

# ***Interactive comment on “Aerosol optical depth determination in the UV using a four-channel precision filter radiometer” by Thomas Carlund et al.***

## **Anonymous Referee #2**

Received and published: 11 January 2017

### General comments

Carlund et al. describe the performances of a UVPFR photometer in measuring aerosol optical depths in the UV (including UV-B) region, a very interesting topic addressed in only few other publications. The paper is well written and the authors clearly explain every step of the analysis (from the calibration to the measurements), describe the potential error sources (as from the finite FWHMs of the instrument) and provide an exceptionally comprehensive discussion about the uncertainty of aerosol optical depth retrievals. The stability of the instrument is proven by Langley calibrations performed about one year apart and through comparison with a Brewer spectrophotometer. The paper fits well within the scope of AMT and only minor corrections are necessary, in

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my option.

I have some general comments to improve the readability:

1. Structure of the paper. A more conventional naming of the sections (e.g. “2. Instruments and measuring sites”, “3. Methods”, etc.) would improve the readability. The description of the Izaña observatory (page 4, lines 6-19) could be moved in a dedicated paragraph. Also, the Davos site should be briefly described. Furthermore, the Brewer spectrophotometer should be shortly illustrated for unexperienced readers in the “Instruments” section. An additional section should also be reserved for the assessment of the stability using the Brewer spectrophotometer (page 16 lines 8-29).

2. The formulae are not entirely commented and further explanation of the terms should be added (cf. “Specific comments” and “Technical corrections”).

Specific comments

- page 5 line 16: “errors in  $d_0$ ”. Isn’t ( $d_0 + d_a$ ) retrieved from the fit in Eq. 3? What kind of error are you referring to?

- page 6 line 15: “due to variation with wavelength in extra-terrestrial solar irradiance and ozone...” clashes with “the FWHM effects ... are entirely caused by the rapidly increasing ozone absorption with decreasing wavelength” (page 8 line 5). Please, explain if the first sentence may refer to larger FWHMs or if the spectral variation of the extra-terrestrial solar irradiance was only a potential, but not real, issue;

- page 6 line 28: explain why you chose these values for the Angstrom parameters. Are they representative of a climatology? (They are also repeated on page 14 line 24)

- page 7 line 24: write formula for ozone optical depth correction. Anyway, wouldn’t it be more physical to consider the slant column density (SCD) of ozone instead of ozone vertical column (VCD) and airmass separately?

- page 8 line 25: explain why two different sets of ozone cross sections and effective

ozone temperatures are used throughout the paper (Bass&Paur in Sect. 3 and IUP in Sect. 2.3);

- page 10 line 14: explain why 1% was chosen for the ozone amount uncertainty. References?

- page 10 Sect. 4.2: are uncertainties from the Rayleigh optical depth (Sect. 4.3), circumsolar radiation (Sect. 4.3), neglected aerosol absorption (Sect. 4.5) and solar position (Sect. 4.6) expected to impact on V0? In that case, include them in the discussion;

- page 10 line 30: a figure of the V0 distribution could be interesting for the reader, even though it is not fitted well by any known statistical function;

- page 12 line 20: “The amount of NO<sub>2</sub> in the atmosphere over the measuring site is unknown”. Is it true for the calibration site as well? Are there no NO<sub>2</sub> measurements at IZO?

- page 15 line 31: notice that the Angstrom relation is not linear, therefore averages should be in principle calculated on log(AOD) instead of AOD to obtain a straight line from log(AOD) vs log(lambda) as in Fig. 5b;

- page 16 line 27: “with 85.6% of the differences within the limits... this indicates a small change”. Could you write what percentage was reached at El Arenosillo at this wavelength during calibration transfer?

Technical corrections

- page 1 lines 28-30: the sentence is a duplicate of the text written just after (page 2 lines 4-9);

- page 2 line 1: clarify that the “expected increase of UV radiation to to the declining ozone levels” applies to past series;

- page line 11: avoid repetition “provides... provide...”;

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- page 1 line 24-25: “based on Brewer AOD retrievals, . . . related direct sun retrieval for AOD”. Redundant?
- page 1 line 28: “PMOD/WRC”: define acronym here, not on page 3 line 4;
- page 3 lines 17-19: “For the filter bandwidths, ...” it is not clear how the two following sentences are connected to the text and what are the results of the determinations by the tunable laser;
- page 4 line 20: “V0” should be maybe repeated after the comma;
- page 5 line 1: “replaces” → “replace”;
- page 5 Eq. 2: why the “ $R^2$ ” factor appears starting only from Eq. 2 and not 1?
- page 5 line 10: “on” → “of”;
- page 5 line 11: clarify what “in these cases” means. You are probably saying that the ozone and aerosol measurement series are useful to accurately calculate the weighting sum  $m2ODw$ ?
- page 6 line 19: remove “Numbers on”;
- page 6 line 20: “exponential” is not rigorous here;
- page 7 line 10: write the formula for correction factors;
- page 7 line 16: “if not a further” → “if no further”;
- page 8 Eq. 5 “ $R^2$ ” should be on the left-hand side;
- page 9 line 1: “more recent Rayleigh scattering coefficients”. Specify what coefficients (Bodhaine?);
- page 9 Eq. 7: define what  $f$  is in the equation;
- page 9 Eq. 8: “ $V_{CS}$ ” included in the equation is explained only 3 pages later in the text (Sect. 4.4). Please, add a sentence after Eq. 8 explaining that this variable will be

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commented later.

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Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2016-367, 2016.

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