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AEMet Agencia Estatal de Meteorología

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ULL Universidad de La Laguna

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IZAÑA 1916 - 2016

AOD measurement and data processing - II -

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Regional Brewer Calibration Center(Izaña Atmospheric Research Center, AEMET), University of La Laguna, and PMOD/World Radiation Center

Henri Dièmoz has already given a complete overview of the determination of the AOD using Brewer instruments

I will now just give you some details on how we calculate the AOD at the RBCCE

The RBCCE team (left to right, top to bottom):

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Lambert equation for the Brewer

$$\tau_a = \frac{1}{\mu_R}\left\{ \ln I_0 - \ln I - X_{O3}\sigma_{O3}\mu_{O3} - \frac{p}{1013}\delta_R\mu_R \right\}$$

where we have

1) approximated the aerosol air mass by the Rayleigh air mass μ_R
2) neglected other contributions to the AOD besides those of the ozone and Rayleigh scattering (e.g., SO_2 is missing)

Reminder: there is one such equation for each slit (wavelength)

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Extraterrestrial constant

$$\tau_a = \frac{1}{\mu_R}\left\{\ln I_0 - \ln I - X_{O3}\sigma_{O3}\mu_{O3} - \frac{p}{1013}\delta_R\mu_R\right\}$$

determined by

1) the Langley-plot method for reference instruments (e.g., Brewer #185 from the RBCCE triad)

2) calibration transfer using simultaneous measurements with a reference during, e.g., Brewer intercomparison campaigns

Counts per second

$$\tau_a = \frac{1}{\mu_R}\left\{\ln I_0 - \ln I - X_{O3}\sigma_{O3}\mu_{O3} - \frac{p}{1013}\delta_R\mu_R\right\}$$

Raw counts for each slit converted to counts/second taking into account the effect of dark counts and dead time, plus

1) Data-quality filters from EUBREWNET's Level 1.5 product
2) Polarization correction from Cede *et al*. 2006 or Dièmoz *et al*. 2016
3) Correction for the Earth-Sun distance variation using Spencer 1971, as quoted by Iqbal 1983

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Counts per second (2)

$$\tau_a = \frac{1}{\mu_R}\left\{ \ln I_0 - \ln I - X_{O3}\,\sigma_{O3}\,\mu_{O3} - \frac{p}{1013}\,\delta_R\,\mu_R \right\}$$

4) Filter and temperature corrections using parameters determined at the calibration campaigns:

i) Filter attenuation coefficients with spectral dependence

ii) Temperature coefficients not normalized to the first slit

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Ozone

$$\tau_a = \frac{1}{\mu_R}\left\{ \ln I_0 - \ln I - X_{O3}\,\sigma_{O3}\,\mu_{O3} - \frac{p}{1013}\,\delta_R\,\mu_R \right\}$$

EUBREWNET's Level 1.5 product:

- Counts from B files, configurations in the server, ozone processed with the Brewer Python Module
- Cloud, airmass, and Hg filters
- Standard lamp, filter, and stray-light corrections

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Spectral coefficients

$$\tau_a = \frac{1}{\mu_R}\left\{\ln I_0 - \ln I - X_{O3}\,\sigma_{O3}\,\mu_{O3} - \frac{p}{1013}\,\delta_R\,\mu_R\right\}$$

Instrumental slit function from calibration (provides the wavelength & FWHM), convoluted with

- Bass-and-Paur's ozone absorption cross sections: σ_{O3}
- Bodhaine's Rayleigh coefficients: δ_R

See A. Redondas' poster "Wavelength characterization of Brewer spectrophotometer with a tunable laser at PTB facilities" (P227, QOS2016-303) for more details!

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Air masses and pressure

$$\tau_a = \frac{1}{\mu_R}\left\{\ln I_0 - \ln I - X_{O3}\,\sigma_{O3}\,\mu_{O3} - \frac{p}{1013}\,\delta_R\,\mu_R\right\}$$

As in the standard Brewer algorithm:

- μ_{O3} ozone air mass
- μ_R Rayleigh air mass
- p climatological pressure at the Brewer site

Reminder: the Rayleigh air mass is also used for the aerosol term

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AOD configuration parameters

One calibration constant I_0 for each slit

One attenuation coefficient for each slit and filter

One non-normalized temperature coefficient for each slit

One ozone absorption cross section σ_{O3} for each slit

One Rayleigh coefficient δ_R for each slit

All these parameters are currently being determined at the RBCCE campaigns!

