Broadband Shortwave Solar Radiation Monitoring: Current Performance and Expectations

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Demand for increased accuracy in high-time-resolution measurements of surface radiation budget components continues to motivate investigators within the monitoring community. For example, during the past decade implementation of component summation methods for monitoring total hemispheric field-of-view irradiance led to studies of nighttime and daytime offsets in thermal detectors and methods of compensating for them. The resulting studies of these subjects have led to the most accurate measurements to date of the surface radiation budget components at well-maintained monitoring sites. However, as each source of error and/or bias is addressed in the instrument characterization process, the next significant source of error and/or bias is revealed. Capabilities of current radiative transfer models mandate accuracy on the order of a few watts if measurements of surface radiation budget components are to be useful and relevant in climate change studies involving radiative forcing. Instrumentation for measuring surface radiation budget components has not changed significantly over the past two decades. However, improved knowledge of high-time-resolution behavior of conventional instrumentation during continuous operation has resulted in more accurate measurements of surface radiation components. Additional improvements in absolute accuracies are also possible using tools summarized in this poster. The improvements are a consequence of spectral behavior knowledge of sensor window or dome material and knowledge of atmospheric constituents primarily responsible for departures from a behavior normalized during instrument calibration, coupled with estimated spectral effects computed using a radiative transfer model. Improved absolute accuracy can then be achieved by minimizing window spectral effects, or adjusting scaled irradiance values for estimated effects based on model calculations. Typical information necessary to accomplish this is illustrated in Figure 1. The figure is for a window material typically used in broadband pyranometry, Schott WG295, and illustrates the broadband flux difference in percent between an unwindowed and windowed measurement under varying atmospheric water vapor concentrations and solar elevation angle. A typical calibration normalizes a given instrument response to the atmospheric conditions on the day of calibration. However, unless identical atmospheric conditions occur at the field site where the sensor is deployed, scaled irradiance data from the sensor will always depart from actual irradiance, depending on the water vapor concentration departure from calibration-day conditions. Estimating the departure and using it to correct the scaled irradiance results in a more accurate measurement.

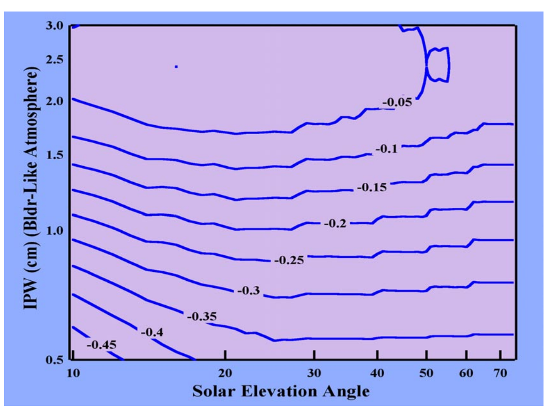

Figure 1. A contour plot illustrating the percent change in irradiance due to spectral window cutoff effects caused by integrated precipitable water (IPC). The isolines are in 0.05 of percent. Under clear-sky conditions and low water vapor amounts, the difference is on the order of 5 W for a typical Boulder atmosphere.