

Figure 4. Beam attenuation at 660 nm (c_{660}) versus salinity for towyo 30 (+). The circled crosses indicate the different layers observed in the water column: surface waters, shallow phytoplankton layer, new sewage plume waters, old sewage plume waters, and deep phytoplankton layer.

observations [Wu *et al.*, 1994]) (Figure 4). Surface data were included for comparison. The highest c_{660} values were associated with new sewage. The magnitude of these parameters varied from day to day, but the relations between the different particle fields were maintained. These types of plots provided greater contrast and allowed better discrimination among the different particle fields than profile plots.

3.2. Inherent Optical Properties

The consistency between the two beam attenuation measurements, c_{660} and a_{c-9} data, was checked and showed that the c values from the a_{c-9} (interpolated between 650 and 676 nm) were 80% higher than $(c - c_w)(660)$ (c_{660} with pure water subtracted). Only the absolute values of c_{660} from the Sea Tech instrument and relative values for a , b , and c from a_{c-9} measurements were used in our analysis.

3.2.1. Absorption spectra. Sewage plume particulate and detrital absorptions at 55 m in cast 9 were larger than corresponding absorptions in the shallow (10 m) phytoplankton layer (Figures 5a and 6a). The DOM signal was stronger in the sewage waters than in the shallow phytoplankton layer for the near ultraviolet (UV), and of the same magnitude for the 450-800 nm range (Figure 5b). Total absorption was stronger at 55 m than at 10 m throughout the UV and visible spectra. Total absorption difference spectra from bench-top spectrophotometric measurements were compared with a_{c-9} measurements and excellent agreement was obtained, especially at short wavelengths (Figure 5b).

3.2.2. Scattering and spectral slopes. Both scattering and beam attenuation coefficients were higher in the plume than in the phytoplankton fields (Figure 6). The contribution of scattering to beam attenuation increased in plume waters compared with the phytoplankton layers. For cast 9, c_{412} was 207% higher in the plume than in the shallow phytoplankton layer (10 m), while a_{412} increased by only 71%. The larger increase in c_{412} is therefore accounted for by a larger (296%) increase in b_{412} due to the presence of wastewater. Scattering spectra features, which usually cancel out absorption features, were quite flat, since a_{c-9} absorption spectra were flatter than traditional phytoplankton, DOM, or detrital absorption spectra (Figures 6a and 6b). Effluent

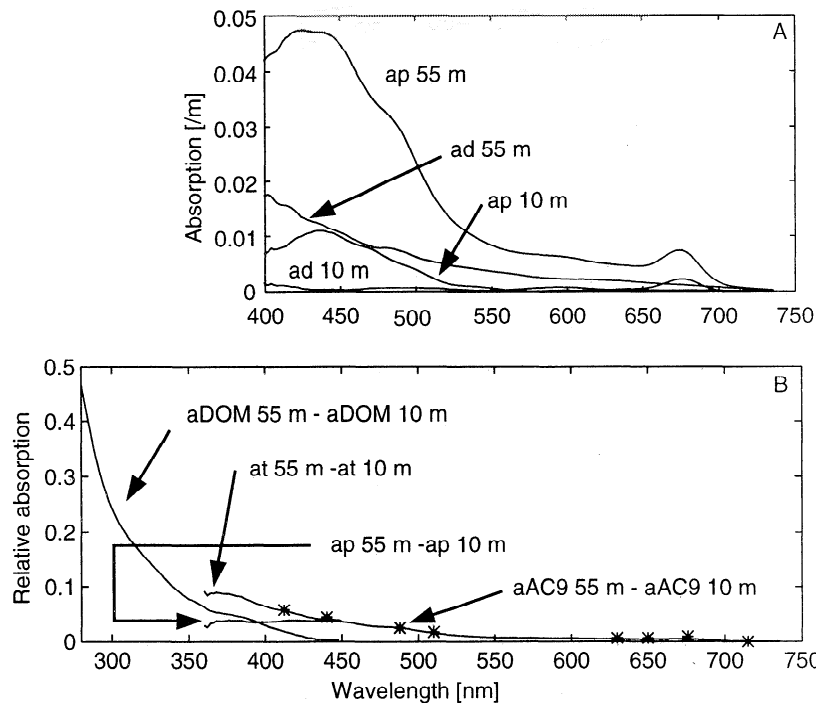


Figure 5. (a) Particulate and detrital absorption spectra at 10 m and 55 m. (b) Relative dissolved organic matter (DOM), particulate, and total (DOM + particulate) and a_{c-9} (asterisks) absorption spectra between 55 m and 10 m. All data are from cast 9.