AOD configuration at EUBREWNET's data server

Preliminary template:

Slit	Cal step	Wavelength	FWHM	Cal const	Rayleigh coeff	O3 abs coeff	SO2 abs coeff	T coeff const	T coeff wl	Filter 1 att	Filter 2 att	Filter 3 att	Filter 4 att	Filter 5 att	StrayL const	StrayL exp	SL ref
0	1024	303.2	0.6	NaN	0	NaN	0	0	0	NaN	10225	14931	21430	NaN	0	0	0
2	1024	306.3	0.6	8.07E+04	4870	1.7807	0	0	0	NaN	10205	14815	21245	NaN	0	0	0
3	1024	310.1	0.6	7.97E+04	4620	1.0049	0	0	-0.2	NaN	10185	14691	21044	NaN	0	0	0
4	1024	313.5	0.6	8.18E+04	4410	0.6767	0	0	-0.2	NaN	10172	14590	20880	NaN	0	0	0
5	1024	316.8	0.6	8.19E+04	4220	0.3751	0	0	0	NaN	10159	14504	20738	NaN	0	0	0
6	1024	320.1	0.6	8.23E+04	4040	0.2938	0	0	0.7	NaN	10151	14432	20615	NaN	0	0	0

Will be inserted as a plain text file

Extra parameters → future proof

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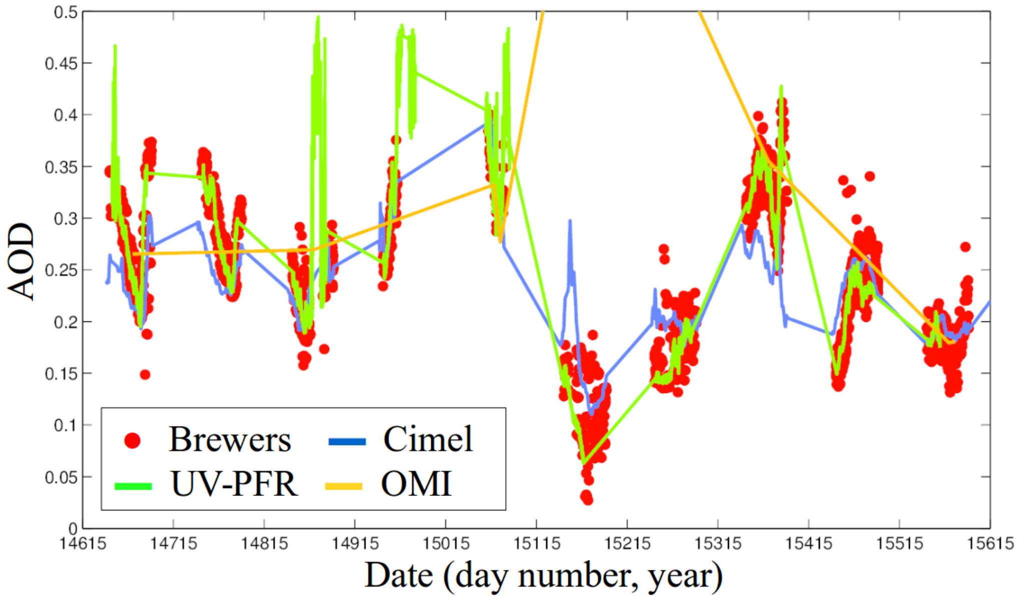
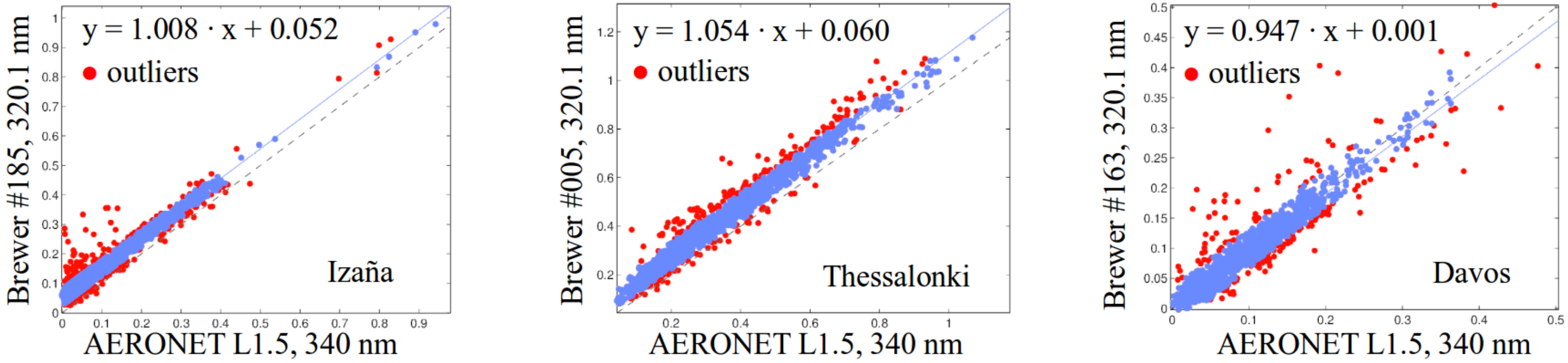
X RBCCE Brewer intercomparison campaign

- 21 Brewers at El Arenosillo (Huelva, Spain), May-June 2015
- Reference Brewer #185 calibrated by the Langley method at Izaña
- Good agreement with UV-PFR, Cimel and OMI data



2015-2016

- Brewers operating at their own stations
- Calibration from the X RBCCE campaign
- Good agreement with collocated Cimels



For more details, see poster P191, QOS2016-91

P191
QOS2016-91

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

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Closing remarks

For the Brewers taking part in the RBCCE campaigns, we already have all the data needed to calculate the AOD

We find a good agreement with products from the UV-PFR, Cimel, and OMI instruments

The Brewer AOD product should be available soon at EUBREWNET's data server:

http://rbcce.aemet.es/eubrewnet