Physikalisch-Meteorologisches Observatorium Davos
World Radiation Center

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T3.3 Report on the comparison of AOD to the WORCC reference Triad

Stelios Kazadzis, Julian Gröbner, Natalia Kouremeti

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Pandora operation at PMOD/WRC

The Pandora #120 was installed at PMOD/WRC on 4 April 2016 and started operating in November 2016. The system has been in continuous operation since November 2016, with only minor disruptions. In the period February - April, 2017 P#120 was moved to the optical laboratory of PMOD/WRC for calibration and characterisation (see deliverables TD 5.1, TD5.2, TD5.3, and TD5.4).

Pandora #120 was continuously supported and maintained:

- Daily checking on operation
- Daily inspection and cleaning of the optics
- Remote operation checking by Pandonia personnel

PMOD/WRC hosts the World Optical depth Research and Calibration Center (WORCC). The WORCC standard group of three PFRs (defined as the “PFR triad”) was established in 2005 by WORCC in order to fulfill the WMO mandate on: “homogenization of global AOD through provision of traceability to the World Standard Group (WSG) of spectral radiometers for contributing networks at co-located sites and/or periodic international filter radiometer comparisons, and further standardization of evaluation algorithms.”

During October 2017, Pandora and WORCC Triad have performed synchronous measurements of direct sun irradiance and retrieved Aerosol Optical depth (AOD) at 368 nm, 412 nm and 500 nm. Data from 9 days (10-16 and 19-20 of October, 2017) were used in order to compare the retrieved AODs from Pandora and the triad. Data have been checked in order to reject measurements under cloudy conditions, as they cannot be used for AOD retrieval, based on the WORCC cloud flagging methods. 262 common cloudless measurements have been used from this comparison.

Results of the comparison can be seen in Figures 1 and 2.

Dorfstrasse 33, CH-7260 Davos Dorf
Phone +41 81 417 51 11, Fax +41 81 417 51 00
www.pmodwrc.ch

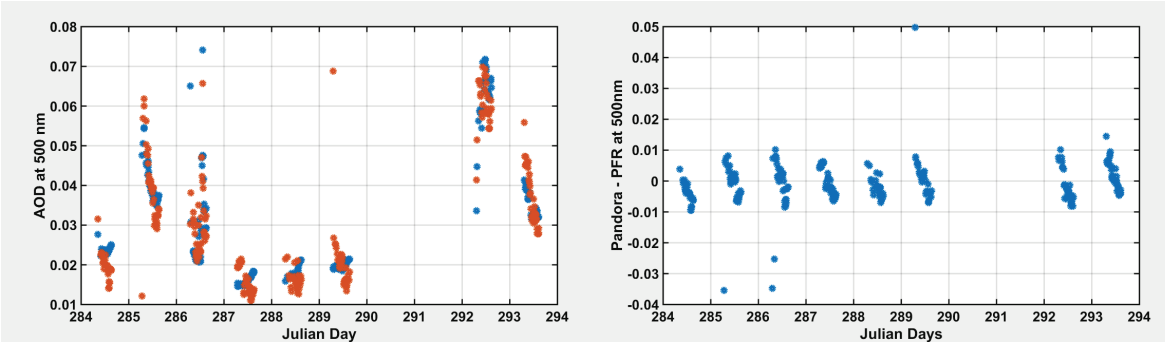
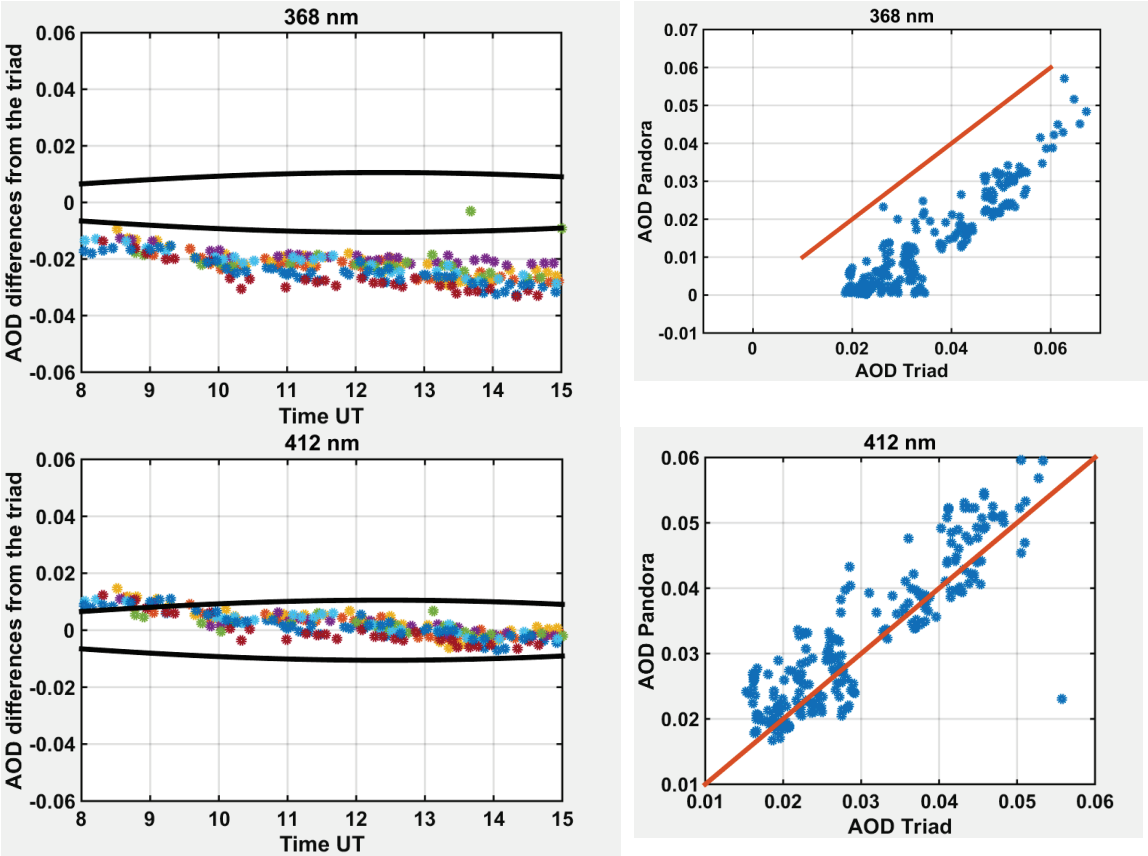


