Using a Blackbody to Determine the Longwave Responsivity of Shortwave Solar Radiometers for thermal offset error correction

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Abstract : Thermopile pyranometers' thermal offsets have been recognized since the pyranometer's inception. This offset is often overlooked or ignored because its magnitude is small compared to the overall solar signal at high irradiance levels. With the demand of smaller uncertainty in measuring solar radiation, recent publications have described a renewed interest in this offset, its magnitude, and its effect on solar monitoring networks for atmospheric science and solar radiation applications. Recently, it has been suggested that the magnitude of the pyranometer thermal offset is the same if the pyranometer is shaded or unshaded. Therefore, calibrating a pyranometer using the method known as the shade/unshade method would result in accurate responsivity calculations, because the thermal offset error is canceled. Nevertheless, when the shade/unshade responsivity is used during the outdoor data collection, the resultant shortwave radiation would be underestimated if the thermal offset error is not corrected for. When using the component sum method for the calibration, the thermal offset error, which is typically negative when the sky is cloudless, does not cancel, resulting in an underestimated shortwave responsivity. Most operational pyranometers used for solar radiation monitoring networks are calibrated using the summation method since it is possible to calibrate many pyranometers simultaneously. From this arises the importance of correcting the summation method results to account for the thermal offset error. Here we describe the use of a laboratory blackbody to calculate the net-longwave responsivity of pyranometers, which is largely responsible for the offset error. This longwave responsivity is then used to correct shortwave responsivity derived from summation method calibration Procedures to accomplish the correction, and the associated uncertainties are described.
Figure 1 illustrates the NREL Blackbody calibration setup. Figure 2 shows the responses of several popular types of pyranometers to net infrared radiation measured during the laboratory calibrations.

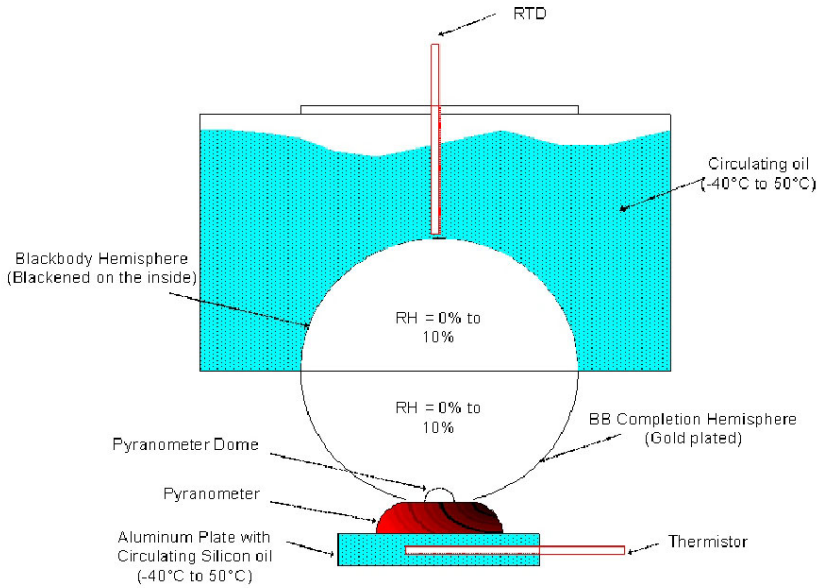

Figure 1. The Blackbody System (BBS) with a pyranometer in place.

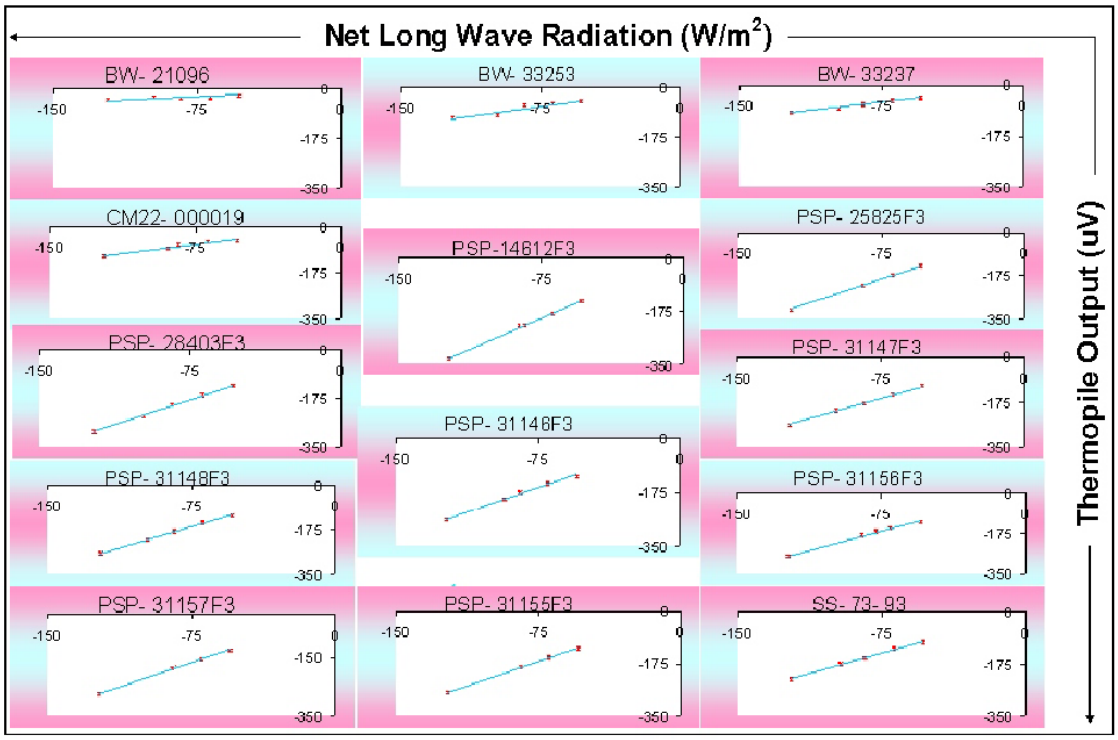

Figure 2. Thermopile voltage versus NET-IR during the Blackbody System (BBS) calibration.