Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2020-1207-RC2, 2021

Atmospheric Chemistry and Physics Discussions
Open Access

Interactive comment on "AEROCOM/AEROSAT AAOT SSA study, part I: evaluation and intercomparison of satellite measurements" *by* Nick Schutgens et al.

Anonymous Referee #2

Received and published: 8 January 2021

Review for Atmospheric Chemistry and Physics

Title: AEROCOM/AEROSAT AAOT & SSA study, part I: evaluation and intercomparison of satellite measurements

Authors: Nick Schutgens, Oleg Dubovik, Otto Hasekamp, Omar Torres, Hiren Jethva, Peter J.T. Leonard, Pavel Litvinov, Jens Redemann, Yohei Shinozuka, Gerrit de Leeuw, Stefan Kinne, Thomas Popp, Michael Schulz, and Philip Stier

General Comments:

This is a fairly well written paper about an important topic, the remote sensing (RS) of

aerosol absorption by satellite and comparison to ground based RS retrievals. These satellite retrievals are potentially an important contribution to the understanding of aerosol effects on climate, atmospheric circulation and aerosol effects on clouds. A fuller understanding of the uncertainty of these satellite retrievals is valuable, as the error bars are often quite large and/or masked by constraints in the retrieval algorithms (see the specific comment for Lines 433-434 below). However, a discussion or even mention of the acceptable or scientifically required uncertainty level in single scattering albedo (SSA) is lacking in this paper. It should be mentioned in the context of the relatively narrow range of the SSA parameter space for the vast majority of atmospheric observations ($\sim$0.8 to 0.99; see Fig 9 third column). This would help to put a limit on acceptable uncertainty regarding the usefulness of the data within the context of the parameter range. Some discussion regarding the accuracy in SSA required for aerosol radiative forcing or other applications need to be included in this paper. This is particularly an issue in several sections, but most notably it needs to be included in the Conclusions section.

Specific Comments:

Lines 46-47: Your current sentence: "From this inversion, columnar properties AOD and AAOD can be derived." No, this is inaccurate since total atmospheric column spectral AOD are measured from sun photometer direct sun observations. The AERONET inversion matches the measured AOD almost exactly since very high accuracy in measured AOD is assumed in the inversion algorithm.

Lines 65-66: It should be mentioned here that SSA uncertainty is significantly larger at longer wavelengths, as this is pertinent to estimation at the 550 nm wavelength. In the paper you currently only give the uncertainties in 440 nm from Sinyuk et al. (2020), while the uncertainty at 675 nm is also relevant and are provided in this same reference.

Lines 67-68: It is strange to continue using this outdated estimate from Dubovik et al.

(2000) as the SSA uncertainty actually decreases below 0.03 as AOD increases above 0.4 at 440 nm (see Sinyuk et al. 2020)). Also the Dubovik et al. (2000) estimate is only for 440 nm, while Sinyuk et al. (2020) provides values for all 4 retrieval wavelengths in the V3 database.

Line 75: Be clearer here that the 2nd part is a separate paper from this one (I think).

Line 187-188: Again, please give the AERONET SSA uncertainty estimates at 675 nm from Sinyuk et al. also since both wavelengths are being used to interpolate to values at 550 nm, for subsequent comparison to satellite.

Line 190-193: It is not strictly accurate to say that the AERONET values of SSA were underestimates since the in situ data also have significant uncertainty due to numerous assumptions and also have less sensitivity at low aerosol loadings. This uncertainty of in-situ data and the lack of a ‘gold standard’ for SSA should be conveyed here.

Line 260-261: Please be clear here, are the Inversion L2 data from AERONET only for AOD(440)>0.4? Note that AERONET produces L2 inversions of aerosol size distributions for all AOD levels. It is only the refractive indices and therefore SSA that are limited to AOD(440)>0.4. This Figure 3 may in part just be comparing results for different AOD levels since only moderate to high AOD are included in L2 refractive index retrievals, while most data measured globally is of AOD<0.4. If so then please include in the interpretation of this figure some discussion as a comparison of lower AOD to higher AOD cases.

