

Response to Referee #1 for the manuscript: “Estimating aerosol emission from SPEXone on the NASA PACE mission using an ensemble Kalman Smoother: Observing System Simulation Experiments (OSSEs)”

Dear Referee #1,

Thank you for reviewing our manuscript. Your comments definitely help to improve and define better some aspects of our work. Below you can find our point-by-point responses to all of your comments.

Best regards,
Athanasios Tsikerdekis

Format

Questions

Responses

“Quotes from the manuscript and revised or added text.”

Comments

If I am not mistaken, the figures presenting the spatial distribution of the differences between the examined experiments present also as “mean” the mean difference (?) globally. Such an approach might result in masking of the error when positive and negative differences appear with similar frequency. I suggest also presenting the global mean of the absolute differences in order to have a more realistic overview of the differences between the experiments. Moreover, I suggest defining (in the text) the metrics used in the study (maybe as Appendix?).

Indeed the global mean error (ME) may end up very close to zero with regional positive and negative error that cancel themselves out (e.g. Fig 7a). Therefore, we have added along with the ME, the mean absolute error (MAE) in all global maps that depict differences, specifically Figure 7, Figure 8, Figure 9, Figure 10, Figure 11, Figure 14, Figure 16, FigureS 1, FigureS 2, FigureS 3 and FigureS 5. Additionally we have cited our previous publication where in Appendix B it contains all the metric used in the present study also.

“ME and MAE equations can be found in Appendix B of our preceding publication (Tsikerdekis et al., 2021).”

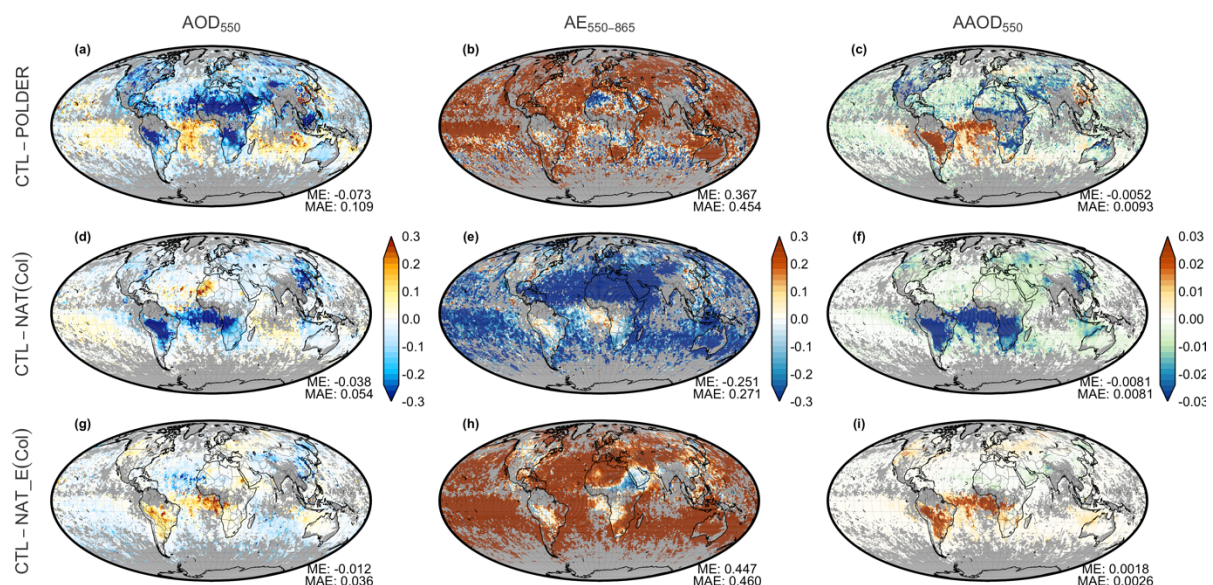
The NAT experiment represents the synthetic observations used for the assimilation. Do the authors have an estimate on how the NAT spatial variance is compared with that of the real observations? How does the comparison between the two might affect the improvement of emissions estimation? This is something that needs to be discussed in the text.

