

Atmos. Meas. Tech. Discuss., referee comment RC2  
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## **Comment on amt-2021-88**

Lionel Doppler (Referee)

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Referee comment on "Accuracy in starphotometry" by Liviu Ivănescu et al., Atmos. Meas. Tech. Discuss., <https://doi.org/10.5194/amt-2021-88-RC2>, 2021

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In this paper "Accuracy in starphotometry", the authors present a detailed and comprehensive study of error sources for retrievals of the optical depth (OD) using the starphotometer technique.

Based on this advanced quantification of errors impacts, the authors give some recommendation regarding maintenance, conditions of utilisation, calibration, observation techniques in order to reduce the uncertainties.

A spectral aspect is discussed, that is very important for the starphotometry community : The pertinence of the existing catalogs of star magnitudes for the use of star photometers, possible improvements and how to deal with all the discussed difficulties (choose of the resolution of the catalog, choose of the spectral channels that allow accurate inversions of the OD).

Despite of some minor and very specific suggestions of improvements that I will explain in my comments, this is a well written paper, both considering the scientific quality (analyses, equations) and considering the quality of the english and the clarity of the text.

Thus, i consider taht this paper is a important contribution for enhancements in the use and for the accuracy of photometry techniques for OD retrievals.

I recommend publication of this paper after some minor corrections.

## Comments

In the abstract (Line 2), since the beginning of the introduction (Line 24 and after in Line 47) and during the whole article, you set the goal of the accuracy of this technique in "observational error level of 1%: a spectral optical depth (OD) error level of 0.01 level of"

-> I have two comments/questions about that:

1) Please define what is the "OD": Is it "AOD" (Aerosol Optical Depth) or "COD" (Cloud Optical Depth) depending on what you want to retrieve, or is it the optical depth like considering the optical path interpretation ( $OD = \ln(I/I_0)$ ), or is it the "TOD" (total optical depth: columnar optical depth):  $TOD = AOD + COD + \tau_{\text{rayleigh}} + \tau_{\text{gas}} + \dots = \ln(I/I_0)/\text{airmass}$ ?

2) Explain briefly in introduction why you want a value of 0.01 as goal of this "observational error level". I suggest to look at WMO recommendation about the error on AOD (Aerosol Optical Depth), depending on the airmass (m):  $\Delta_{\text{AOD}}$  must be  $< 0,005 \pm 0,001m$  (Formula can be found in Kazadzis, S., Kouremeti, et al. 2018. Results from the Fourth WMO Filter Radiometer Comparison for aerosol optical depth measurements. Atmos. Chem. Phys. (5), 3185–3201). From this formula of recommendation on AOD error, you can find out the most strict airmass condition, and compute the acceptable error on the OD that result of it.

About "C"

You introduce the parameter C ("instrument specific calibration parameter") in Line 193 (in 3.3. Practical considerations). This is maybe the most important parameter for operational retrieval with a starphotometer.

During the whole article, you assume that C is not star dependent: you use the same C for the two different stars in the TSM method for instance.

This assumption (C is the same for two different stars) may be acceptable under some conditions that are mainly respected in the star photometry. One condition is that the channels are relatively narrow so that the convolution of the instrumental response function with the spectrum of the star magnitude is the same for the two stars that have different spectra of star magnitude.

I think it is worth to give an information about below which value of bandwidth the assumption is valuable; cherry on the cake would be a quantification of the possible error that can result for a larger band or for different convolution of response function with star spectra (in case of big differences of star spectra inside the spectral band of the channel).

This assumption should be remember when you explain the basics of the TSM in equations (25) and (26) (Line 258 and 261, at the end of the paragraph 3.4.2)

Again, you write this assumption without proof or discussion at line 286 (Beginning of Part 4): "the more convenient star-independent calibration in terms of C"

Question about Figure 14 and the discussion about it at the end of paragraph 6.3: you consider  $\Delta\tau/\tau$  as the important parameter and you look the forward parameter part. Is it only a formula that is plotted on the figure, or are there the results of a real irradiances computation with a radiative transfer code ?

A proper radiative transfer simulation would have the benefit to consider not only single scattering, but also multi-scattering and scattering between the different layers.

Before 8.2 (recommandations): Here it would be welcome to have a table that summarizes all sources of errors that have been quantified above, with the values of the possible errors considering different way of dealing with the instrument (calibration often or rare, weather conditions, elevation of the stars, etc...).

Appendix D: Symbols and accronyms: Please make two tables: one for the symbols used in equations ( $\tau$ ,  $\omega$ ,  $f$ , etc...), and one for the accronyms. And please sort both of

them in alphabetical order

Minor comments/Typos:

Line 28: "Sunphotometry, and to some extent moonphotometry, are much more mature technology" -> Moonphotometry (after 2013) is less mature than starphotometry (beginning of the 90ies)

Line 298: Typo: "shorcomings" -> \*shortcomings

Line 584: Problems are mentioned above 1000 nm, what is not a big issue considering the range of the SPST starphotometers

Line 774: You give the value of tau\_NO2 for 400 nm, please give also the value at 500nm, since the order of magnitude of this parameter is better known at this wavelength (standard of the community)

Table 2, Channel 15: "almost WMO lambda" is more true than "WMO lambda" (20 nm shift)

Table 12, Channel 17: 936 nm is also an AERONET standard (935 nm is used by AERONET, but only for the PWV retrieval, not for the AOD, thus if you want to compare starphotometer and AERONET for WV, this channel is the most important one)

Line 947 (Appendix A1): "at the Lindenberg observatory in Germany" -> \*at the Deutscher Wetterdienst (DWD) Meteorological Observatory of Lindenberg (Germany)

Line 1065 (Appendix D: Accronyms): SPST = Schulz and Partner STarphotometer (or "Schulz and Partner STernphotometer" in German)

Line 1072 (Appendix D: Accronyms): FOV = "Field Of View"