

Review of amt-2022-290, “Assessment of Severe Aerosol Events from NASA MODIS and VIIRS Aerosol Products for Data Assimilation and Climate Continuity”, by Amanda Gumber, Jeffery S. Reid, Robert E. Holz, Thomas F. Eck, N. Christina Hsu, Robert C. Levy, Jianglong Zhang, and Paolo Veglio

The paper provides an assessment of two MODIS AOD datasets (the combined Dark Target / Deep Blue and MAIAC) in comparison to the operational VIIRS dataset (and AERONET ground-based sun photometer measurements) with a focus on high AOD events.

The paper is of high relevance as it provides significant and detailed insights into the performance and deviations of MODIS vs. VIIRS which prepare the ground for the transition between those instruments in late 2023. Given the importance of MODIS for operational modeling systems through data assimilation, the assessment of the consistency of continuing observations (e.g. for air quality) and of long-term Climate Data records after this transition is of high importance.

I found one type of maps presented in a confusing way / not completely described (mean bias – absolute or relative) – this should be harmonized and its descriptions extended for better clarity.

I have a few minor suggestions on wording and graphics, symbols where I struggled to grasp the key messages (see detailed comments at the end).

I therefore recommend publication with minor revisions.

#### Response to review questions

1. Does the paper address relevant scientific questions within the scope of AMT?

Yes, a specific assessment of high AOD cases and of the consistency of datasets related to a sensor transition are of great value and importance.

2. Does the paper present novel concepts, ideas, tools, or data?

Yes, the paper is innovative with its specific focus on a comprehensive assessment of high AOD cases for different regions stratified by their different dominant aerosol types or mixtures of them.

3. Are substantial conclusions reached?

Yes, the paper does go into detailed regional / aerosol-type stratified analysis, and in its conclusions extracts major overall findings relevant for data assimilation and direct use of VIIRS AOD in sequence to MODIS AOD.

4. Are the scientific methods and assumptions valid and clearly outlined?

Yes, the paper applies an appropriate combination of methods to assess / compare the long tails of probability distributions with their specific complexity of low

numbers. Applying different methodology for the bulk of the AOD range ( $< 0.8$ ) and for the rare high AOD cases is fully appropriate. Furthermore, the limitations entailed in the methodology used as well as due to the Aeronet reference data limited coverage are clearly described to put this part of the analysis into the right context.

5. Are the results sufficient to support the interpretations and conclusions?

Yes, the paper does provide a wealth of plots which justify in detail the conclusions drawn; in particular in the analysis of specific regions in section 4. The discussions do include some qualitative aspects of possible reasons for the differences (as proving each hypothesis would go far beyond the paper's scope). However, those discussions are all well underpinned by plausible arguments based on the observations in the various plots.

I found one type of maps presented in a confusing way / not completely described (mean bias – absolute or relative) – this should be harmonized and its descriptions extended for better clarity.

6. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)?

Yes, the methodology is either described or referenced in their underlying publications.

7. Do the authors give proper credit to related work and clearly indicate their own new/original contribution?

Yes, I could not identify any major gap in the references quoted and there are clear (and valid) statements highlighting the unique elements of the paper).

8. Does the title clearly reflect the contents of the paper?

Yes, the title highlights the focus on high AOD cases as well as the intended applications of data assimilation and climate data record consistency.

9. Does the abstract provide a concise and complete summary?

Yes, the abstract summarizes the goal, methodology and overall conclusions.

10. Is the overall presentation well structured and clear?

Yes, the presentation starts with a brief introduction of the datasets / their underlying algorithms, and then conducts the analysis first globally and then regionally, which provides a rich set of analysis details.

11. Is the language fluent and precise?

Yes, overall, the paper is well written. I have a few suggestions for small improvements.

12. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used?

Yes, overall, I see clear definitions and consistent usage. I have a few minor suggestions for improvements (see below).

13. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated?

No, as the authors have already taken care to split some further analysis into a supplement, so that the overall flow of the argumentation can be better followed.

14. Are the number and quality of references appropriate?

Yes, I see all relevant work cited.

15. Is the amount and quality of supplementary material appropriate?

I appreciate the provision of further interesting detail in the supplement.

#### My few small concerns

- 1) Maps of mean bias are presented in Fig. 5 (right column) and Fig. 6 (all) and only the caption of Fig. 5 calls it “mean relative bias”. As there are no negative values and in Fig. 6 over ocean for the lowest AOD range the value 1.0 dominates, it cannot be absolute biases, but the captions / text on a fast reading made me expect absolute bias. Can you please add one or two sentences clearly defining what is shown in the maps and use consistent terminology to ease a reader’s understanding?
- 2) In the abstract and the methodology you call your common consistent product used for the analysis “a Level3 product”. I understand that you want to stress the consistent aggregation (which is important) and the fact, that you work with a gridded dataset. As there exist the operational Level3 products, can you please introduce a naming which makes it clear that you are using a specific gridded product which also included AERONET data and all satellite datasets under investigation which differs from (some of) the operational Level3 products?

