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QOS2016-91

Aerosol optical depth in the ultraviolet range: a new product in EUBREWNET

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COST is supported by the EU Framework Programme Horizon 2020

Introduction

Aerosols play a key role in the weather and climate of the Earth system. This has motivated the development of ground-based monitoring networks like the Aerosol Robotic Network (AERONET) [**1**], and of satellite products like the OMAERUV, provided by the Ozone Monitoring Instrument (OMI) on board of the NASA Aura satellite (see [**2**] and references therein).

Brewer spectrophotometers have already demostrated their ability to measure the Aerosol Optical Depth (AOD) in the UV range (see [**3**,**4**] and references therein). Within COST Action 1207 – European Brewer Network (EUBREWNET) [**5**,**6**], at the Regional Brewer Calibration Center for Europe (RBCCE, Izaña Atmospheric Research Center, AEMET) we have developed a new AOD product. Once fully operational, it will allow for the real-time monitorization of aerosols at more than 20 stations, from Algeria to Finland.

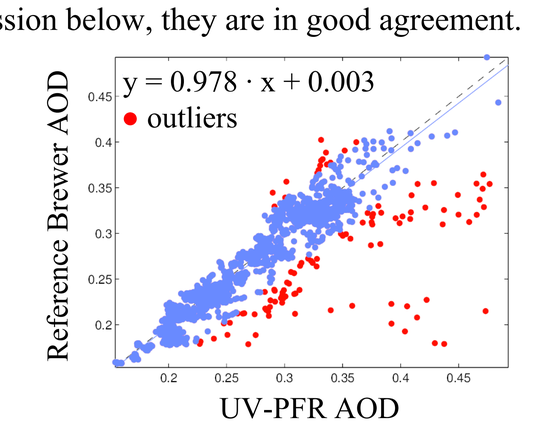
AOD for Brewer spectrophotometers

From the Lambert-Beer-Bouguer equation, the AOD at each wavelength measured by the Brewer is

$$\mathrm{AOD}=\frac{1}{m_R}\left\{\log f_0-\log f-D_o k_o m_o-\frac{p}{1013}k_R m_R\right\}$$

The counts f are directly obtained from the Brewer instrument, after compensating for filter and polarization effects, among others. The total ozone column D_o is provided by EUBREWNET's level 1.5 product, and includes multiple data filters and corrections to ensure a high accuracy. The Bass and Paur prescription for the ozone cross section is used for k_o, and Bodhaine's Rayleigh coefficients for k_R. We use a standard expression for the ozone and Rayleigh air masses, m_o and m_R, and approximate the aerosol air mass by the Rayleigh one. For the pressure p we use the climatological value of the Brewer station.

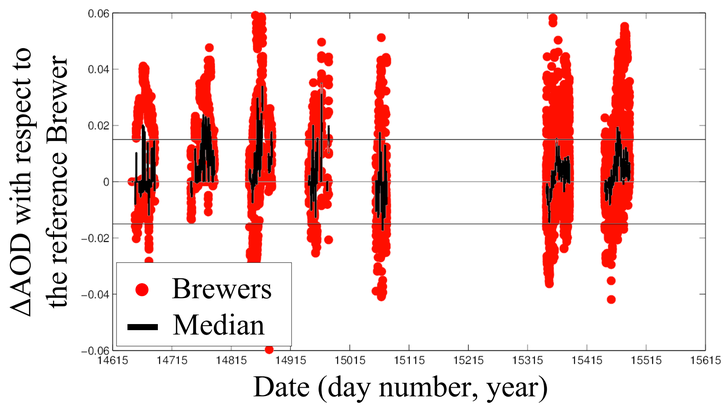
For the reference Brewers of the RBCCE triad, the calibration constant f_0 is determined by the Langley method. These instruments operate at the Izaña observatory (AEMET, Spain), where the conditions to perform absolute calibrations are usually exceptional. We show below the Langley plots for one morning.



