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DIFFUSE SHORTWAVE IRRADIANCE AT SURFACE - FURTHER ISSUES AND IMPLICATIONS

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ABSTRACT

Several recent studies indicate that radiative transfer models accurately compute the direct-normal solar irradiance (DNSI) at the surface while overestimating the diffuse downward irradiance (DFDI) in cloud-free skies. This can only mean that for realistic aerosol scattering, some atmospheric absorption process was unaccounted for in the models that compute irradiance components and those that estimate the aerosol optical thickness (AOT) from sunphotometer measurements. The amount of model overestimation is a point of current dispute arising mainly from a lack of knowledge of the accuracy in DFDI measurements. (DNSI in contrast is measured to ~0.3 percent). Shaded pyranometers, employed to measure DFDI, use calibration methods that do not account for zero offsets, which can be a substantial portion of the measured DFDI. The offsets are thought to arise from instrument IR cooling to the atmosphere. Extrapolation of nighttime values to daytime measurements may not be appropriate, as the radiative environment in which the pyranometer operates may be different during day and night, even for a shaded device. Correlation of DFDI with longwave cooling at night as measured by a pyrgeometer has been traditionally used to estimate daytime offsets. Here we show that even when corrected daytime offsets are used, the problem of model overestimation persists in all but one of more than 40 cases examined; this case will be explored in more detail. If, as some studies indicate, the daytime offsets are in excess of nighttime values by tens of watts, it would be difficult to account for substantial model underestimate at high altitudes. At high altitudes the atmosphere is mainly molecular, and Rayleigh scattering is well understood. In any case it is unlikely that the model overestimation can be explained away by increasing the offsets since the estimated diffuse/direct ratios are in excess of measured values using silicon detectors, which exhibit no offsets due to infrared emission. For high apparent AOTs (>0.2 at 550 nm) models can be made to agree with measurements if single scattering albedo is reduced to within reasonable limits, indicating that the comparison between models and measurements is not so sensitive to aerosol scattering properties as at low apparent AOTs.