<u>**Review report acp-2019-446**</u>

The current study is divided in two parts. In the first one, an intercomparison among the most widely used aerosols datasets (obtained from spaceborne passive sensors) is performed while at the second one, various merging techniques are applied towards the development of a unified AOD product. To realize, monthly AODs derived by 15 satellite databases are analyzed over the period 1995-2017. The submitted manuscript is too long thus making difficult to the reader to get the information in a straightforward way. Moreover, the authors should make an effort to provide a better description of their merging methodology and their interpretation of the associated findings. Between the two parts, the first one (up to Section 4) can be a stand-alone paper without making substantial modifications while the second one (from Section 5) needs a lot of improvements regarding the description, interpretation and figures (e.g., add legends wherever do not exist, better description in the captions). Therefore, my recommendation to the authors is to split the current version of the manuscript in two separate works thus helping any potential reader to understand the overarching goal of the study as well as its components and the obtained scientific results. Below are listed my comments that should be addressed prior the publication of the submitted text.

1. **Page 4; Lines 14-16:** Is not clear what the authors want to say here.
2. **Page 8; Lines 2-3:** According to Table 1, there are not available data for 2000 from the AVHRR. Why don't you use 2001 in order to have full temporal coverage also from MODIS-Terra and MISR?
3. **Section 2:** Is there any criterion applied in the monthly products aiming at improving their quality (e.g., temporal representativeness, best quality retrievals) or just the raw products are utilized?
4. **Page 9; Lines 14-15:** Has any significance this threshold?
5. **Section 4.1:** It would be useful to add a table with the AOD averages over continental and maritime surfaces as well as for the whole globe.
6. **Page 10; Lines 26-27:** Where exactly? In the storm track zone (emission of marine aerosols due to strong winds) of the Southern Hemisphere or in the Southern Atlantic Ocean attributed to the transport of biomass aerosols from the central/south parts of Africa?
7. **Page 12; Lines 25-26:** Similar diversity levels are also encountered in the US, Mexico, S. America and Tibetan Plateau. Is there any explanation for that?
8. **Page 14; Lines 23-24:** The defined thresholds of Ångström exponent must be modified in order to create a buffer zone between fine and coarse aerosols modes. For example, fine and coarse particles can be "identified" when Ångström is higher and lower than 1.2 and 0.8, respectively. Even though the proposed limits are not the optimum, they are more realistic than the selected ones. An another solution could be the selection of representative AERONET stations for specific aerosol types or aerosol mixtures.
9. **Page 14; Lines 31-33:** I don't agree with the regional averaging of AERONET observations. Instead of giving equal weight on each AERONET site, it would be more correct (representative) to calculate the statistics on the whole AERONET dataset for each region.
10. **Page 15; Lines 3-4:** How has been defined the spread envelope? Why don't you use only the uncertainty limits defined by GCOS?
11. **Section 4.2.1:** The authors should guide better the reader by adding colors corresponding to aerosol groups in Figure 4. Also, rephrase the sentences in lines 13-15 and 25-27. In Figure 4, in the y-axis write that the difference is defined as satellite-AERONET, add a legend and rewrite the caption. Moreover, which is the background AOD? Are there available results for the total AOD without considering different aerosol classes?
12. **Figure 5:** Clarify that the offset is defined as satellite-AERONET.
13. **Page 22; Lines 8-10:** Rewrite this sentence because it is not clear.

14. **Section 5:** Definitely, a better and more analytical description of the applied merging approaches is needed explaining the benefits and the drawbacks of each methodology.
15. **Section 5.3:** In the RM2, why the levels are 10 and not 9 according to the discrimination of the computed statistics? For example, for the correlation coefficient they have been defined equal-range bins between 0.5 to 1 with a 0.05 step. If I have understood correctly this corresponds to 9 groups of R values instead of 10.
16. **Section 6:** The overarching goal of the current study (stated clearly in the title) is to merge different satellite databases. However, it is not clear to me which is the optimum methodology that should be followed. Also, I fully agree with the rearrangements proposed by the Reviewer #2.
17. **Page 23; Lines 26-27:** Please explain better this sentence.
18. **Figure 8:** Check if the shaded area corresponds to ±0.04.
19. **Section 7:** It is not clear why this Section is important.
20. **Page 37; Line 7:** What do you mean "*…AERONET monthly mean gridded dataset…*"?