Geoscientific
Model Development
Discussions

Interactive comment on "Representativeness errors in comparing chemistry transport and chemistry climate models with satellite UV/Vis tropospheric column retrievals" *by* K. F. Boersma et al.

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We thank the reviewer for the constructive comments. Below the reviewer's comments are in italic fonts.

The authors have described an approach to quantity three types of errors that can arise when trying to compare modelled NO2 fields with UV/Vis retrievals of column NO2. They have focused on horizontal and vertical representative errors, and errors associate with cloud cover. These are all issues that the community is aware of and is

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struggling to address using various approaches. In that context, the manuscript is not innovative, but I believe that it will be useful to the community. By providing a coherent approach for dealing with these errors, the manuscript will help reduce misuse of the NO2 column data, and it may even spur new approaches for mitigating the errors. The manuscript is well written and I recommend it for publication after minor revisions to address my comments below.

Thank you for the positive criticism.

Comments

1) Page 7828, line 25, and Page 7840, line 8 (title of Section 5.2): It is not clear to me what is the temporal component here. It seems to me that this error, which is the focus of Section 5.2, is really an issue with the representativeness of the cloud cover. Referring to this as temporal (or meteorological) representativeness error is vague and confusing. Why not just call it representativeness errors in cloud cover?

On page 7828, we removed the adjective 'meteorological' to clarify that this category of errors is addressing temporal aspects that not just relate to cloud cover. Temporal representativeness errors arise from models not properly representing the temporal evolution associated with changing cloud cover or with changing emissions such as the weekend effect, so just labelling them as 'representativeness errors in cloud cover' would not be a complete description. The title of section 5.2 is in our opinion appropriate as it is.

2) Page 7832, lines 21-23: Here the authors state that they treat all of the errors as random errors. However, in Section 5.1 and Appendix B they account for a correlation in the errors, so clearly they are accounting for some systematic errors. This confusing and needs to be better explained.

We removed the sentence that we treat the retrieval, modelling, and representativeness errors as random errors in response to Rev1. In section 5.1, we discuss how to

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calculate representativeness errors, taking into account error correlation, so that combined observation and (spatial) representativeness may be obtained. In many data assimilation studies, representativeness errors are included in the observation errors, as already stated in our original manuscript, and now also stated in the revised manuscript right after introducing Eq. (3).

3) Page 7833, lines 8-12: I do not agree with the statement that the vertical transport errors will be smaller, in an average sense, when aggregated over a month. That is, for example, unlikely to be the case in the tropics or over eastern North America in summer, when convective transport is strong. Indeed, the monthly mean differences in the vertical distribution of NO2 in the lower troposphere between GEOS-Chem andTM5 shown in Figure 7a are not that different from those shown in Figure 6a for Feb 18th.

They will be smaller in a monthly average sense, because not all days in the month will have strong convective activity, especially in a region like North America. Furthermore, Figures 6 and 7 do not necessarily indicate that GEOS-Chem suffers from vertical transport errors but rather that GEOS-Chem and TM4 simulate vertical transport of NO2 differently.

4) Page 7836, line 17: Are there additional references besides Lin (2012) that should be included here? What about Lamsal et al. (2010, J. Geophys. Res., D05302, doi:10.1029/2009JD013351)?

We have now included the Lamsal et al. [2010] reference, also in a number of other occasions where we thought it appropriate.

5) Page 7845, lines 2-6: Not all of the NO2 products provide averaging kernels. It would be helpful if the authors could explain what one should do to mitigate the vertical representativeness errors in the case when averaging kernels are not provided.

There is not much one can do except but go back to the NO2 product developers and make a request to make a available the averaging kernels or the scattering weights

for each pixel in the product. Using the averaging kernel of another product would not help, unless all the a priori data used in calculating the averaging kernels (albedo, cloud parameters, atmospheric profile) is exactly the same, which is highly unlikely to ever happen.

6) Figure 7 caption: Explain that the numbers given in each panel, e.g. 5.75 for GEOS-Chem, are the integrated column abundances.

Done, also for Figure 6.

7) Figure 10 caption: Should "100% x (B/C − 1)" be "100% x (B/A − 1)"? Why not make these differences relative to experiment A, which is believed to be better, so that for C vs A is it 100% x (C/A − 1) and for B vs A it is 100% x (B/A − 1)?

Thanks for spotting this. The experiments were indicated relative to experiment A. We adapted the caption accordingly.

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