

Report on the outcomes of a Short-Term Scientific Mission¹

Action number: CA21119

Grantee name: Lionel Doppler

Details of the STSM

Title: Comparison of AOD retrievals out of spectral irradiance measurements of different spectroradiometers and methods during FRC-VI intercomparison campaign.

Start and end date: 04/10/2025 to 11/10/2025

Description of the work carried out during the STSM

Description of the activities carried out during the STSM. Any deviations from the initial working plan shall also be described in this section.

The purpose of this STSM grant was to support the applicant's participation in the FRC-VI campaign. The Filter Radiometer Comparison (FRC) campaigns, organized by the WMO every five years at PMOD/WRC in Davos, run in parallel with the International Pyrheliometer Comparison (IPC). During FRC campaigns, Aerosol Optical Depth (AOD) retrievals from photometer and spectroradiometer measurements are compared. In the sixth FRC edition, 35 instruments representing 14 types (5 spectroradiometers and 9 filter radiometers) were compared against the PMOD/WRC reference spectroradiometer (QASUME UV&IR) and reference photometers (GAWPFR-TRIAD).

This STSM addressed Deliverable D1.4 of WG1 in the HARMONIA project, which focuses on high-spectral-resolution AOD retrievals from spectral DNI (Direct Normal Irradiance) measurements using spectroradiometers. The aim was to develop a method for AOD retrieval based on spectral DNI data collected by the instruments participating in the campaign. The applicant has been present at PMOD/WRC during FRC-VI and did following essential activities in presence during the campaign:

- 1) Support of the PMOD/WRC team in campaign operations, particularly in handling DWD instruments and trackers used in the FRC and IPC campaigns.
- 2) Observation of the operational procedures for spectral DNI measurements to define the AOD inversion strategy. The spectroradiometer involved included the array spectrometers PSR (PMOD/WRC Triad and DWD PSR#004), BTS-VL units from CIEMAT (Madrid) and PMOD/WRC, and the reference monochromator spectrometer QASUME UV-VIS and QASUME VIS-NIR of PMOD/WRC (see Figure 1).

¹ This report is submitted by the grantee to the Action MC for approval and for claiming payment of the awarded grant. The Grant Awarding Coordinator coordinates the evaluation of this report on behalf of the Action MC and instructs the GH for payment of the Grant.

- 3) Engagement in discussions with campaign PIs at PMOD/WRC, other PMOD/WRC experts in spectral measurements, and other international experts in photometry and spectral measurements participating in parallel WMO campaigns (IPC, FRC, IPgC) at PMOD/WRC.
- 4) Participation to HARMONIA WG4 first meeting about instrumental developments on 8 October 2025 (participation funding is included in this STSM).



Figure 1. Spectroradiometers involved in the FRC-VI campaign in Davos. From left to right: (1) PMOD/WRC BTS-VL and QASUME (reference), (2) PMOD/WRC PSR Triad with two PFRs, (3) CIEMAT BTS-VL on the DWD tracker, and (4) DWD instrument suite at FRC-VI with two PFRs and PSR#004 on a PMOD/WRC tracker.

Description of the STSM main achievements and planned follow-up activities

Description and assessment of whether the STSM achieved its planned goals and expected outcomes, including specific contribution to Action objective and deliverables, or publications resulting from the STSM. Agreed plans for future follow-up collaborations shall also be described in this section.

The following achievements were obtained during this STSM:

- 1) Acquisition of a valuable spectral DNI (Direct Normal Irradiance) dataset from the reference spectroradiometers QASUME UV-VIS and QASUME VIS-NIR, as well as from the compared spectroradiometers PSR (PMOD/WRC PSR-Triad and DWD PSR#004) and BTS-VL units (from PMOD/WRC and CIEMAT) (see Figure 2, top).
- 2) AOD measurements from multiple photometers, including the PMOD/WRC reference photometers—AERONET Cimel (see Figure 2, bottom, and Figure 3) and GAW-PFR Triad—as well as additional DWD PFR photometers.
- 3) Spectral AOD retrievals from spectral DNI data using the PMOD algorithm applied to QASUME UV-VIS and BTS-VL instruments (see Figure 2, bottom).
- 4) Preliminary campaign results as of 24 October 2025: Figure 2 shows comparisons of spectral DNI (top) and spectral AOD (bottom) for a spectrum measured at 13:00 UTC on 2 October 2025. Figure 3 presents AOD at 500 nm retrieved from spectral DNI compared with one reference photometer (AERONET Cimel of PMOD/WRC, blue circles) for all measurements on 2 October 2025.

