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Comment on acp-2022-176

Anonymous Referee #1

Referee comment on "Monitoring multiple satellite aerosol optical depth (AOD) products within the Copernicus Atmosphere Monitoring Service (CAMS) data assimilation system" by Sebastien Garrigues et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-176-RC1>, 2022

This paper is an evaluation of the Copernicus SLSTR and NOAA VIIRS near real time aerosol optical depth (AOD) products for upcoming data assimilation purposes (for the CAMS system), based on statistical comparisons to CAMS as well as the AOD products which CAMS currently assimilates (MODIS and PMAp). The evaluation is global, for two 3-month periods that were characterized by different aerosol regimes. Offsets between the various data sets are explained, and interesting points about how scattering angle sampling differences between sensors (i.e. it's not just the spectral/spatial characteristics, it's when/where it's looking) are also raised. A follow up paper will go into more detail on the effects of assimilation of these products on CAMS.

The topic is in scope for the journal and is scientifically relevant. I appreciate the authors' reworking of the text based on comments at the Quick Report stage, which makes this version more readable and clearer. The overall quality of writing and presentation is now fairly good, and the paper's length is more manageable. I have a number of comments, below. All are fairly minor corrections/clarifications, with the more substantial comment being that the Conclusion should be rewritten. As a result I recommend minor revisions before the manuscript is suitable for publication in ACP. I am primarily a satellite person and so recommend at least one other reviewer of this manuscript is a data assimilation modeler in case there is something I miss on that front. Comments are as follows:

- Line 170: is this really how DB and DT are combined here? If so, why not just use the merged product provided within the files? It is not the same as gap filling DB with DT, there is some averaging and QA comparison done too. See the Levy (2013) paper mentioned earlier.

- Line 222: for non-modeler readers, it would be useful to state what the TL511 model resolution corresponds to in km or degrees. Is this the same as the 40 km resolution mentioned on line 230 or something different?

- Paragraph beginning line 248: if I understand correctly, the first guess departure will be useful for the absolute evaluation of the satellite products if the (un-assimilated) model itself is somewhat skillful. If the model is not good at a certain place/time then you wouldn't necessarily know whether the difference is due to model or observation errors, and conversely if the model were perfect you could use it perfectly to diagnose observation errors (but then assimilation itself wouldn't bring a benefit). Is that right? I suggest adding a sentence or two here for non-modeler readers to explain more why this is a useful metric and what the caveats/assumptions are. Presumably the fact that first guess departure is based on the model field including MODIS/PMAp assimilation from previous time steps, makes up for some potential errors in the model (assuming in that case that MODIS/PMAp in the previous time step were good).

- Figure 1, 2, 5, 6: the paper says the analysis is only for data with latitudes smaller than 70 degrees. The maps include data above 70 degrees (except for MODIS which seems to have a cutoff). So it's not clear if that data is used in the discussion of this figure or not. If data above 70 degrees are not used, I would suggest not plotting it in the maps.

- Mapped figures: these still say SDD for standard deviation, not SD like in the rest of the paper. I also wonder if it's possible to put the mean and SD on the same line as the sensor name, with the two-line plot titles there's a lot of space between panels which makes it a bit harder to visually compare than if they were closer together.

- Line 374: I wonder if here (or earlier) you could introduce an acronym FGD or a symbol for "first guess departure". The phrase appears a lot in this section, it would be easier if there were some shorthand for this term. I counted 22 uses on page 22 alone, and about a dozen on the corresponding land section (page 24).

- Line 376: if I understand correctly, negative first guess departure means the satellite is lower than the model field. Is that right, or do I have it backwards? For a non-modeler reader, as this is the first example given in the paper, it would be good to state this clearly to make sure people don't get the conclusions backwards. If that is correct then would it imply the model AOD is higher over ocean (since we know most satellites are also too high) – possibly because of the assimilation of biased MODIS and PMAp observations in the previous time step?

- Figures 7, 16, D5, D9: it would be useful to add the horizontal line $y=0$ here, as a reference for zero mean departure.

- Section 4.2: how are the unphysical negative AOD retrievals in the Dark Target land product handled here? Are they set to 0, set to invalid data, or something else? From

presented is that neither of these products are likely to help CAMS much, at least so long as the current MODIS products remain available. Is that a fair assessment, and if not, why not? This is the sort of content I think the conclusions should be giving, i.e. don't repeat the results of the analysis but more talk about what they mean. There is some of that in the current Conclusions but not much.

- Appendix A: thank you for moving this section out of the paper into an Appendix, it makes the main paper more readable, and now if someone wants to know more details but not read the algorithm/validation papers this gives a summary.

- Appendix B: it's not obvious to me what the blue lines on the plots represent, what is it? I'm not sure they are useful and maybe they can be deleted to reduce clutter. I also think it's more useful to show the 1:1 line than what I guess is a regression line here (again, the Appendix doesn't say). That way one can more directly see whether one data set is higher/lower than another by whether they are above/below this line, without having to cross-reference the existing lines to the labels on both axes. The regression lines seem skewed by offsets at low-AOD conditions (as most of the points are there) whereas as a reader I am more interested in whether one is lower or higher than the other across the full range of AODs. That is less clear when showing the regression line than showing the 1:1 line would be.