

Reply to Reviewer Comment 2 on “**Intercomparison of Aerosol Optical Depths from four reanalyses and their multi-reanalysis-consensus**”

Review comments are in italic font, and our replies are in regular font.

This paper is comparing and analyzing the difference of aerosol reanalyses (RA) from NAAPS-RA, JRAero, NASA MERRA-2, CAMSRA and a consensus of these for RAs named multi-analysis consensus (MRC). The parameter used for the comparisons are the AOD (Aerosol Optical Depth), and the FM (fine mode) part of the AOD, and the CM (Coarse mode) part of the AOD. The four RAs are compared to each other and the RMC is confronted to all four methods also. As evaluation, AODs from these RAs are compared with AEROSol Robotic NETwork (AERONET) and with the combined MODIS Dark Target/Deep Blue retrievals.

The paper is well written, in perfect English, all the parts are very clear.

The paper is brilliant in showing the differences between the four RAs and the RMC, also in showing, commenting and analyzing the trends and seasonal and geographical variabilities of AOD, FM-AOD and CM-AOD.

The paper suffers of a lack of an explanation concerning the methods. Especially in introduction and part 2. We would expect a longer explanation about what is meant with the “consensus” (RMC). The RMC should be better explained in details: Is it an average of all four other methods? How it differs to a simple average, are there situations/regions/seasons/periods for which one method will have a larger or a weaker weight in the consensus compared to others? If yes why? -> A real effort should be done for explaining better the methods and specificities of this RMC “consensus”. Also, you should explain what are the needs of this consensus. Are the four RAs methods not enough?

Other lack of explanation in the methods is for the method of comparison AERONET vs. RAs and RMC. The comparison method should here be much better explained (Part 3.3). Especially for the regional comparison: Which stations are taken account for a given region? Is the AERONET value used in the comparison for the region an average of all stations present in the region and accepted for the comparison regarding the criteria explained in Part 2.5? If yes, is it a relevant method = are all n AERONET sites of the region representative with the same weight $1/n$ for this region? How do you deal then with sub-regions with higher concentrations of AERONET stations? Are there then not over-weighted in the computation of the “regional AERONET-AOD”? Do you have considerations concerning urban and rural AERONET sites?

Reply: We thank the reviewer’s comments. We have followed the constructive comments and revised the manuscript. The “consensus” (RMC) is better and explicitly explained in the introduction, abstract and especially the data/method sections.

To better describe the method of verification of the RAs and MRC with AERONET, we've updated Table S1 to list sites for each region, with latitude/longitude and elevation information of all sites. We've added the following description about how to derive regional validation statistics at the end of section 2.5 "For every AERONET site, the time series of monthly modal AOD from each RA is first extracted from the model grid that encompasses the site's location. Bias, root mean square error (RMSE), and coefficient of determination (r^2) are then computed for each site and each RA. The regional validation outcome is derived from the average of validation statistics across all sites within the region (see Table S1 for the sites included in each region). Following the criteria for site selection outlined in section 2.3, only 200 sites are available globally, and certain regions have only a few sites (a minimum of three sites, such as in South Africa) to represent the entire region; hence, no site weighting within a region is applied. It is acknowledged that this averaging method could bias the global validation result toward regions densely populated with sites, notably North America and Europe. The AOD validation results for total, FM, and CM AOD at 550nm are presented accordingly."

To address the urban versus rural question, we've added a new section 3.5 to analyze the difference in the performance of these RAs in terms of modal AODs compared to AERONET.

These for the general scientific comments.

A general presentation comment is that they are a lot of acronyms used. Positive is that the authors very often detailed in the text several times the meaning of the acronym.

Nevertheless, I suggest you to add an acronym table in order to help the reader to understand quickly the acronyms.

Reply: Thanks for the suggestion. We've added an acronym table in Appendix A, and definition of terminologies in Appendix B.

I have some specific comments/questions for two pictures:

- Maps of Figure 1: First line of maps (MODIS): I understand that on the Antarctic region during JJA there are no measurements, but why is it the same during the other seasons (example austral summer in DJF)?

Reply: We've added "In the MODIS plots, the white area means a lack of data attributed to either none valid-retrievals or quality-control filtering" in the figure caption for Figure 1. The MODIS AOD product we used is a data-assimilation quality product, which has a cut-off at 40°S to filter out potential cloud-contaminated data south of this latitude. This is added in the data description in Section 2.4.

- Figure 10: 10b) On the Antarctic Graphic: It is so obvious that JRAero is much more overestimating the AOD that it is worth that you give an explanation in a comment in the text of the article

Reply: We've added in the Figure 10 result "The total AOD in JRAero exhibits exceptionally high levels, primarily attributed to elevated sea salt and sulfate AODs (Fig. S5). This anomaly stems from the MASINGAR model used to produce JRAero, which tended to underestimate the removal of aerosols via cumulus convection. Consequently, this led to an overestimation of aerosol concentrations in the polar regions and the upper atmosphere. The underestimation of the removal process has been resolved in the current MASINGAR model and the overestimation of AOD over the polar regions will be improved with the JRAero version upgrade. "

And a comment about References:

- The most important cited reference (Sessions et al. 2015), cited L104, L235, L292, L351 is missing in the "References" part.

- Sessions et al. 2016 (cited in L66-67) is missing in the References list

Reply: Thank you for bringing this to our attention. We have included the Sessions et al., 2015 reference in the reference list. Regarding "Sessions et al. 2016", the year "2016" was indeed a typo. It has been corrected to "2015" now.