Spectra DNI & AOD - 20251002 - FRC-VI, Davos

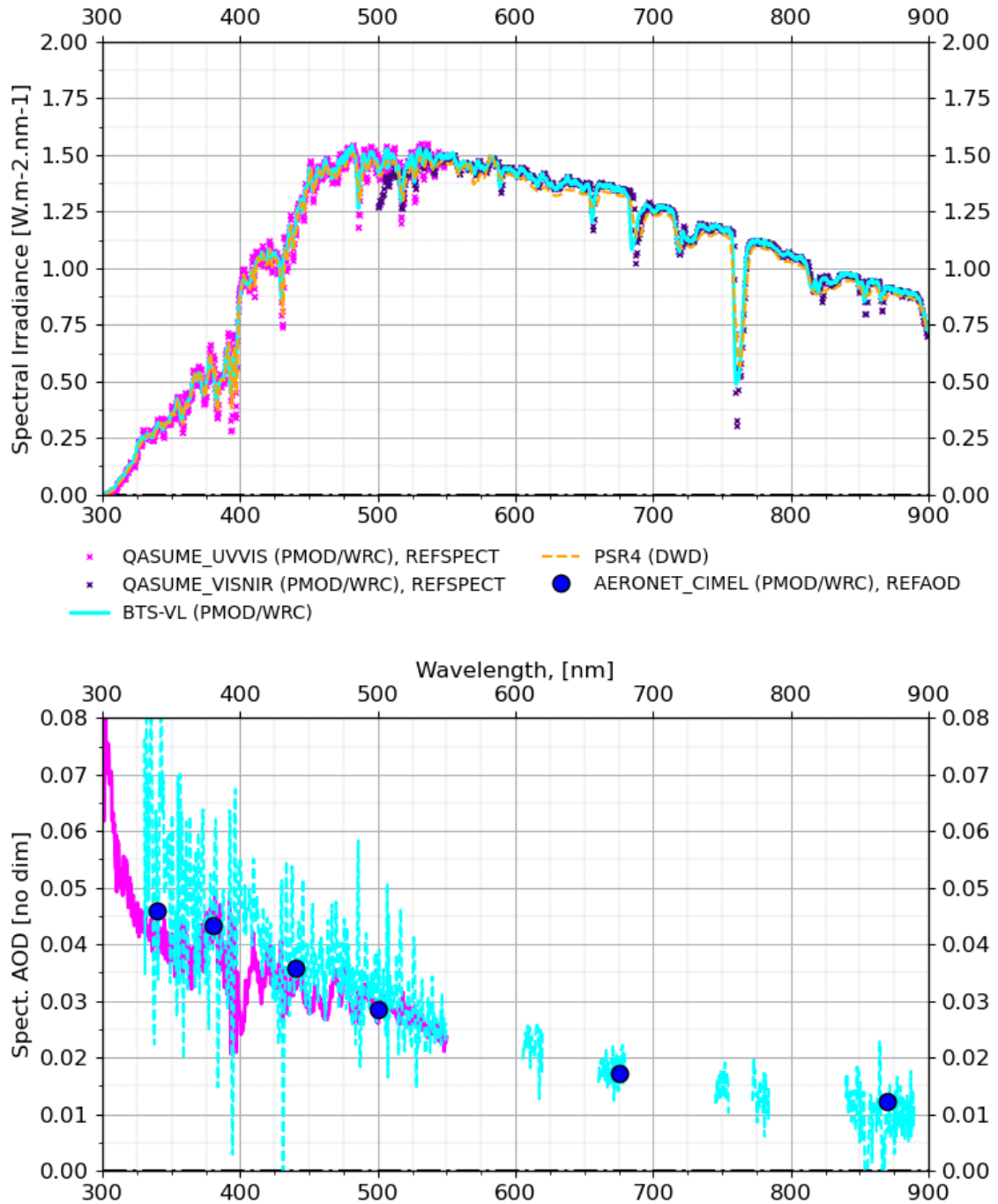


Figure 2. (Top) DNI spectra from various FRC-VI systems, including the reference spectroradiometer QASUME, on 2 October 2025 at 13:00 UTC. (Bottom) Corresponding AOD spectra for the same systems, including AOD from the reference Cimel AERONET photometer at selected wavelengths (blue circles).

