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A Method of Correcting for Tilt from Horizontal in Downwelling Shortwave Irradiance Measurements on Moving Platforms

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The downwelling shortwave (SW) irradiance typically consists of both a direct component of radiation from the sun, and a diffuse component of scattered sunlight from the sky. Significant offsets can occur in downwelling shortwave irradiance measurements made from moving platforms due to the tilt of the instruments from horizontal which changes the angular orientation of the direct component of sunlight to the instrument and causes an artificial variation in the measured signal. Without a proper tilt correction, even data limited to 5° of tilt can still exhibit large errors, greater than 100 Wm^{-2} in some cases. To properly correct for this tilt, a-priori knowledge of the partitioning between the direct and diffuse components of the total shortwave irradiance is needed. This partitioning information can be adequately provided using a newly available commercial radiometer named the SPN1 that produces reasonable measurements of the total and diffuse shortwave irradiance (and by subtraction the direct shortwave irradiance) with no moving parts and regardless of azimuthal orientation.

We have developed methodologies for determining the constant pitch and roll offsets of the radiometers for aircraft applications, and for applying a tilt correction to the total shortwave irradiance data. Results suggest that the methodology is accurate for tilt up to $\pm 10°$, with 90% of the broadband SW data corrected to within 10 Wm^{-2} at least for clear-sky data. Current efforts are in progress for extending this approach to narrowband irradiances as well. Given the low cost, low weight, and low power consumption of the SPN1 total and diffuse radiometer, opportunities previously excluded for moving platform measurements such as small Unmanned Aerial Vehicles and solar powered buoys now become feasible using our methodology. The increase in measurement accuracy is important, given current concerns over long-term climate variability and change especially over the 70% of the Earth's surface covered by ocean where long-term records of these measurements are sorely needed and must be made on ships and buoys.

We will present a description of the methodology, and show examples from the long-term 6-month RACORO* aircraft field campaign.

*Routine AAF (ARM Aerial Facility) Clouds with Low Optical Water Depths (CLOWD) Optical Radiative Observations (RACORO, 2009)