

Atmos. Meas. Tech. Discuss., referee comment RC1  
<https://doi.org/10.5194/amt-2022-101-RC1>, 2022  
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## **Sogacheva et al. (2022) amt-2022-101**

Anonymous Referee #2

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Referee comment on "Extended validation and evaluation of the OLCI-SLSTR SYNERGY aerosol product (SY\_2\_AOD) on Sentinel-3" by Larisa Sogacheva et al., Atmos. Meas. Tech. Discuss., <https://doi.org/10.5194/amt-2022-101-RC1>, 2022

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### **Review for Atmospheric Measurement Techniques**

Title: Extended validation and evaluation of the OLCI-SLSTR Synergy aerosol product (SY\_2\_AOD) on Sentinel-3

Authors: Larisa Sogacheva, Matthieu Denisselle, Pekka Kolmonen, Timo H. Virtanen, Peter North, Claire Henocq, Silvia Scifoni and Steffen Dransfeld

#### **General Comments:**

This manuscript presents a very thorough and detailed validation of the SY\_2\_AOD and related Angstrom Exponent products by comparison to AERONET and MODIS data sets. This analysis provides the user community with the statistics that are required to intelligently utilize these datasets. What is somewhat lacking in many sections (see some specifics below) are explanations and/or reasons for poor performance in the satellite retrieval AOD products versus AERONET measured AOD in some specific regions. This

contrasts with much better performance in other regions yet there is little to no discussion on why some regions are much better than others. I think the authors should include much more discussion on the likely algorithmic and/or physical reasons for the discrepancies in the problem regions, much as they did in the last paragraph of the Conclusions section. Additionally I feel that this paper is too long with too many multi-panel figures for most readers. I suggest that the authors select a significant fraction of the figures (maybe one third) and associated text and move them to an appendix section. This would significantly improve the readability and clarity of the paper.

### **Specific Comments:**

Lines 28-30, Abstract: "The retrieval of Angstrom exponent, related to aerosol size distribution, shows good spatial correlation with expected sources but generally overestimates AE for cases where AERONET Angstrom is low, resulting in overall high bias." I think this somewhat overstates the accuracy and utility of the satellite retrieved AE. The regional AE comparisons in Figure 24 show very poor accuracy for most regions in the satellite AE product. I suggest removing this sentence from the abstract or making a more quantitative statement on the retrieved AE accuracy. Similar comments can be applied to the poor retrieval accuracy of the satellite FMF in Figure 22, except for good agreement at the highest AOD levels.

Line 172-173: Please describe somewhere in the text how is AE computed from FMF.

Line 176: Typo, I assume 'duct' is supposed to be 'dust'.

Line 196-197: Please provide a brief explanation as to why the back scatter at the TOA is

more critical in the northern hemispheres versus the southern. Is this just because the percentage of land in the SH is much lower? This is an example of a general lack of physical/algorithm explanations for anomalies and/or comparison results in this manuscript.

Line 250: 'was be' should be 'has been'

Line 265-266: It might be noted that the MAN instruments are calibrated against the same reference instruments as utilized in AERONET. These reference instruments are calibrated by Langley method at Mauna Loa Observatory to an accuracy of 0.002 to 0.005 in the visible and near IR and  $\sim 0.009$  in the UV.

Line 287, Section 6.1: Since AERONET does not measure at 550 nm, please note the spectral interpolation method used. Note that the quadratic or 2nd order fit of AOD versus wavelength is more accurate than the linear or Angstrom fit.

Line 295-296: It seems the word 'error' or 'bias' may be missing here. How could 91% of AOD be  $< 0.04$ ? This AOD level is too low for the majority of the earth.

Line 311: Please define the acronym GCOS here.

Line 380: Please provide some reasons or explanation for the smaller retrieval errors in the SH.

Line 396-397: An obvious missing region is the Pacific Ocean since oceans dominate the Earth's surface (70%). The Arctic Ocean, Indian Ocean, Southern Ocean, are also very important. Why were these regions not included?

Line 408: It is surprising that the performance is poor for Europe. An explanation of the reason is warranted here.

Line 409: The scatter and results for the boreal forest region are very poor. This is surprising since the surface is dark (green forests) and the aerosol type is dominated by fine mode (biomass burning smoke). Please explain/discuss the causes of the poor accuracy retrievals in this region.

Line 414: An explanation is certainly needed/expected for the large regional differences in the fraction of pixels in EE.

Line 417-419: The Aus and AO<sub>b</sub> regions both had very low AOD, none > 0.3 so that is a major factor. This should be mentioned in the text otherwise it is somewhat misleading to the reader.

Lines 444-448, Section 6.1.4 : This is an awkward writing style to have a section consist of mainly one line equations and short statements, with no full sentences. I suggest trying to expand it a little to make more readable.

Line 467-468: In Figure 9 I am missing the separation of NH and SH data that you suggest here. Is there a missing label or legend in this figure?

Line 521-523: The AOD decreases significantly as wavelength increases (except for dust). This may be part of the reason for the offset and rms to decrease as wavelength increases. There is almost consistently a lack of explanation for the observations/comparisons in this manuscript.

Line 642-643: This is too vague, it does not really say how the AERONET fine mode AOD from SDA was estimated at 550 nm from the 500 nm product. Please provide more detail here.

Line 733-734: A bias in AE of  $\sim 1$  and rms of 0.5 effectively renders the satellite retrieval of AE as almost useless for most applications. This should be discussed or summarized in the text.

Line 735: By what metric is this syAE considered 'good' quality? I cannot agree with your assessment unless you define 'good' more clearly.

Line 740: Validation over ocean: Why are the AE retrievals not compared for over ocean? This would be a useful comparison/validation to include.

Line 793-794: Any ideas or explanation about this large difference between MODIS and Sentinel S3A retrievals over Nigeria? This is a striking gradient in large AOD differences, both positive and negative. Which one is more likely to be closer to reality? This is another example of the lack of analysis in giving some explanations in this paper.

Line 815-816: The way this sentence is written is confusing and does not make too much sense. Please rephrase and clarify.

Line 884-889: This type of analysis and reasons for biases and differences, while good, are mostly lacking in the main text of this paper. It is strange to wait until the Conclusions section to provide this type of analysis. These types of explanations should be significantly expanded throughout the paper in the revision of this manuscript.