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Atmospheric Measurement Techniques Discussions

Interactive comment on "Characterization of an EKO MS-711 spectroradiometer: aerosol retrieval from spectral direct irradiance measurements and corrections of the circumsolar radiation" *by* Rosa Delia García-Cabrera et al.

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Reviewer Comments to Garcia et al., AMTD 2017

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Discussion paper

Journal: AMT

Title: Characterization of an EKO MS-711 spectroradiometer: aerosol retrieval from spectral direct irradiance measurements and corrections of the circumsolar radiation

Author(s): Rosa Delia García-Cabrera et al.

MS No.: /amt-2019-467

MS Type: Research article

1. General Comments justifying the evaluation

This paper presents a method to retrieve aerosol optical depth (AOD) out of spectral DNI (direct sun normal irradiance) radiation measurements from the spectroradiometer EKO MS-711. The paper presents the instrument, the site of the observations (IZO: Izaña Atmospheric Observatory), and the method used. An issue that is well discussed is how to correct the measured DNI, obtained with the EKO instruments that has a larger field of view than the WMO standards suggest for AOD measurements. The solution found is to estimate the CSR (circumsolar radiation) by simulating the forwarded scattered radiation with a radiative transfer code and multiplying it with a so-called penumbra function depending on the solar angles (azimuth and zenith). The method of AOD inversion is validated thanks to a comparison to a reference instrument (the Cimel – Aeronet photometer) for six wavelengths in UVA, VIS and NIR at the site of IZO during four months (April – July 2019). A statistical study is presented to validate the AOD retrieval method and evaluate the gains of the CSR correction.

The most innovative part of the paper is the presentation of the CSR estimation and the correction of the DNI for this instrument having a field of view of 5° in order to be compared to photometers having a field of view of less than 1.2° (WMO standards). This method is well explained in the paper and the reader can be convinced of the reliability of it.

The main concept presented in the paper is the AOD retrieval out of spectral DNI mea-

surements from a spectroradiometer, this is not new, but only few articles are making a detailed presentation of the method explaining each step and showing all the equations. This is well done in this paper and will be useful for the AOD community, the photometer community and the spectroradiometer community.

The validation of the method is shown thanks to a detailed statistic comparison to a reference instruments, mentioning WMO traceability criteria and discussing objectively, fairly and humbly the weak points of the method and instrument. Thus, substantial conclusions are reached: the paper evaluates quantitatively the DNI correction method, the AOD retrieval method and its application to the instrument EKO MS-711, convincing the readers that these methods can be used operationally with this instrument.

The scientific methods used are well described their validity are discussed, a good balanced use of figures and mathematic equations contributes to a clear outline of them.

The references list is complete enough giving proper credit to current and past work related to this topic. The number of references is good balanced and the references are of excellent quality. Thanks to this literature work, the authors could clearly put forward their own contribution to the topics approached in this paper.

The title of the paper reflects the content of the paper in a good way; the abstract is a good complement of the title and a concise and truth summary of the paper.

The overall presentation is well structured, and despite some minor details (to which I suggested improvements in the part below named “technical comments”) clear expressed. The language is fluent and precise and it is an obstacle neither to get rapidly a good comprehensive view of this work nor to understand the technical and mathematical details The mathematical formulae are shown in a good way. The equations are correct written, without mistake and well understandable.

I would suggest some minor improvements to be done: A table with all acronyms would

be welcome. Also I join a list of technical corrections (see below: “technical comments”). Moreover some points should be briefly discussed, these questions are asked below in “specific comments”. These are minor/technical corrections that I suggest.

Despite these technical corrections that have do be done, the article is of good scientific quality, of good significance and of good presentation. This justifies my evaluation here above and the fact that I suggest the editor to accept the manuscript and to ask for technical corrections and to answer to the four questions mentionned here below in "specific comments / questions"

2. Specific Comments / questions

- About the CSR correction presented in 3.4.: The simulated forwarded scattering radiation is computed using desert dust aerosol. How can we adapt the correction factors to other type of aerosols? And if it is possible: How is it possible to integrated the characterization of the aerosol kind in an operational algorithm in order to have directly the CSR correction factors suitable to the defined aerosol type?

