3. Compare the magnitudes of measured $E_S(\lambda,t)$ to clear-sky model estimates $\tilde{E}_S(\lambda,t)$ (*e.g.* Frouin *et al*. 1989, Gregg and Carder 1990) calculated for the solar zenith angle at each time *t*. Reject as suspect any measurements exceeding the threshold

$$E_S(\lambda,t) > 1.25\tilde{E}_S(\lambda,t). \qquad (3.2)$$

The factor 1.25 allows measured spectral irradiances to moderately exceed calculated clear sky irradiances due to reflections from scattered clouds. Although larger $E_S(\lambda,t)$ values (up to factor of 3) may occur under some cloud conditions (*e.g.* scattered cumulus), these large values are intermittent and will not persist over the averaging periods usually applied to buoy measurements.

4. Combining the previous two steps, the shape of each $\hat{E}_S(\lambda,t)$ spectrum should be consistent with its magnitudes relative to the clear-sky model. In other words, if the magnitudes of $E_S(\lambda,t)$ indicate clear-sky conditions, then the spectral shape should fall off significantly with increasing wavelength. And conversely, if relatively low $E_S(\lambda,t)$ magnitudes suggest overcast conditions, the shape of the spectrum should be relatively flat and not decrease strongly with wavelength.

5. Examine the $E_S(\lambda,t)$ time series for consistency with the seasonal cycle of incident solar irradiance throughout the period of the deployment.

6. If $E_S(\lambda,t)$ is measured at 6 or more wavelengths consistent with the specifications of Volume II, Chapter 2 (Table 2.1), it should be possible to compute an estimate of Photosynthetically Available Radiation (PAR) at each time *t*. As a further quality control measure, these PAR estimates may be compared to independently measured PAR (if a PAR sensor is mounted on the buoy) and/or to regional PAR estimates modeled using cloud imagery measured using radiometers on geostationary satellites (*e.g*. Frouin *et al*. 1989).

In-Water Radiometric Data

Radiometers are mounted underwater on moored and drifting buoys, in a variety of configurations, to measure time series of upwelled spectral radiance $L_u(z,\lambda,t)$, downwelled spectral irradiance $E_d(z,\lambda,t)$, and less often, upwelled spectral irradiance $E_u(z,\lambda,t)$ (Sect. 3.4; Tables 3.3 and 3.4).

Data Processing: The initial steps in processing data from underwater radiometers are the same as for the above-water spectral irradiance:

1. Dark counts, from local midnight scans, are subtracted from each the data for radiometric channel.

2. Responsivity calibration factors determined in air are applied to convert radiance sensor counts to spectral radiance $\left[\mu\text{W cm}^{-2}\text{nm}^{-1}\text{sr}^{-1}\right]$ and irradiance sensor counts to spectral irradiance $\left[\mu\text{W cm}^{-2}\text{nm}^{-1}\right]$ units. The above comments regarding $E_S(\lambda,t)$ calibrations apply here also.

3. Calibrated radiances in each radiance sensor channel are multiplied by radiance immersion factors to determine $L_u(z,\lambda,t)$, and calibrated downwelled and upwelled irradiances are multiplied by irradiance immersion factors to determine $E_d(z,\lambda,t)$ and $E_u(z,\lambda,t)$, respectively. The immersion factors for radiance are calculated based on the refractive index of the radiometer's window material, and immersion factors for spectral irradiance sensors must be determined experimentally, following the protocols described in Volume II, Chapter 3 (Sect. 3.5). The instrument manufacturer ordinarily provides these factors, but frequently, only "representative values" for a "collector class" are listed. As pointed out in in Volume II, Chapter 3 (Sect. 3.5), immersion factors may vary up to 8 % between irradiance sensors of the same design and material specifications. To comply with these protocols, therefore, an investigator must ensure that the immersion factors for each in-water irradiance instrument have been experimentally characterized.