Hurricane Edouard first became evident in the beam c record when the storm was greater than 900 km from the CMO site. The greatest beam c values (up to about 30 m^{-1}) are seen in the near bottom (68 m) time series during the time of closest passage, however the signal is clearly seen in the 37 m depth record (up to 2 m^{-1}) as well. The beam c values are reduced by about a factor of five between 68 and 52 m and by about a factor of two between 52 and 37 m. The NDBC buoy shows that the significant wave height exceeded 9 m at this time. It is worth noting that the onset of the increased beam c values occurred first at 68 m, then about a half-day later at 52 m, and finally an additional half-day later at 37 m (Fig. 2). The return of beam c values to pre-hurricane levels was slower at the shallower depths than at the deeper depths. This is consistent with size distributions biased toward smaller particles (with lower settling velocities) at the shallower depths.

Figure 3 shows curves for size distributions taken six hours apart, beginning 12 hours before the peak in Hurricane Edouard-induced bottom pressure. The volume distributions clearly indicate the presence, disappearance, and reestablishment of large particles in the water column as the intensity of the hurricane-induced bottom currents and oscillations increased to their maximum and then weakened as the hurricane moved away from the bottom tripod. These data support the photographic results that show high levels of localized shear and turbulence (e.g., turbulent dissipation rate) in the water column, due to currents and waves, broke up flocculates. These flocs then rapidly reappeared as the intensity of turbulence weakened.

The greatest increases in beam c did not coincide with the time of closest passage of Hortense. At the time of closest passage, winds peaked at 11 m s^{-1} and significant wave height was 4 m at the NDBC buoy site. The cause(s) for the abrupt dip and then rise in the beam c record at 68 m (Fig. 2e), is not obvious. One hypothesis is that the sediments could have been resuspended some distance away from the site and then advected past the mooring. This possibility seems unlikely in that the increase in beam c did not occur at all depths at the same time. The signal was first observed at the bottom, then about three-fourths of a day later at 52 m, and then an additional three-fourths of a day later at 37 m. It is possible that two trains of wind-generated surface waves could have caused the successive peaks.

The principle physical process that determines the structure of the near-bottom flow field on a continental shelf is the interaction of surface waves with mean currents [Glenn and Grant, 1987].

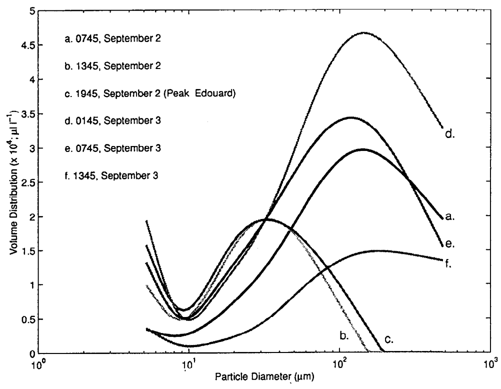

Figure 3. Six curves of volume size distribution of particles (µl l^{-1}) at six hour intervals, beginning 12 hours prior to the peak of Hurricane Edouard-induced bottom rms pressure (1945 on September 2).

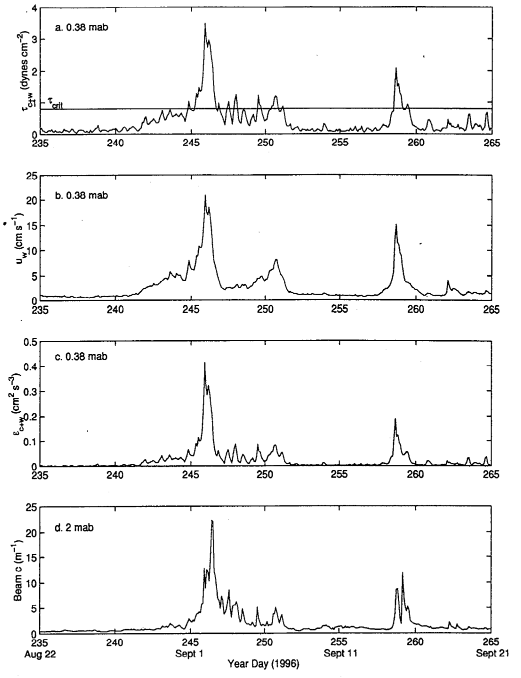

Figure 4. a. Time series of current-wave bottom shear stress at 0.38 mab computed using near-bottom current measurements (half-hour averages), wave orbital velocity, and the model presented in Christoffersen and Jonsson (1985). b. Time series of wave-orbital velocity at 0.38 mab. c. Time series of dissipation rate at 0.38 mab calculated using friction velocity derived from the Christoffersen and Jonsson (1985) model. d. Beam attenuation coefficient (676 nm) at 68 m (2 mab).

The current-wave interaction has been shown to be a non-linear phenomenon (e.g., Grant and Madsen [1979]; Christoffersen and Jonsson [1985]; Glenn and Grant [1987]). The frequency differences between waves and mean currents result in an oscillatory wave boundary layer within a relatively steady current boundary layer. The small scale of the wave boundary layer causes the wave boundary shear stress to be an order of magnitude greater than that of the shear stress associated with a current of comparable magnitude. The suspension of sediment by waves in the absence of strong, subcritical currents is not unexpected (e.g., Grant and Madsen [1979]; Glenn and Grant [1987]); it is associated with the time-varying part of shear stress, which has oscillatory amplitudes clearly in excess of critical values. To characterize the near-bottom flow field, combined current-wave shear stresses must be considered.

Sediment is expected to be resuspended when bottom shear stresses exceed a "critical" shear stress [Twichell et al, 1987]. The critical combined current-wave shear stress was first exceeded at the time of increased sediment resuspension during the passage of Hurricane Edouard (Fig. 4a). Current-wave shear stress values periodically exceeded the critical value (up to a maximum of about 3.5 dynes cm^{-2} during the time of greatest sediment resuspension) for about five days following the peak of the Hurricane Edouard winds. Mean current shear stress exceeded the critical value during the passage of Edouard as well, with τ_c exceeding 2.5 dynes cm^{-2} (data not shown). Sediment resuspension associated with Edouard was possibly due to intense bottom mean currents with little interaction with waves. In contrast, the sediment resuspension caused by Hurricane Hortense occurred when boundary shear stresses associated with