Evaluation of the hyperspectral radiometer (HSR1) at the ARM SGP site

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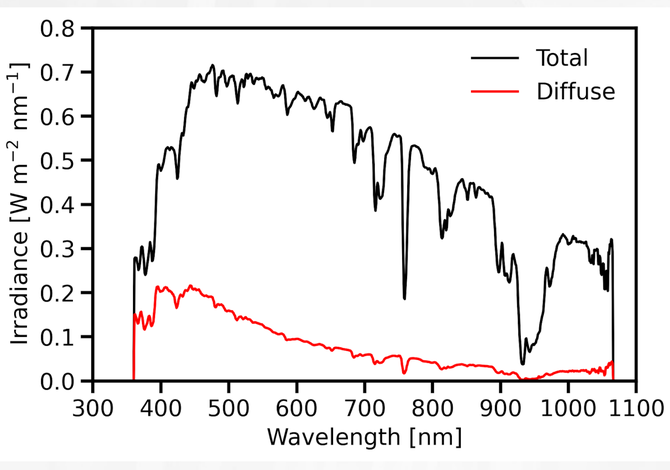
Introduction

The HSR1 prototype instrument developed by John Wood measures total and diffuse downwelling spectral irradiances from 360 to 1100 nm (spectral resolution of 3 nm). The HSR1 follows the SPN1 design with a shadow pattern and seven sensors (Wood et al., 2017, AMT).

The HSR1 was tested at the ARM SGP site in Oklahoma (36.61 °N, 97.49 °W) from May to July 2022. The HSR1 is evaluated by comparing the spectral irradiance and aerosol optical depth (AOD) to other collocated instruments including the multifilter rotating shadowband radiometer (MFRSR), Cimel sunphotometer (CSPHOT; AERONET AODs), and shortwave array spectroradiometer-hemispheric (SASHe).



(left) Fig. 1: HSR1 at the Guest Instrument Facility (GIF) at the ARM SGP Central Facility. (right) Fig. 2: Example total (black) and diffuse (red) spectral irradiance measured by the HSR1.

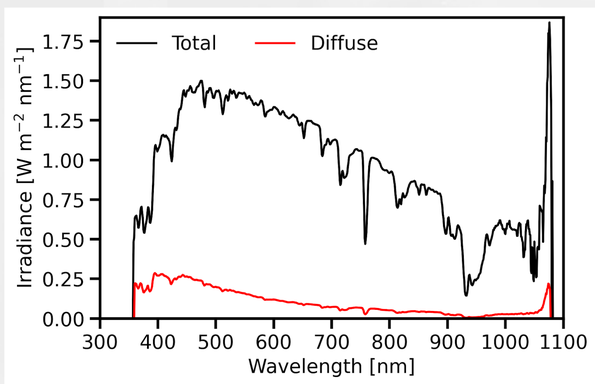
Spectral total, diffuse irradiance comparison

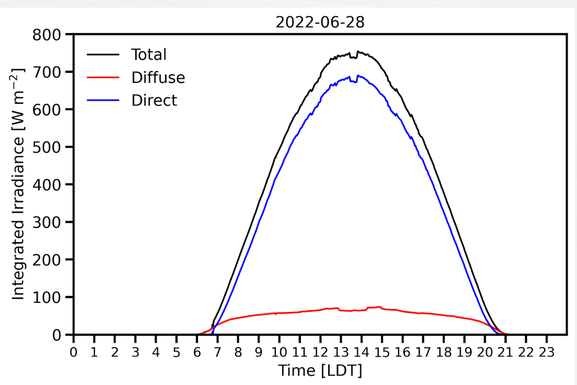
Total: HSR1 agrees well with MFRSR/SASHe, slightly larger by 1-2%.
Diffuse: HSR1 is smaller by 10%.