Figure 1. AOD at 500 nm as measured by Pandora and the PFR triad instruments together with their day to day absolute differences.

According to WMO, 2005, as traceability is not currently possible based on physical measurement systems, the initial form of traceability will be based on difference criteria. That is, at an inter-comparison or co-location, traceability will be established if the difference between one network's AOD and another's is within specific limits. Those limits for finite field of view instruments have been set to 0.005 + 0.01/m optical depths and the acceptable traceability is when 95% of the absolute AODs are within those limits. So requiring 95% uncertainty (U95) within ±0.005 + 0.01/m optical depths, where the first term (0.005) is linked to instrument uncertainties (signal linearity, sun pointing, temperature effects, processing, etc.) and the second term to a calibration uncertainty of 1%.



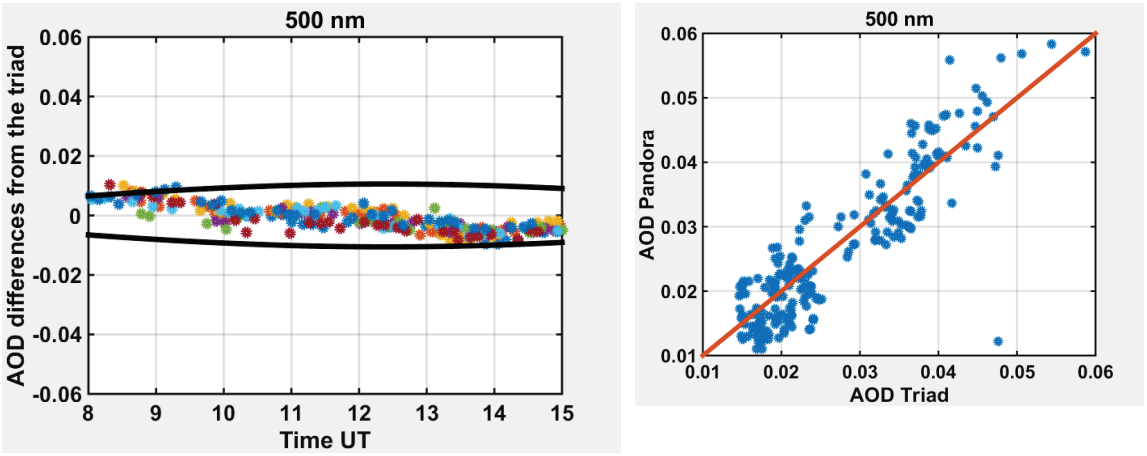


Figure 2: Left AOD differences of Pandora-triad synchronous AOD retrievals. Colors represent different days and black lines the U95 WMO limits. Right Pandora and Triad correlations.

It has to be noted that Pandora AOD retrieval has been performed by Luftblick. In general, Pandora retrievals compared with the Triad showed very good agreement for 412 nm and 500 nm. Differences in these wavelengths were mostly inside the U95 WMO limits with the exception of few early morning measurements. For 368 nm Pandora shows a constant, over time and air mass, underestimation of the retrieved AOD, in the order of 0.02. Correlation coefficients for the three wavelengths were in the range of 0.87 (368 nm) to 0.93 (500 nm).

These first results of the Pandora – WORCC PFR Triad comparison show a very good agreement among the two instruments. Small differences in the visible wavelengths and more important at UV wavelengths have to be identified and assigned either in: an instrument calibration, Pandora direct irradiance post processing methods or AOD related post processing methods and relative atmospheric (Rayleigh scattering, Ozone, NO_2) inputs used by Pandora in comparison with the ones used for the PFRs.

The Pandora – WORCC Triad comparison will continue in 2018 during the next phase of the Atlas project in order to increase the number of the analyzed data, identify possible deviations and provide a long term assessment of the Pandora instrument stability, towards it's use for AOD retrievals in a monitoring phase.