Abstract:

AOD long term comparisons of CIMEL and PFR measurements at the ACTRIS sun-photometer calibration sites

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1. Introduction

Aerosol optical depth (AOD) describes the overall direct effect of the aerosol column on solar radiation. Various instrument networks measure AOD worldwide such as the Aerosol RObotic NETwork (AERONET), the Global Atmospheric Watch Precision Filter Radiometer (GAW-PFR) network (Kazadzis et al., 2018). PMOD/WRC maintains the world reference AOD standards and under CARS (Center for Aerosol Remote Sensing) of ACTRIS, PMOD/WRC aims to establish the traceability link between the AOD measured by ACTRIS instruments to the WMO reference. In this work we focus on the comparison of AOD measurements from CIMEL and PFR traveling reference standards at the three ACTRIS/CARS and AERONET calibration sites during the period of this collaboration: Izaña Observatory (IZO), Tenerife, Spain (2021-2025), Observatoire de Haute-Provence (OHP), France (2021-2025) and University of Valladolid (VLD), Spain (2022-2025).

2. Methodology

- We focus on comparison of coincident measurements of the 2 directly comparable channels between AERONET and GAW-PFR instruments (500 and 865 nm). As coincident we define measurements with maximum time difference of 30 seconds.
- We also quantify the percentage of data within the WMO traceability limits (WMO, 2016), data within the typical uncertainties of the two networks for air mass 2 (Kazadzis et al., 2024) and optical depth difference due to Nitrogen Dioxide correction (NO_2).

3. Long-term comparison

- All 3 locations show median difference within -0.005 at both wavelengths and 90% of differences within 0.015 (Fig. 1).