Line 277: Can you please explain why it would be expected that POLDER-GRASP-M has relatively low SSA over land while it is expected that OMAERUV has relatively high SSA over land? If there are references to previous investigations then they should be cited here.

Line 289-290: Please elaborate with another sentence or two here in describing what aspect of the non-collocated data accounted from such a large change in correlation.

Was it different regions or different time periods sampled?

Line 318-319: So, is this filtering of the POLDER-GRASP-M significantly different from all the other data sets? If so, then what is the value in including that particular dataset in Figure 8 since it may therefore be very misleading. Additional discussion is warranted. In section 2.2.4 you discuss some sampling issues regarding SSA and AAOD with this particular satellite product but it is unclear whether this applies to the AOD dataset.

Line 332: Please note in the text that the scatter deceases significantly for AOD>0.3 which is similar to the L2 threshold in AERONET. Also, I assume that the wavelength of all parameters in Figure 9 is 550 nm. This should be included in either the plot labels or in the figure caption to make it clearer the readers. Also please explain better the green color bars in the left-most 3 columns of Figure 9. Include this clarification in the figure caption.

Line 337-338: At low AOD the major sources of uncertainty in AERONET retrievals of imaginary refractive index and SSA are biases. These are sky radiance calibration (this is independent of the direct sun calibration), extra-terrestrial solar flux, and BRDF from a MODIS product. The analysis in Sinyuk et al. (2020) of the U27 (see paper) only considers these bias errors and does not attempt to evaluate random errors. Therefore you can utilize the Sinyuk et al. paper to get an estimate of the biases in AERONET retrieval data. However these biases for a given site and deployment can be either high or low since it is not known what the direction of the bias in calibration and BRDF are for a given site and date. Additionally the bias direction of the solar flux error is also unknown however this remains constant for all sites and dates.

Line 341: This should be taken with more than a grain of salt since the data sampling at high AAOD is extremely sparse for POLDER-SRON. This statement ("it seems to underestimate AAOD by 25% at high AAOD") seems much too strong given the weak data sampling constraints here.

Line 346-347: Note that AERONET retrievals of SSA also have a maximum value that is only slightly higher than 0.99 due to a minimum constraint on the value of the imaginary refractive index.

Line 364-365: Yes, agreed that cloud contamination is a likely issue with the relatively large satellite pixel sizes for POLDER and OMI. Also please clarify if the global statistics (the first - labeled in purple in Fig 10) are for all AOD levels or for only AOD(550)>0.25 as in the third comparison in green. It would be very useful to look at the GLOBAL histogram for different AOD levels and include information from that into the text of the paper or even possibly added as part b to the figure.

Line 368: Please avoid clipping off the x-axis labeling in Fig 11 of all but one plot. It would be easier to read if all were labeled.

Line 374-375: The diagonal x-axis labeling is confusing and awkward. Please try to improve the readability and visual discrimination between these comparisons in Figure 12.

Line 433-434: It should be noted in the manuscript that the good agreement cannot be due to actual skill in SSA retrievals from the POLDER algorithms over these low AOD conditions over ocean when the absorption signal is far too low for any reasonable accuracy in remote sensing retrievals. This good agreement is likely just due to other factors such as assumptions and/or constraints that were made in the algorithms. Also note that cloud contamination is probably a greater issue over oceans than over land.

Line 441-442: This statement does not make much sense. It is not the sensors but the physics of the retrieval problem that limits the accuracy of the SSA retrievals. Also calibration uncertainty is a major factor in SSA retrieval uncertainty and this not a sensor problem per se. Another major factor in the retrievals is uncertainty in the underlying surface BRDF, especially at low AOD levels, and this has nothing to do with AERONET sensors, but is a required auxiliary input data set.

Line 442-443: Please be clear here that you are only referring to the impact of the lower

AOD threshold imposed in L2 and not some other aspects that exist between L1.5 and L2. Note that L2 retrievals exist for all AOD levels but only for the size distribution retrievals. Therefore the investigator can match all L1.5 retrievals with these L2 low AOD retrievals in date and time to already get a SSA product in L1.5 that has all the quality controls and cloud screening of L2 except for the AOD threshold levels. The text of the paper needs to be revised here to correct this misunderstanding.

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2020-1207, 2020.