Fig. 5: (top) Frequency histogram of collocated (left) total, and (middle) diffuse irradiance at 500 nm for (a&b) MFRSR/HSR1, and (d&e) clear-sky SASHe/HSR1. Mean values provided above each subplot. (right) Mean collocated total (black) and diffuse (red) irradiances for (c) MFRSR/HSR1, and (f) SASHE/HSR1.

General instrument performance notes

- Measurement noise due to straylight issues for wavelengths < 400 nm and for wavelengths > 950 nm, especially for wavelengths > 1000 nm.
- Data exhibits step functions due to channel switching based on the shadow pattern design as the sun angle changes throughout the day.
- Data logging was interrupted by PC processing or possible software updates during the test period. The issue was partially remedied by reducing the data collection interval.





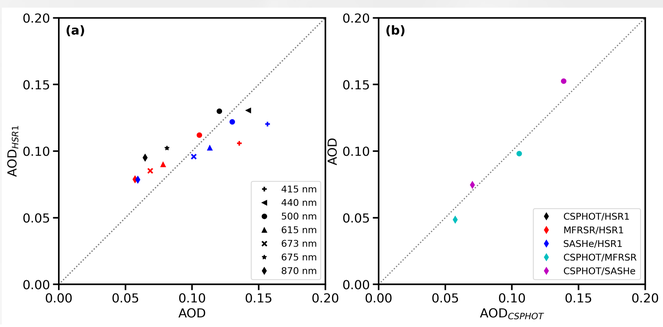
(left) Fig. 3: Example of noisy total (black) and diffuse (red) irradiances at wavelengths > 1000 nm.
(right) Fig. 4: Example of step function exhibited due to channel switching in the total (black), diffuse (red), and direct (total - diffuse; blue) integrated irradiance (400-1000 nm) on 28 June 2022.

Aerosol optical depth retrieval, comparison

Retrieval: The AOD is retrieved by considering Langley regressions (Ermold et al., 2013; Koontz et al., 2013) for clear-sky periods only.

Comparison:

HSR1 AOD is larger than the CSPHOT, MFRSR AODs by ~0.01. CSPHOT and MFRSR AODs agree well.



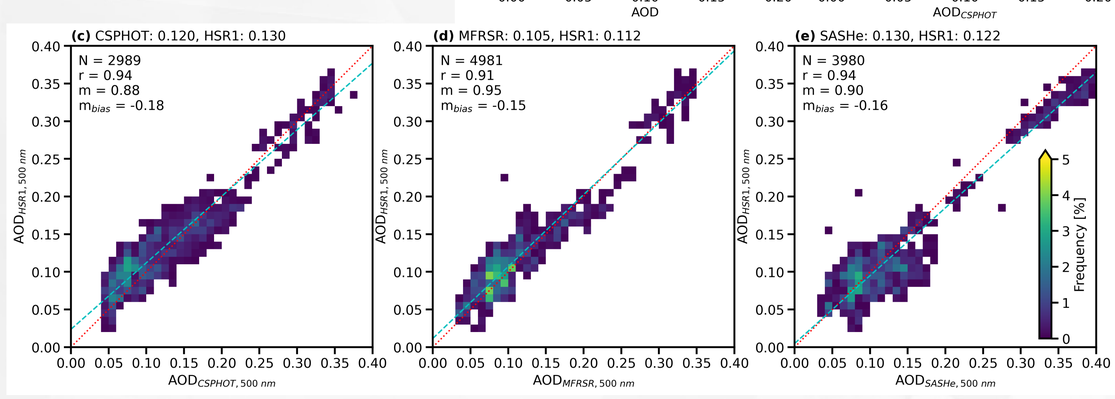


Fig. 6: (top) Mean collocated AOD between CSPHOT/HSR1 (black), MFRSR/HSR1 (red), SASHe/HSR1 (blue), CSPHOT/MFRSR (light blue), and CSPHOT/SASHe (purple). (bottom) Frequency histogram of collocated AOD at 500 nm for (c) CSPHOT/HSR1, (d) MFRSR/HSR1, and (e) SASHe/MFRSR. Mean AODs shown above subplots.

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