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Comment

***Interactive comment on* “Investigation of the accuracy for single scattering albedo retrieval from global UV irradiance measurements” by S. Kazadzis et al.**

Anonymous Referee #2

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Review: S. Kazadzis “Investigation of the accuracy for single scattering albedo retrieval from global UV irradiance measurements “

General comments:

The title of this study is investigation the accuracy deriving aerosol single scattering albedo in UV spectral range combining the measurements of global (direct plus diffuse) spectral UV irradiances with radiative transfer models. The problem of accurate SSA from ground based radiative measurements is very important and far from operational solution, especially at the UV wavelengths. This study focuses on one specific aspect of the problem, namely assuring accurate absolute measurements of the surface UV

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global irradiance by European network of UV spectrometers: "... main interest of this work was to calculate the SSA retrieval uncertainty only from UV spectral measurement deviations and not to mix other sources of uncertainties such as ones related with RTM input parameters."p.1309. Although this is an important task by itself, it is not even necessary for estimating of any aerosol property from ground-based radiation measurements. Accurate knowledge of dimensionless atmospheric transmittance is sufficient for deriving any aerosol property and it can be measured without absolute calibration of the instrument (e.g. using Langley technique). Second, there are other important sources of systematic errors in irradiance measurements in addition to absolute calibration (e.g. accuracy of the angular response) that are not mentioned or discussed. Third, even most accurate measurement of global irradiance does not provide all the information necessary for accurate SSA retrieval. Any practical SSA retrieval method requires accurate knowledge of gaseous absorption (ozone, NO₂, SO₂, and 3 additional parameters at each wavelength: aerosol extinction optical depth (AOD), surface albedo (As) and asymmetry parameter (g) of the aerosol phase function. Therefore, even the most accurate GSI measurements cannot assure acceptable SSA retrievals (i.e. within 0.03) without accurate (i.e. within 0.01) and co-located measurements AOD and gaseous absorption. The authors seek to isolate the SSA error due to uncertainty in measured global irradiance (+/-5%) assuming all other parameters are perfectly known. This makes this an incomplete theoretical sensitivity study. As such, the paper addresses only part of its title and goals: "investigating the limitations and the level of SSA retrieval accuracy through global UV measurements (GSI method)" p.1306. This inconsistency needs to be reconciled.

I also strongly disagree with conclusion that the global irradiance (GSI) method is superior to all other methods of deriving SSA in UV: "So, only results from the GSI method can be used in order to investigate possible long term SSA changes in a number of locations worldwide." - p.1312 This particular study does not prove such conclusion. Indeed, the GSI method requires similar input information as other methods (i.e. AOD, surface albedo).

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I suggest revisions summarized below.

General suggestions

1) Re-write introduction and abstract, limiting the discussion to specific contribution this study provides to the general problem of estimating SSA in UV spectral range.
2) It is not clear what is shown in Figure 1 (Y axis). The capture says: “per cent attenuation of UV irradiance at 340nm as function of different AOD and SSA”. Figure 1 shows zero UV attenuation for different AODs if SSA=1. Perhaps this means that Y axis actually shows irradiance difference between SSA=1 and SSA shown in X-axis? If so, the caption should be changed. Also, why is aerosol absorption effect appears to be stronger at SZA=30 (left panel) than at SZA=60 (right panel)?
3) English needs improvements.
4) What AOD and other parameters (surf albedo, asymmetry factor) were used in calculating SSA shown in figure 4? If different AODs were used for each station, I suggest changing X axis from station number to AOD

Specific comments:

1304 2 remove “retrieval of” 4 “columnar SSA” -> “column average SSA” 8 explain abbreviation QASUME

1305 8: total scattering and extinction depend on aerosol mass loading, but the SSA does not 10 “understand the effects “ - on what?

20. and -> of

21: Method of Krotkov et al 2005 is different from Kassianov et al (2005) , since it is based on combination of co-located AERONET extinction measurements with MFRSR diffuse and global transmittances.

24. I do not agree that measurements in UV are more difficult than in visible wavelengths. Indeed, the opposite is true: AOT is larger and surface albedo is smaller in UV than in the visible wavelengths. Rayleigh scattering and gaseous absorption can be accurately measured, and instrument calibrations have been performed by far more

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rigorously in UV than in VIS.

1306

5-10: Using particular radiative quantity for SSA retrieval is not important. For example, Krotkov et al (2005b) had demonstrated that using either global transmittance or diffuse transmittance or diffuse to global or diffuse to direct ratios provide essentially the same SSA retrievals. The principal distinction could be either using absolute radiation measurements (i.e. absolute global flux) or using just dimensionless quantities (AOT, transmittance). These 2 approaches require quite different calibration techniques.

11. “Not validated yet” . The MFRSR technique has been validated with AERONET technique to provide essentially the same SSA values at common wavelength 440nm:

Krotkov N., G. Labow, J. Herman , J. Slusser, R. Tree; G. Jason; B. Durham , T. Eck, B.Holben, Aerosol column absorption measurements using co-located UV-MFRSR and AERONET CIMEL instruments, in Ultraviolet Ground- and Space-based Measurements, Models, and Effects VI, edited by Jay R. Herman, Wei Gao, Proceedings of SPIE, 7462, (SPIE , Bellingham, WA, 2009).

12-13. Most importantly that both GSI and GDIR methods require accurate AOT and surf albedo measurements (see general comments).

13. GDIR method can be re-formulated to use only global transmittance in addition to AOT measurements. This provides essentially the same SSA results are using direct to global transmittance ratio.

15-20: Even most accurate GSI measurements can not provide accurate SSA retrievals (i.e. within 0.03) without accurate (i.e. within 0.01) AOT and gaseous absorption measurements.

20-21: re-formulate

25- : AOT needs to be constrained either in GDIR or GSI method. The discussion

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needs to state clearly how AOT is measured in both methods.

27: remove “level of”

1308:

11. Figure 1 shows zero attenuation for different AODs when SSA=1. Clarify the meaning of Y axis in the caption (see general comment)

18. Actually the figure shows the opposite: attenuation is higher at SZA=30 (left panel) than at SZA=60 (right panel). Please, check the figure to make it consistent.

19 foe -> for

1310: Figure 2: are the differences at specific wavelengths representative of whole spectral regions: UVA and UVB? What was FWHM for spectral channels?

1311:Figure 4: What AOD and other parameters (surf albedo, asymmetry factor) were used in calculating SSA shown in figure 4? If different AODs were used for each station, I suggest changing X axis from station number to AOD

19. AERONET sun photometers provide AOD measurements better than 0.02 in UV

24: It is not clear which parameter the 3% uncertainty is referred to?

1312: 10. I do not agree with this sentence. The GSI method also requires input AOD information. The AOD derivation in turn requires accurate measurement of direct solar transmittance (i.e sun photometer). Therefore, GSI method is not different from other methods that require measurements of global and direct irradiance.

Interactive comment on Atmos. Meas. Tech. Discuss., 3, 1303, 2010.

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