AOD & AODdiff - 20251002 - FRC-VI, Davos

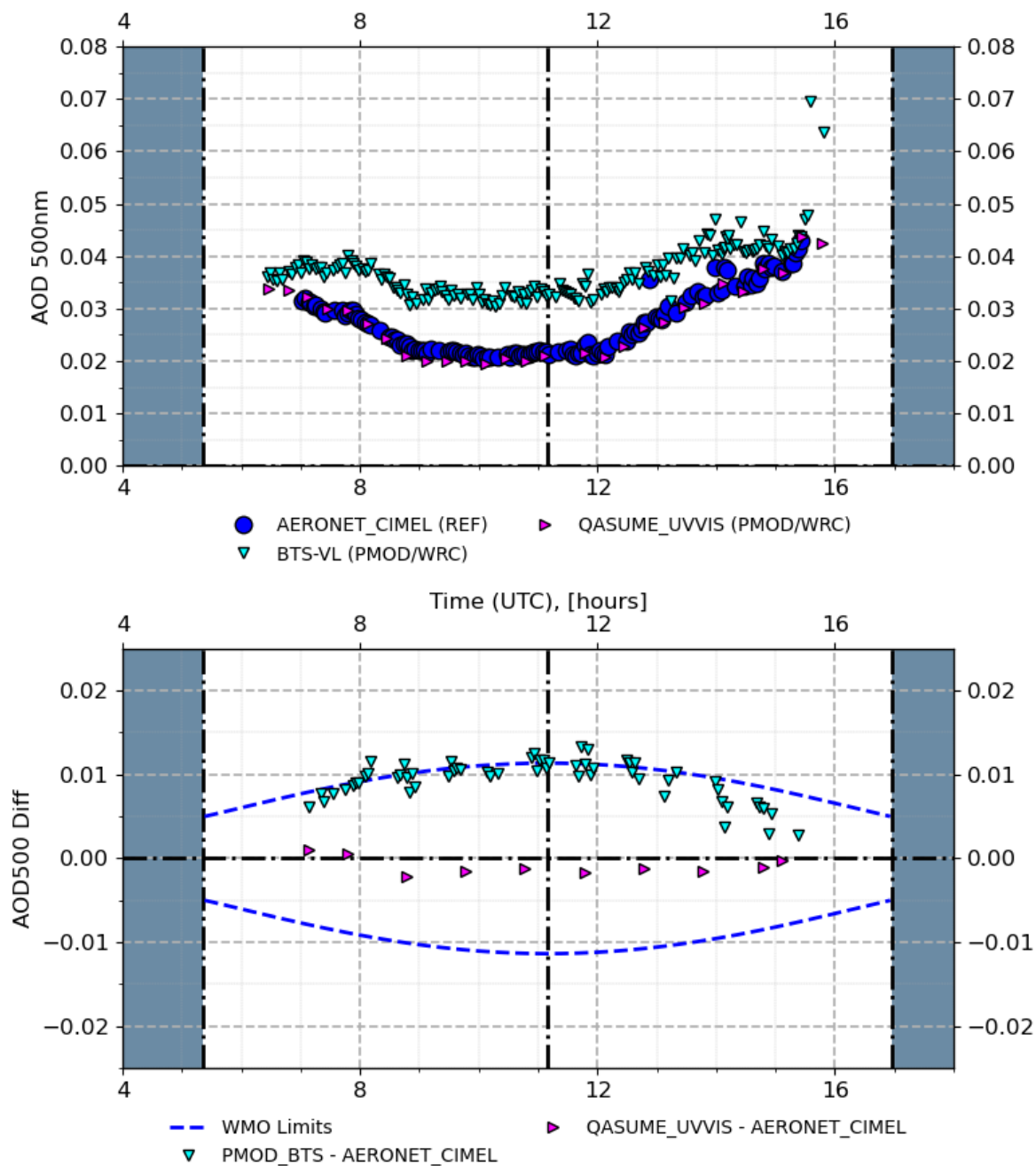


Figure 3. (Top) AOD at 500 nm along the time UTC from various FRC-VI systems, including the reference photometer Cimel AERONET, on 2 October 2025. (Bottom) AOD Difference 'System minus Reference' with Cimel AERONET as reference.

The results presented above are preliminary, as the campaign is ongoing. Nonetheless, the STSM has been completed, serving as the starting point for a broader study on high-spectral-resolution AOD retrievals from spectral DNI measured with spectroradiometers during FRC-VI. The following outcomes are currently being developed, building on the STSM work:

- 1) Acquisition of additional spectral DNI data from other systems (CIEMAT BTS-VL, PMOD/WRC PSR-Triad).
- 2) Collection of AOD measurements from more campaign photometers (DWD PFR, PMOD/WRC GAW-PFR Triad, etc.).
- 3) Retrieval of spectral AOD using the PMOD algorithm for all PSR instruments.
- 4) Retrieval of spectral AOD using the DWD algorithm for all spectroradiometer systems.
- 5) Comparison of spectral AOD retrieved with the PMOD algorithm versus the DWD algorithm.

All these analyses will be incorporated into the broader study on high-spectral-resolution AOD retrievals from spectral DNI measurements with spectroradiometers (ongoing Deliverable 1.4 of HARMONIA WG1) and are intended for future publication. This STSM also contributes to Deliverable 1.3 (Harmonized AOD retrieval methods) of HARMONIA WG1.