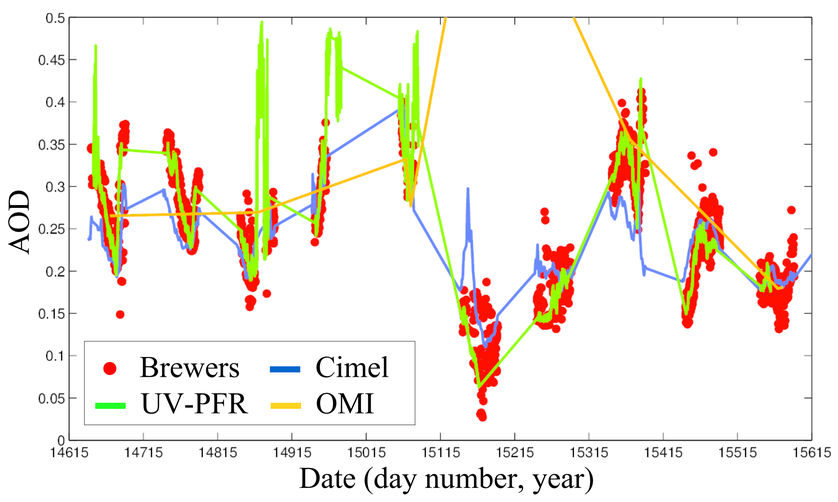
Every two years, at the intercomparison campaigns, this absolute calibration can be transferred from the reference to other Brewer spectrophotometers.

AOD during the X RBCCE campaign

21 Brewer instruments took part in the X RBCCE Intercomparison campaign, held at the El Arenosillo station (INTA, Huelva, Spain) from May 25th to June 5th 2015. Each instrument was issued a new calibration, including values of filter attenuations, ozone cross sections, and Rayleigh coefficients.



With the data from the campaign, we have also been able to calibrate the AOD. The figure above shows the AOD differences at 320 nm between participating instruments and the RBCCE reference Brewer. 93% of the medians of the differences are smaller than 0.015.



Above we show the AOD at 320 nm measured by the Brewer instruments during the campaign. For comparison, we have also included data from the AERONET AOD level 1.5 product of the Huelva station (shifted up by 0.07 because the lowest wavelength measured by this particular Cimel sunphotometer is 440 nm), the OMI OMAERUV level 2 overpass data at 352 nm from the Aura Validation Data Center [**7**], and the AOD measured at 320.1 nm by a UV-PFR instrument operated by the PMOD/WRC.

There is a reasonable agreement between the AOD measured by the Brewer and the other two ground-based instruments. The high correlation with the AERONET data shows that the Brewer is capable of measuring the AOD variability with a similar precision as the Cimel instruments. The Brewer and UV-PFR instruments operate at close wavelengths and, as shown by the linear regression below, they are in good agreement.