#### Minor / detailed comments which could help optimize the paper for reading

- In a few places I got lost whether analysis over ocean is part of the paper or not
- You have many “-“ between parts of sentences without empty spaces, which confuse reading – please change them all to “ – “
- use “AERDB” instead of “DB” for VIIRS in all places to distinguish from the MODIS DB product
- There are a few cases, when your sentences are missing a verb (e. g. lines 35, 123, 575)
- Can you be consistent in “84<sup>th</sup> percentile ...” instead of sometimes using “84<sup>tho</sup>% ...”?

- Please use “1° x 1°” consistently throughout the paper instead of “1 degree x 1 degree”
- Please use “biomass burning” consistently instead of sometimes only using “burning”
- Line 60 “conditions” should be moved before the bracket (then you keep together “lower boundary conditions”)
- Lines 93-96: split into two sentences
- Line 107: AERONET is not a sensor (CIMEL is)
- Line 115: I would add “comparison of the” before “product performance”
- Line 128: add “to” before “provide”
- Line 129: can you find a more appropriate word to replace “finalizing”
- Line 132: I do not understand what you want to say with “use the benchmark AOD values” / line 576
- Line 133: can you explain the principle behind “designed after commonly applied DA products”
- Line 135: can you please say, which fraction of pixels is typically kept for each of the three dataset by applying the QA flags?
- Line 143: please add “as level2” after “criterion”
- Line 145: why do you use Aeronet lv1.5?
- Line 148: replace “isolate” by “separate”
- Line 163: which version of MYD04 do you analyse (collection 6.1 I guess) – please add.
- Line 163: what is the impact of comparing MCD19 which is a combined TERRA / AQUA product to the other afternoon only products?
- Line 167: it would be very interesting to include VIIRS /DT, but I accept it was not yet available when the study was made – consider to delete the sentences on the new VIIRS version (here and later in the paper)
- Line 170: this sentence says that there is no fine mode AOD over land for any of the products – please reword
- Sections 2.2.1 – 2.2.3: the MDOIS part is much longer than the other two – maybe consider to harmonize
- Line 179: add “pre-defined” before “fine and coarse”
- Line 190: add “in visible bands” after “signal”
- Line 225: please explain “M band channels”
- Line 228/229: so VIIRs AERDB has fine mode over bright land?
- Line 245: what do you mean by “aggregated to longer time domains”
- Line 264: replace “this subsection” by “section 3”
- Caption to fig. 2: filtering of ratios for 84<sup>th</sup> percentile of AOD<0.1 (for one of the datasets or for all?)
- Fig. 2: To simplify reading, I suggest a shorter legend title for the top right maps ( $\sigma_g$ ) – better to define “ $\sigma_g = \text{AOD } 84^{\text{th}} \text{ percentile} / \text{median AOD}$ ” in the text as equation
- Fig. 3: is the same filtering applied for rations as in fig. 2?
- Table 1 / caption: I would add “AOD550: “ at the caption start
- Line 316: what does “good” mean here?

- Lines 365ff: I suggest to avoid the word “capture” as it indicates that an algorithm detects something as compared to a truth, which you explicitly say cannot be assessed. Better use “observe” or “detect” or similar.
- Lines 370 – 372: I find this a very complicated sentence to understand.
- Fig. 4 / caption: duplication “detection” – “detected”
- Line 406: better say “pre-defined” instead of “programmed”
- Line 437: I would replace “excellent” by “outstanding”
- Line 437: what do you mean by “model comparisons”?
- Line 443: add “truly” before “different”
- Figure 7: the lines are for which dataset? Aeronet, I guess – please add
- Line 487: add “which” before “have”
- Line 514: replace “less different” by “smaller”
- Line 338: add “showed that they” before “were”
- Line 545: what do you mean by “observed integer factors”?
- Line 560: “constancy ???”
- Line 562: replace “concerning” by “of concern”
- Line 573f: “Notable are differences include” is not a proper sentence.
- Line 629: replace “lower still” by “even lower”
- Line 725: replace “particulate” by “particular”
- Line 746: delete “when”
- Line 771: sometimes you use past tense, mostly you use present tense.
- Line 780: “under-sampling”
- Line 788: delete “The last aerosol regions studied” by combining the first two sentences “Regions with mixed pollution and dust within Asia include southwest Asia ...”
- Line 794: is “dark target types of algorithms” the correct summarizing of all algorithms here?