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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Observation operator for the assimilation of aerosol type resolving satellite measurements into a chemical transport model" *by* M. Schroedter-Homscheidt et al.

Anonymous Referee #2

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General comments

The paper provides a lot of useful information on the satellite observations. An observation operator is derived, which is a significant step toward data assimilation of aerosol-related satellite observations. The assimilation part itself is a bit weak because of lack of explanations, strong biases and limited impact. It should be seen as a preliminary step. I recommend that the paper is published in ACP after the following points are addressed.

Main remarks

1) Page 860: A formula would help understanding the least square fit.

2) Page 863, line 21: "Maritime and mineral aerosol components are not included in the EURAD version used for this study." There should be a discussion about this. This can have significant consequences on the simulations.

3) Page 868, line 22: "Observations are assumed to be uncorrelated to each other". Why? This may be questionable because all observations are produced by the same instruments and the same algorithms.

4) Page 868, line 24: please give the formula.

5) Page 869, line 1: Why the correlation length (actually, decorrelation length) for AOD is taken as (de)correlation length for *errors* in AOD?

6) Page 872, line 20: this step seems to make the observation operator non linear. If so, it should be mentioned.

7) Page 873, line 4: the statement is too optimistic. I suggest to reword. If I understand correctly, 18% of AODs have an error greater than 50% of the target average error. This is not negligible. The error may be neglected in the present study, nonetheless it should not be qualified as negligible.

8) Page 875, line 13: if 0.12 is the RMSE, it cannot be the diagonal of the matrix R. R is a variance and the RMSE can be identified to the standard deviation (if there is no bias). In addition, the authors should comment why they use the RMSE with AERONET data, without discounting the error in AERONET measurements. Likely, they assume that the error in AERONET is negligible compared to that of SYNAER, which is supported by earlier considerations but should be written explicitly in this paragraph. Finally, there should be a discussion about the bias. In their data assimilation approach, observations should be unbiased. But here, the bias does not seem negligible at all. The bias is -0.08, which is comparable to the standard deviation of 0.1, and it is 30% of the mean before the quality control. I understand it is difficult to apply rigorously the chosen data assimilation procedure, and I think it is acceptable here. However this issue should be

explicitly noted. Future work should remove the bias in some preprocessing stage or more powerful assimilation schemes should be used. There is just a discussion later for the background. The observation part should be mentioned as well.

9) Page 877, line 3: what does "coincidences" mean? This is not a lot of observations, compared to the 2268 "coincidences" mentioned earlier. How are the 189 coincidences found? Explanations are needed. Every time an observation is available, an analyzed field can be computed. One the one hand, an AERONET observation may be far from the locations observed by the satellite. In this case, the analysis is essentially the same as the background. On the other hand, how the corrections are spatially distributed in space is important. Thus one should not compare only in the grid cells where there is a SYNAER observation.

10) Page 877, line 11: how is it possible that the analysis increment is zero? Is there some clipping in the values of B?

Minor remarks

1) Page 857, line 12: replace "methodologies" with "methods" or "methodology".

2) Page 857, line 26: there are 6 references to papers of the second author and 6 references to the work of the rest of the community. Although the second author did a good job in the field, I think his contribution is far from deserving half the citations for such a generic topic (assimilation in chemical transport modeling).

3) Page 859, line 25: what does "internal" mean?

4) Page 862, line 18: replace "km" with "kilometers".

5) Page 863, line 26: it is not clear what "in the meanwhile" means.

6) Page 869, line 3: "approximately the SYNAER pixel size" in one direction, and half the size in the other direction.

7) Page 871, line 18: "speciese"

8) Page 872, line 7: replace "methodology" with "method"

9) Page 873, line 15: I suggest to replace "a negligible low probability" with "a negligible probability".

10) Page 874, line 14: the second sum in the inequality depends on l, not on i.

11) Page 875, line 17: why referring to "coincidences"? The model is available all time and everywhere in the domain. Only AERONET is limiting here.

12) Page 879, line 1: what does "impact" refer to?

13) Page 879, line 21: replace "und" with "and".

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