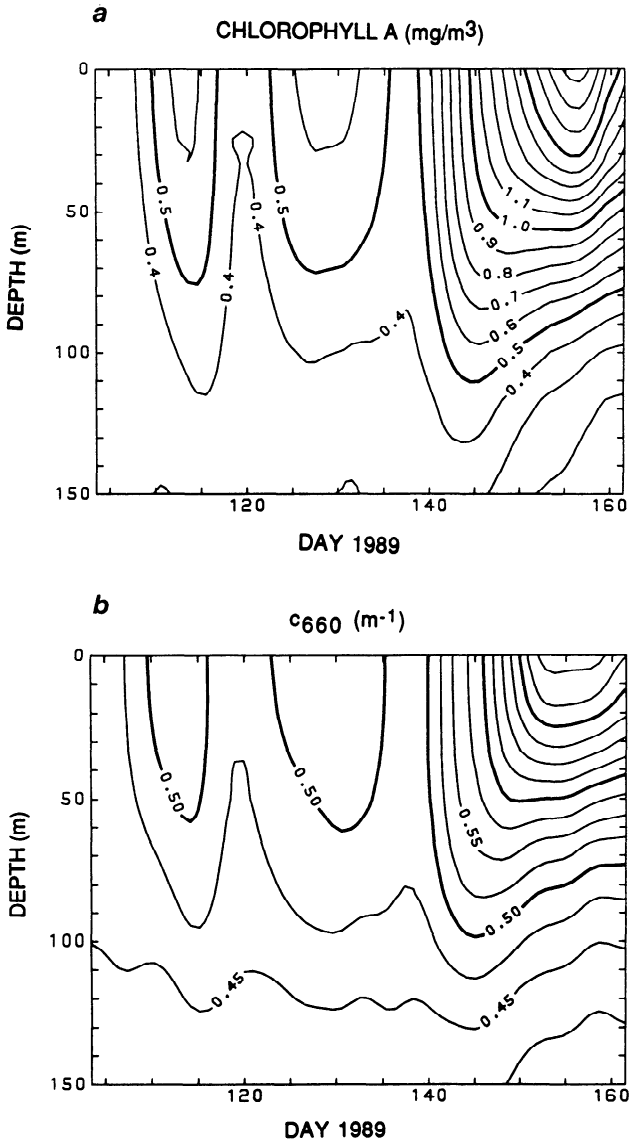

Figure 4. Time versus depth contours of (a) fluorometrically determined concentration of chlorophyll a and (b) beam attenuation coefficient at 660 nm from mooring measurements.

maximum losses occur in the evening when phytoplankton concentration is highest. Primary production (Figure 6c) is equal to zero at night and positive during the day, when it displays a strong decrease with depth.

All three components of the biomass balance are shown in Figure 7 as time series at a depth of 2 m. Regarding the loss term caused by mixing in the surface waters, it is apparent that this effect is much greater during the day than at night. This pattern is induced by the strong decrease of productivity with depth, which in turn leads to larger vertical gradients in phytoplankton distribution during the day than at night. Thus the model results presented here suggest that the diel cycle in phytoplankton concentration in the surface water results from the changing balance of phytoplankton gains and losses, with the losses being much larger during the day than at night.

This observation is important for estimating primary productivity from any method based on the diel variability of the biomass concentration, for example, using beam attenuation coefficient data [*Siegel et al.*, 1989; *Cullen et al.*, 1992]. In order to avoid errors, such methods should account for the losses described above. It is worth stressing here that the diel pattern in the components of the biomass balance can generally change in time in response to mixed layer dynamics and light availability for primary production. In particular, dramatic changes may occur during time periods of increased heat loss from the sea surface and during high winds. Under such conditions, phytoplankton are efficiently mixed downward, in consonance with the mixed layer deepening. The result is that while phytoplankton concentration decreases significantly in surface waters, it can reach relatively high values at greater depths, even though local production is very low there because of low light levels (Figures 8 and 9).

Discussion and Conclusions

The crucial variable in phytoplankton models is the light energy captured by phytoplankton cells, since it controls the

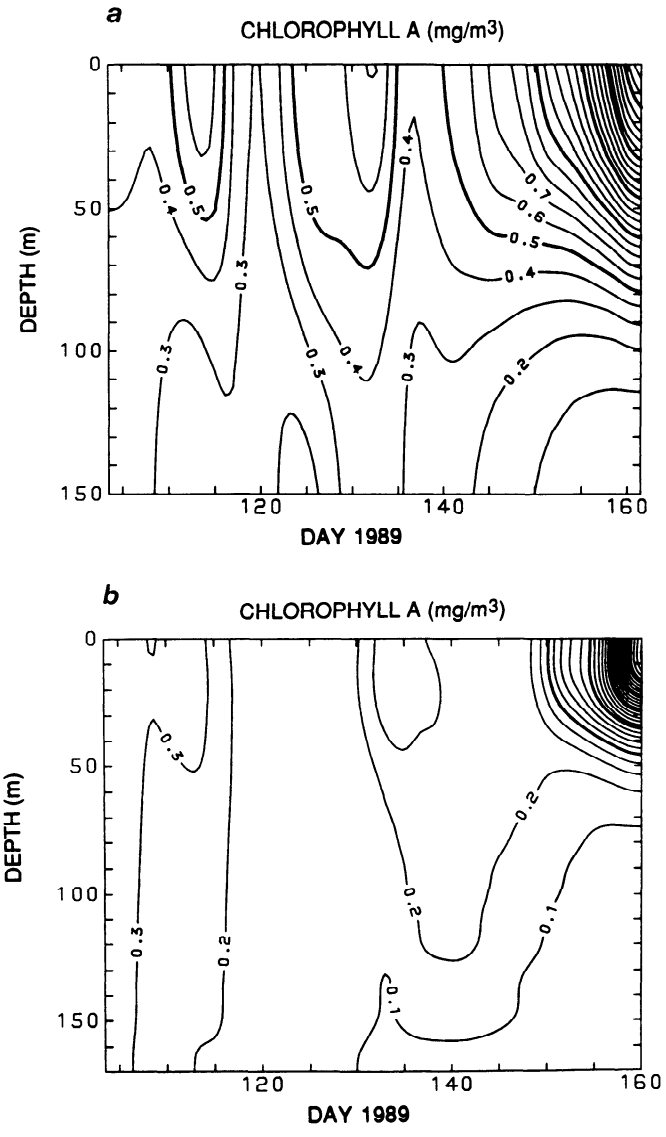

Figure 5. Results of coupled biophysical model simulation (see text for details). (a) Concentration of chlorophyll a obtained using equation (5). (b) Concentration of chlorophyll a obtained using equation (6).