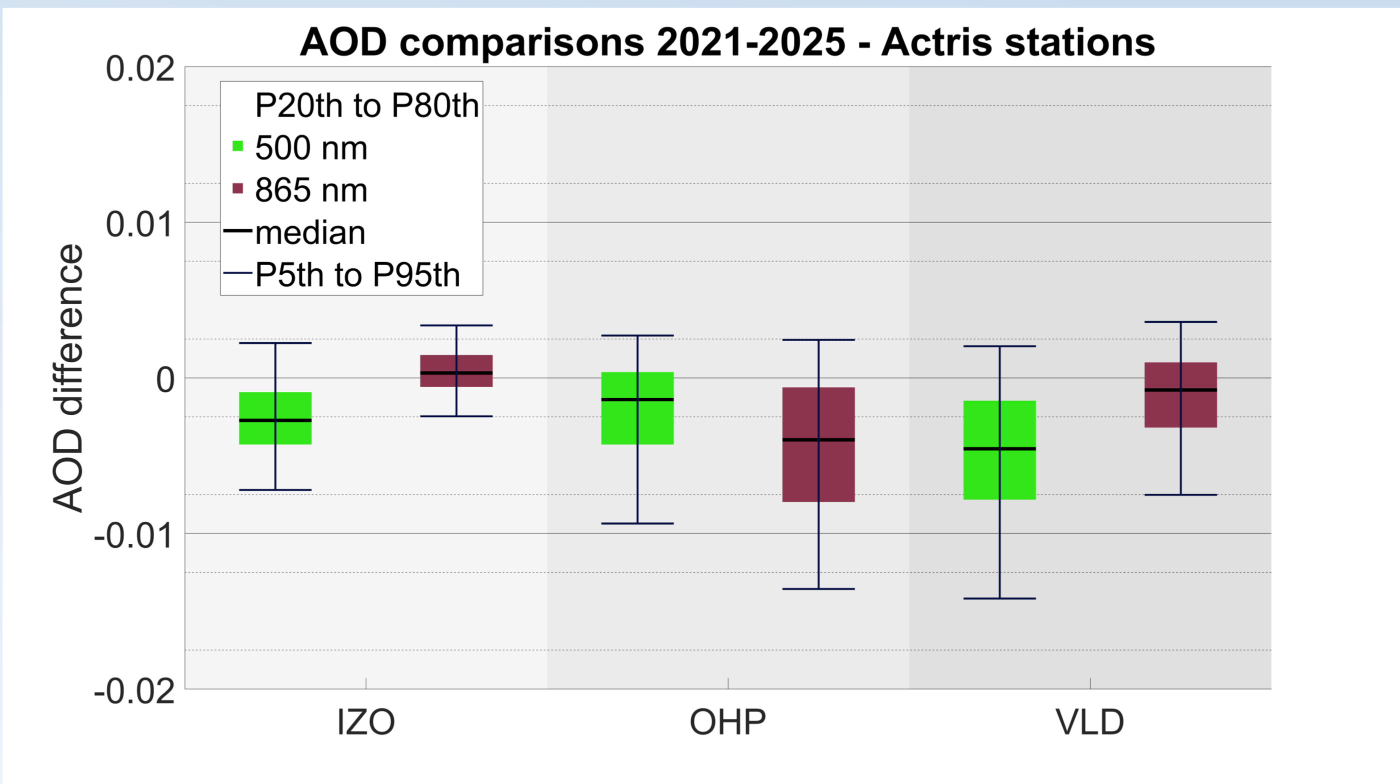

Figure 1: Box plot of all intercomparisons in the 3 stations at both wavelengths, including median differences, 5th, 20th, 80th and 95th percentiles.

- Mean AOD corrections for NO_2 were 0.001 at 500 nm for AERONET and not considered for GAW-PFR. At 865 nm 0 for both networks.

4. Intercomparison statistics

- More than 87% of the differences are within the WMO limits in all cases and more than 77% within the AOD difference typical expanded uncertainty for reference instruments at air mass 2.

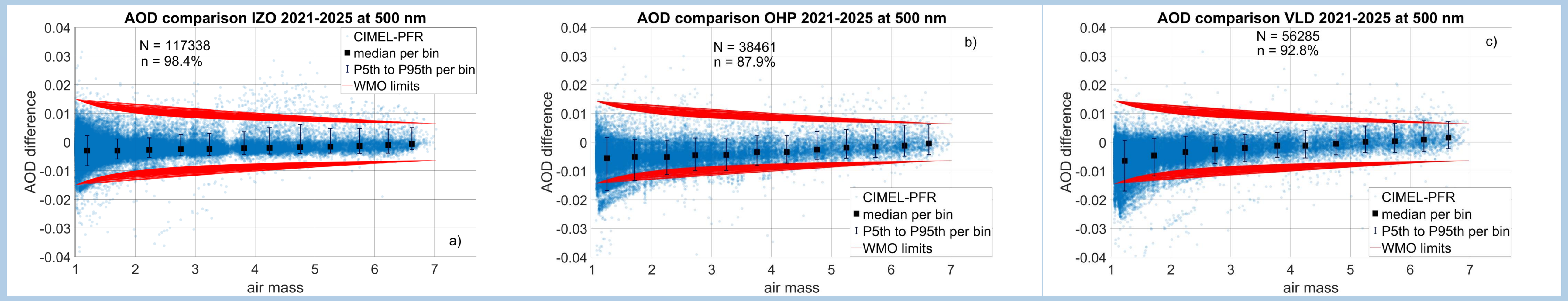

Figure 2: Point to point and binned comparisons of AOD at 500 nm in Izaña, Spain (a), Observatoire de Haute-Provence, France and University of Valladolid (c) during the period 2021-2025. N shows the number of measurements, n the data within WMO limits and red lines the WMO limits. The bins correspond to air mass range of 0.5.

Table 2: Percentage of differences within the WMO limits and the uncertainty of the differences (0.0075) based on the estimations for reference instruments and air mass 2.

	Data within the WMO limits (%)			Data within the expanded combined uncertainty (%)		
Wavelength	IZO	OHP	VLD	IZO	OHP	VLD
500 nm	98.4	87.9	92.8	94.7	77.2	76.5
865 nm	99.2	96.7	98.6	98.6	90.9	94.2

The monthly medians show excellent correlation between the GAW-PFR and AERONET datasets (Table 2):
- Coefficient of determination (R^2) is between 0.97 – 1.00 in all cases.
- Linear fits between datasets show slopes in the 0.98 – 1.00 range and intercepts in the -0.005 – 0.000 range.

Table 2: Correlation and linear fit between monthly medians of CIMEL and PFR at 500 and 865 nm.

	IZO			OHP			VLD		
Wave-length	R^2	Slope	Intercept	R^2	Slope	Intercept	R^2	Slope	Intercept
500 nm	0.998	0.998	-0.003	0.997	0.996	-0.005	0.994	0.975	-0.002
865 nm	0.999	0.997	0.000	0.972	0.940	-0.001	0.987	0.985	0.000

5. Conclusions

- All intercomparisons except OHP and VLD at 500 nm show more than 95% within the WMO limits and more than 90% of data within the reference instrument uncertainty.
- All monthly medians show excellent correlation between the instruments (R^2>0.97).
- AOD differences show clear dependence with the air mass.
- NO_2 correction differences explain a small part of the differences between the networks (0.001 increase AOD from PFR) at 500 nm only.

References

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Acknowledgements

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