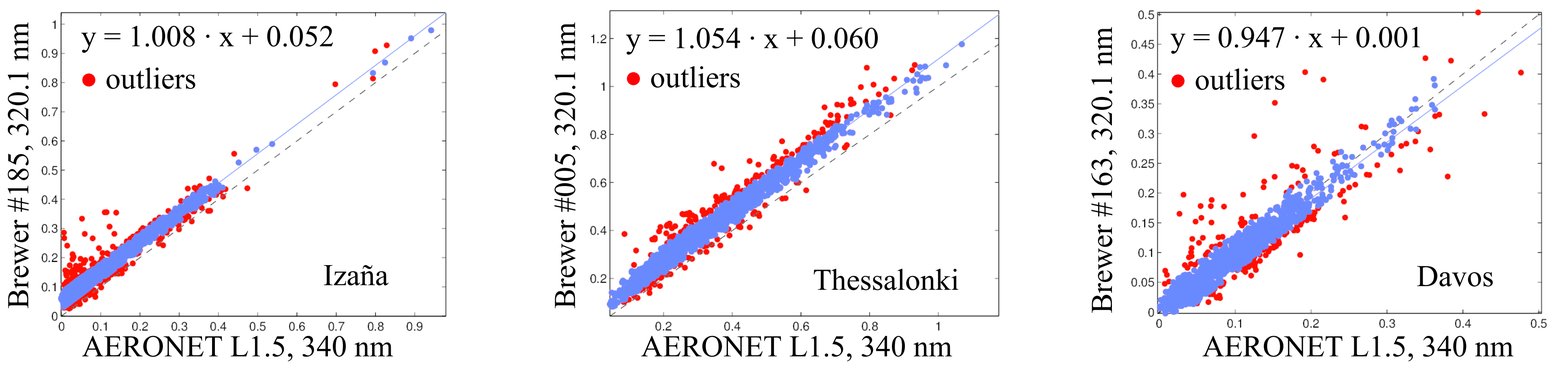
There is also an overall good agreement between the Brewer and OMI data. However, it is worth noting that for the days 151 (May 31st) and 152 (June 1st) the OMAERUV product provides a much higher AOD than any of the three ground-based instruments.

2015-2016 Brewer-Cimel validation

Using the same calibration issued after the X RBCCE campaing and the data acquired during the normal operation of the Brewer spectrophotometers at their own stations, we have also been able to determine the AOD in the period from June 2015 to June 2016.

In the figures below we show three examples of the comparison with the AERONET level 1.5 data.

Brewer-Cimel slopes are close to 1 and intercepts to 0, even despite the difference in wavelength. Furthermore, close examination of the data series shows that the differences do not increase along the year, which is an indication of the stability of the Brewer instruments. It can thus be expected that the AOD calibration will have to be updated just once every two years, at the same time as the ozone calibration.



Summary

►We have developed a new UV AOD product for the European Brewer Network, COST Action 1207.

►All the data required for the AOD calibration and determination is available from the RBCCE campaigns and normal ozone operation of the Brewers.

►There is a good agreement between the AOD of the Brewer, Cimel, UV-PFR, and OMI instruments.

►Once fully operational in the EUBREWNET data server, this new product will provide near-real time AOD at more than 20 Brewer stations.

References

[**1**] AERONET's website, http://aeronet.gsfc.nasa.gov

[**2**] Torres, O., Atmos. Meas. Tech., **6**, 5621–5652 (2013)

[**3**] Rodríguez-Franco, J.J., *Brewer AOD Calibration and Retrieval in the UV-B*, EUBREWNET STSM report (2015)

[**4**] Carlund, T., *Comparison of AOD calibration methods for Brewer spectrophotometers using a UV-PFR or a Brewer as reference*, EUBREWNET STSM report (2016)

[**5**] Website of COST Action 1207 – European Brewer Network (EUBREWNET), http://www.eubrewnet.org/cost1207

[**6**] EUBREWNET's data server, http://rbcce.aemet.es/eubrewnet

[**7**] Aura Validation Data Center, http://avdc.gsfc.nasa.gov

Acknowledgments

This work has been developed within the IDEAS+ project of the European Space Agency in collaboration with LuftBlick Earth Observation Technologies. This work has been supported by the European Metrology Research Programme (EMRP) within the joint research project ENV59 "Traceability for atmospheric total column ozone" (ATMOZ). The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union. These activities have been partially developed in the WMO-CIMO Testbed for Aerosols and Water Vapor Remote Sensing Instruments (Izaña, Spain). The AERONET sun photometers at the Izaña station have been calibrated within the AERONET Europe TNA, supported by the European Community-Research Infrastructure Action under the FP7 ACTRIS grant agreement no. 262254. We thank E. Cuevas, A. Bais, and N. Kouremeti for their effort in establishing and maintaining the Izaña, Thessaloniki, and Davos AERONET sites, and the AVDC for providing access to the OMI data.