4. As with $E_S(\lambda,t)$, it is often necessary, or desirable, to average individual $L_u(z,\lambda,t)$ and $E_d(z,\lambda,t)$ measurements over periods of minutes, or hours. If so, clearly the averaging interval for the in-water and above water data must be the same. Averaging should be applied with caution, if at all, *in situ*ations where bio-optical conditions (*e.g.* chlorophyll a concentration) at the measurement site may be expected to vary significantly during the averaging period. When chlorophyll a variability during the averaging period is large, *Chl* determined using, *e.g.*, $\frac{\bar{L}_u(0^-,443,\bar{t})}{\bar{L}_u(0^-,555,\bar{t})}$ in a remote sensing algorithm is always an underestimate of the mean chlorophyll a concentration. This is a well-known, direct consequence of the nonlinear relationship between remote sensing reflectance and absorption in seawater.

Data Analysis: methods are described to determine diffuse attenuation coefficients, water-leaving radiance, normalized water-leaving radiance, and remote sensing parameters including chlorophyll concentration *Chl*. The methods applicable to data from a particular buoy are determined by the available combination of measurements. Small, expendable drifters often carry only a single radiance sensor (*e.g.* a 7 wavelength Satlantic OCR-100) mounted beneath the buoy's hull (or flotation collar) at a depth $z_o \sim 1$ m (for example the OSU SOFeX drifter illustrated in Figure 3.12). The MOOS (Fig. 3.3) and ARGOS (Fig. 3.5) moored arrays, on the other hand, combine an $L_u(z,\lambda,t)$ sensor (OCR-100) mounted immediately beneath the buoy hull with paired $L_u(z,\lambda,t)$ and $E_d(z,\lambda,t)$ sensors at 10 m and 20 m depths. The GoMOOS optical moorings have paired Lu and Ed sensors at 3m, and an Ed sensor at 18m. Somewhat different data analysis schemes are possible with data from each of these and other radiometer configurations on a buoy. Zheng *et al*. (2002, 2003) describe procedures for the BTM data sets. In general, the uncertainty of derived quantities will be both lower and better understood for configurations with radiometers at several depths. Many of these uncertainties are not as important with profiling moorings, where virtually continuous profiles may be obtained and analysed using the methods of Vol. III, Chapter 2.

1. ***Diffuse Attenuation Coefficients*** $K_d(z,\lambda)$ for $E_d(z,\lambda)$ and $K_L(z,\lambda)$ for $L_u(z,\lambda)$ may be determined directly either from radiometric measurements at two depths (z_i,z_j), $j>i$, or modeled, from ratios $\frac{L_W(\lambda_m)}{L_W(\lambda_n)}$ using remote sensing algorithms, as average values $\bar{K}(\lambda)$ (denoted also as, *e.g.*, *K490* or *K520*, for wavelengths of 490 nm or 520 nm).

   a. $K490(t)$ and $\bar{K}(\lambda,t)$ from water-leaving radiance ratios: Assuming that $\frac{L_u(z_o,\lambda_1,t)}{L_u(z_o,\lambda_2,t)} \cong \frac{L_W(\lambda_1,t)}{L_W(\lambda_2,t)}$, ratios of upwelled radiance from a radiometer mounted under the buoy at a depth $z_o \sim 1$ m may be directly substituted into satellite remote sensing algorithms to determine ***Chl*** concentration [mg m^{-3}] (*e.g.* O'Reilly *et al*. 2000, Strutton *et al*. 2001) and ***K490*** [m^{-1}] (*e.g.* Austin and Petzold 1981). The remote sensing parameter $K490(t) \equiv \bar{K}(490,t)$ is the diffuse attenuation coefficient at 490 nm averaged over the first attenuation depth, *i.e.* the depth where $E_d(z,490,t)$ is 37 % of $E_d(0^-,490,t)$. Given $\bar{K}(490)$, the empirical algorithm and coefficient tables of Austin and Petzold (1986) may be used to determine $\bar{K}(\lambda)$ at other wavelengths. Morel (1988) provides an alternative algorithm for determining $\bar{K}(\lambda)$ from remote sensing *Chl*.

   b. $K_d(\bar{z}_{01},\lambda,1)$ from $E_S(\lambda,t)$ and $E_d(z_1,\lambda,t)$: Given irradiances measured by radiometers located above the surface and at depth z_1 [m], $E_d(0^-,\lambda,t)$ is determined from $E_S(\lambda,t)$ using