

Protocol of the intercomparison at ARPA, Aosta, Italy on June 2021 with the travelling reference spectroradiometer QASUME from PMOD/WRC

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The purpose of the visit was the comparison of global solar irradiance measurements between the spectroradiometer AAO operated by the Sezione Agenti Fisici - Radiazione Ultravioletta Solare, Agenzia Regionale per la Protezione dell'Ambiente (ARPA) and the travel reference spectroradiometer QASUME. The measurement site is located at Valle d'Aosta; Latitude 45.74 N, Longitude 7.34 E and altitude 569 m.a.s.l. The horizon of the measurement site is free down to at least 80° solar zenith angle (SZA). Measurements between 4:30 UT and 19:00 UT have been analysed.

QASUME was installed at ARPA Aosta 21 June 2021. The spectroradiometer was installed next to AAO with the entrance optic of QASUME within 1 m of AAO. The spectroradiometer in use at ARPA Aosta is a Bentham DTMc300 double monochromator. The intercomparison between QASUME and the ARPA spectroradiometer lasted four days, from the morning of June 22 to noon of June 25, 2021.

QASUME was calibrated several times during the intercomparison period using a portable calibration system. Two lamps (T68523 and T685240) were used to obtain a spectral irradiance calibration traceable to the primary reference held at PMOD/WRC, which is traceable to PTB. The daily mean responsivity of the instrument based on these calibrations varied by less than 1 %. The internal temperature of QASUME was 26.7 ± 0.27 °C and the diffuser head was heated to a temperature of 29.3 ± 0.53 °C. The wavelength shifts relative to an extraterrestrial spectrum as retrieved from the matSHIC analysis were between ± 50 pm in the spectral range 290 to 500 nm.

Protocol:

The measurement protocol was to measure one solar irradiance spectrum every 30 minutes from 290 to 500 nm, every 0.25 nm, and 1.5 seconds between each wavelength increment.

DOY	Date	DAY	Weather	Comment (times are in UT)
172	21. Jun	Monday	Overcast	Installed at 15:22
173	22. Jun	Tuesday	Overcast, slight rain at around 18:00	8:25 calibration using T68523
174	23. Jun	Wednesday	cumulus; clear sun from 6:00 until 10:00, afternoon overcast	12:55 calibration using T68523 13:36 T685240
175	24. Jun	Thursday	sun visibility 0-0.25 between 5:00 and 6:00; clearsun for 9:00 until 10:30 afternoon overcast	10:54 calibration using T68523
176	25. Jun	Friday	clear sky	9:25 calibration using T68523 9:39 end of campaign

Results:

In total 92 synchronised simultaneous spectra from QASUME and AAO are available from the measurement period. Measurements between 4:30 UT and 19:00 UT have been analysed (SZA smaller than 90°).

The spectra from AAO were corrected for wavelength shift and convolved with a 1 nm triangular slit function before being submitted for the calibration.

Two datasets were submitted: The main dataset was processed according to the standard procedure applied at ARPA Aosta. The second dataset was corrected for the angular response of the diffuser of AAO. Where not otherwise noted the remarks and results refer to the main dataset.

Conclusions:

1. The spectral ratios of AAO are in excellent agreement with QASUME close to 1. A significant averaged offset cannot be detected.
2. The spectral ratios show the largest increase of up to 6% at SZA 79° and 3% at SZA 74° correlated with wavelength coming from a slight global cosine error of the new AAO diffuser. For the other SZA, almost no spectral trend of the ratios can be observed.
3. When a clear sky cosine correction (CosCorr) is applied to the dataset of the clear sky morning of day 176 spectral correlations of the ratios are observed for SZA between 79° and 54° . The spectral ratios have an averaged offset of around +1.0%.
4. **All 92 spectra from the main dataset A and the cosine corrected dataset are within the combined expanded uncertainties of AAO (4%) and QASUME (1.6%).**

Remarks:

1. Due to the quality assessment with QASUME and the new laboratory facilities at Aarpa, AAO can be considered as an excellent station observing global UV radiation. The observed diurnal variation between AAO and QASUME is within the expanded combined uncertainties.
2. The 1000W standard lamp calibration procedure in the laboratory allows monitoring the stability and quality of the AAO instrument for long-term global UV radiation observations.

Suggestions:

1. Due to the suggestion of the last audit report, the AAO diffuser was changed. The new diffuser is now a Bentham D7 diffuser, which shows a good agreement with QASUME in terms of the cosine response. Therefore, an additional cosine correction is not recommended.

Comments from the local operator:

The local operator mentioned the change of the diffusor to a Bentham D7 for clarification of the suggestion No. 1.

The data of the Appendix Figure is outdated by a ESSD publication [1]. In particular, the publication shows the differences between the "Level-1 data" (as shown in the Appendix Figure) and the "Level-2 data" after reprocessing.

Reference

[1] Fountoulakis, I., Diémoz, H., Siani, A. M., Hülsen, G., and Gröbner, J.: Monitoring of solar spectral ultraviolet irradiance in Aosta, Italy, *Earth Syst. Sci. Data*, 12, 2787–2810, <https://doi.org/10.5194/essd-12-2787-2020>, 2020