- IZO is a site of low aerosol amount. The results presented in the statistical study to validate the method (part 4.) shows AOD ranging between 0.0 And 0.2 (eg: Figure 9). How many points of comparison do you have for AOD > 0.15? What do you expect it should happen for other sites having larger AOD (continental sites in middle Europe or close-urban areas)?

- Are the results shown in Part 4 restricted to cases with desert dust aerosols? If yes, do you have some preliminary results for other kinds of aerosols? What do you expect it should happens? If no (= the results shown corresponds to different mixtures and kinds of aerosols), do you have some differences between different kinds of aerosols detected?

- The AOD retrieval method presented in 3.1 and 3.2 is well described. Nevertheless, I would discuss two points more in detail: 1) Do you take the same airmass for

aerosols, water vapour, mixed gases and ozone? 2) How do you compute Rayleigh optical depth? With which formula (Bodhaine ?) and with which values of the air pressure (Aeroent uses a 6 hours average taken from a model)?

3. Technical comments

General comment: Please introduce a list of all acronyms used

Abstract:

- At the beginning of the abstract, should be explained what is the spectral range and resolution of EKO MS-711.

Introduction

- L25: “properties, such as single scattering albedo, size distribution, etc” -> please avoid “etc”, write a complete list, best sorted in decreasing importance order.

- L47: (again etc.) -> please complete list or use “e.g.:”

- L47: reference is Barreto 2014 (and not 2013) for spectroradiometer and Aerosol.

- L67: Go to next line before presenting the parts of your papers with “We have devided. . .”

Part 2: Site Description, Instrument and ancillary information

2.2 Instrument: Maybe explain what kind of technology it is: monochromator or array spectrometer (it is not specified).

- L98: Specify in this part of the text that the world AOD reference is the PFR in order that the reader knows from which instrument you are talking about.

- L104: Bias < 0.01 (and not > 0.01) (citing Sinyuk, GRL 2012)

Part 3. Methodology

- L130+L136+L141, maybe use a different description for “b” of each gas: b_H2O,

b_O2, b_O3 for example. Here you have the same letter and the reader can thinkthat we have the same coefficient for all the three gases.

- L141: What about b_O3?

- L167: “dependence [in] particle size”(not [pn])

- L167: I cannot understand the whole sentence. Do you mean: “high dependence in particle size [distribution] THROW the aerosol phase function?

- Figure 4.: In the legend, maybe mention that P has no unit and also mention that P*L (figure on the right) is in W.m-2.sr-1 (like L). If not, the reader has to guess it from L-graphic and P-graphic.

- L231 (Equation 13): Are you sure? I would write: DNI_corr = DNI_measured – CSR = DNI_SUN_estimation

- L239 You define the CR (Circumsolar Ratio). Please write the equation that defines it as Equation 15

- L248 You cite Equation 15 that does not exist (surely it was your intention that Eq 15 is the definition of CR but you forget it)

- Figure 7 (Legend): “at at”

- Table 4: It is unclear regarding the table, which columns are with and witch columns are without CSR correction, since it is written “CSR Unc.” everywhere. I guess that in each column pair, left is without and right is with correction, but please correct the header.

- L271 “good agreement”, maybe you should here define what you consider being a “good agreement”, by mentioning WMO traceability criteria that is cited below (L304).

- L290 340 nm. Instrumental uncertainty only? Maybe also because Rayleigh is higher and also aerosol scattering is higher -> Same comment for discussion in L311-L312

- L291: “model characterization [in] this range”

- L298: “MB >= -1.6 %” this is confusing, please discuss in absolute: “abs(MB) <= 1.6 %”

References:

For WMO Reports, please cite the page, at least the part of these very large reports in which the information is, in order to help the reader to find the relevant information for this study.

- L570 (Reference WMO, 1986): “GAW Report-No. 43” (not “437”).

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