* tracks the 1% light level. Again, the classical Sverdrup hypothesis appears to be supported [a more detailed interdisciplinary model of the NE monsoon is presented in Wiggert et al., (2000)]. Mesoscale eddies play roughly equal roles in the evolution of chlorophyll *a* at the observational site (Fig. 10.8). Other aspects of these time series are described below.

Finally, the physical dynamics of the equatorial Pacific have become increasingly well understood over the past decade in large part because of the measurements made from the Tropical Atmosphere Ocean (TAO) mooring array (e.g., McPhaden, 1995). However, understanding of biological and optical variability has been limited because few dedicated ship-based experiments could be performed in such a remote region. In particular, only a few biological observations of chlorophyll and primary productivity were made each year prior to 1988; these were our only bases for annual estimates of chlorophyll and primary production for the expansive Pacific equatorial waveguide (e.g., Cullen et al., 1992). However, bio-optical instruments were added to the TAO physical mooring at 0°, 140°W for an 18-month period in 1992 and 1993 (Foley et al., 1997). This sampling period was most fortuitous as the observations spanned both El Niño and "normal" phases. During the El Niño, the mixed layer, the thermocline, and a very weak equatorial undercurrent were very deep (at times in excess of 150 m) and Kelvin waves (about a 60-day period) propagated eastward past the site (with depressions of the thermocline). Although the light levels were high, relatively high concentrations of nutrients, including iron, were deep; consequently, measured chlorophyll *a* concentrations in the upper layer were low (less than 0.2 mg m^{-3}). However, as "normal conditions" returned, Kelvin waves ceased and the thermocline and a strong equatorial undercurrent shoaled allowing for the transport of nutrients into the euphotic layer. Importantly, westward-propagating tropical instability waves (TIWs with periods of about 20 days) also contributed to large vertical upwelling cycles. TIWs are easily seen in the meridional current records (also in ocean color images; see Yoder et al., 1994) and appear to be manifest in the chlorophyll *a* time series, with values doubling and at times tripling those observed during the El Niño period. Importantly, strong, although highly complex coupling is evident between the physical processes (El Niño, Kelvin waves, and TIWs) and the phytoplankton biomass and primary productivity (here roughly proportional to chlorophyll *a*) of the equatorial Pacific. It is worth noting that Barber et al. (1996) have suggested that the passages of the TIWs are analogous to a natural iron