K(λ) Analysis

Following the above processing through equation (2.6), the attenuation coefficient for $L_u(z,\lambda)$ is computed from measurements at two discrete depths z_i and z_j as

$$K_L\left(\bar{z}_{ij},\lambda\right)=\frac{1}{z_j-z_i}\ln\left(\frac{L_u\left(z_i,\lambda\right)E_s\left(t_j,\lambda\right)}{L_u\left(z_j,\lambda\right)E_s\left(t_i,\lambda\right)}\right),\ z_j>z_i,\ i=1,2,3,\ j=2,3,4, \quad (2.7)$$

where t_i and t_j are the times of radiance measurements at depths z_i and z_j, respectively. The ratio of incident surface irradiances appears in (2.7) to account for changes in illumination, *e.g.* due to clouds, between the times of the two radiance measurements. The mean depth in the interval between z_i and z_j is

$$\bar{z}_{ij}=\frac{z_i+z_j}{2}. \quad (2.8)$$

The diffuse attenuation coefficient for $E_d(z,\lambda)$ is computed similarly to (2.7) as

$$K_d\left(\bar{z}_{ij},\lambda\right)=\frac{1}{z_j-z_i}\ln\left(\frac{E_d\left(z_i,\lambda\right)E_s\left(t_j,\lambda\right)}{E_d\left(z_j,\lambda\right)E_s\left(t_i,\lambda\right)}\right),\ z_j>z_i,\ i=1,2,\ j=2,3. \quad (2.9)$$

For computing $K_L\left(\bar{z}_{ij},\lambda\right)$ and $K_d\left(\bar{z}_{ij},\lambda\right)$ from data measured with the shipboard MOS instrument, the actual depths z_i are determined to the nearest cm using data from its high precision depth transducer.

Determining $L_W(\lambda)$ by Upward Extrapolation

To determine $L_W(\lambda)$, the measurement of upwelling radiance from a selected depth z_i is propagated to the surface as

$$L_u\left(0^-,\lambda\right)=L_u\left(z_i,\lambda\right)e^{K_L\left(\bar{z}_{ij},\lambda\right)z_i}. \quad (2.10)$$

The depth z_i is selected according to the following hierarchical rules:

1. If the data from the top arm are valid, then that depth is selected.
2. Else, the data from the middle arm, if valid, are selected.
3. Else, the data sequence is rejected entirely.

Water-leaving radiance is calculated by propagating $L_u(0^-,\lambda)$ through the interface as

$$L_W\left(\lambda\right)=\frac{1-\rho}{n^2}L_u\left(0^-,\lambda\right), \quad (2.11)$$

where the upward transmittance through the interface, for nadir viewing radiance, is approximately constant, with value

$$\frac{1-\rho}{n^2}=0.543, \quad (2.12)$$

being only weakly dependent on wavelength and insensitive to wind speed (Austin 1974; see also Vol. I, Chapter 2, and Vol. III, Chapters 2 and 4).

Normalized Water-Leaving Radiance

Since the water-leaving radiances are apparent optical properties and are dependent upon the effects of the atmosphere, variations in solar zenith angle θ_o, and the earth-sun distance d, it is necessary to normalize the data to remove these effects for some applications. The normalizing approach used with MOBY water-leaving radiances follows the procedures that were defined by Gordon and Clark (1981) to compute *solar-normalized water leaving radiances* as