Thank you for this comment. Although these nature runs were created in order to test the data assimilation system capabilities and do not aim to represent the exact differences with a specific observational dataset (as indicated in subsection 3.3), it is interesting to test if the differences between CTL minus nature runs captures some of the general patterns of the differences between CTL minus an observational dataset. As an observational point of reference for this analysis we use retrievals from POLDER, since it could provide the same variables with SPEXone. We compare the difference between (i) CTL – POLDER, (ii) CTL – NAT (collocated over POLDER) and CTL – NAT_E (collocated over POLDER). We don’t show the differences CTL – NAT_M, since they are pretty similar with the differences CTL – NAT.

The AOD underestimation over the biomass burning sources of Africa and South America as well as the overestimation over isolated ocean regions observed in CTL – POLDER is well

represented in CTL – NAT. Further the AE global overestimation and AAOD overestimation over South America observed in CTL – POLDER is captured by CTL – NAT_E. Independent of the sign of the differences, ME and MAE for the POLDER differences and the two nature run differences is comparable for all variables. Thus, this makes the nature runs of this work a fairly good proxy to represent some of the patterns illustrated in CTL – POLDER differences. Further the differences of CTL – NAT and CTL – NAT_E are contrasting in each of the variables, making them an ideal combination to test the emission estimation system under diverse scenarios. Further we have added the underlined sentence in main manuscript on subsection 3.3.

“These emission factors are chosen arbitrary, aiming to test if the data assimilation is able to estimate them correctly (test the system), rather than to reduce biases between NAT and a specific set of observations of an existing satellite (e.g POLDER-3). Nevertheless the differences between CTL – POLDER and CTL – NAT exhibit similarities in the biomass burning region in the Tropics and the global ME and MAE of these differences are on the same scale (not shown).”



Aerosol optical properties differences of CTL – POLDER (a,b,c), CTL – NAT collocated over POLDER (d,e,f) and CTL – NAT_E collocated over POLDER (g,h,i). Left column depict AOD (a,d,g), middle column AE (b,e,h) and right column AAOD (c,f,i). Plots correspond to the period 15-08-2006 to 20-09-2006. Global Mean Error (ME) and global Mean Absolute Error (MAE) is depicted in the right bottom corner of each map.

Minor Comments

P2, L33 and where applicable: I suggest using the Oxford comma as “size, and absorption with..”.

Thank you for your suggestion. The lack of Oxford comma is consistent throughout the manuscript. Since this is a matter of preference according to the guidelines of GMD (as long as is consistent), we kept it as it is.

P2, L42: Add a comma after “In addition”.
Added.

P2, L50: the have largest -> have the largest
Done.

P4, L104: Add angle units

Added.

P4, L105: that it measures -> measuring
Changed.

P4, L106 and where applicable: Add space before nm in 700nm.
Added.

P4, L107. Multiple sentences here starting with SPEXone. Please rephrase
Thank you for noting it. We have rephrased the three sentences.

P5, L139: taken into account -> are also taken into account
Corrected.

P11, L330: I suggest replacing the first sentence with “Figure 4 shows that the differences between DAS and NAT (solid lines) reach a value close to zero after 26 days.” In this case you can delete “(Figure 4)” in the next sentence.
Changed as suggested.

P12, L357: “nature run” Please use the abbreviations (NAT here) throughout the manuscript
Corrected.

P12, L386: from NAT -> from NAT for AOD, AE, and AAOD.
Corrected.

Figure 2: Maybe replace purple with green to better distinguish from blue.
Changed purple with dark yellow. The green and red combination is bad for people with the most common color deficiency (deuteranopia).

Figure 6 caption: Please indicate what the presented Mean value stands for.
Added in caption: “Mean stand for the global mean value, estimated by averaging all the available grid cells.”

Captions of Figures 10 and 11: depict -> depicts
Corrected.

Figure 13: The experiments name is missing from the DU and SS figures.
Added.

Figure 18c: I suggest replacing orange rectangle with a blue one to better distinguish from the red one. Please also describe what the rectangles stand for in the respective caption.
Corrected the colors in the plot and made the boxes thicker. Also added the following in caption: “In subplot (d), blue and red boxes highlight regions where dust emissions are overestimated and underestimated respectively in CTL compare to NAT E. In the first case the data assimilation can modify the emissions and correct the overestimation, while in the second case it cannot (details in the subsection 4.3.2).”

Figure A 1: There seem to be some color shade areas in the scatter plot. Please indicate in the caption what they stand for.

Thank you for noting this. We added on the caption: “The shaded areas represents the 2D kernel density estimation for each experiment.”