

Authors' response to comments from Anonymous Referee #1

General comments:

I have gone over the changes made in response to my previous comments as Reviewer #1, and am satisfied that all my comments have been addressed.

Thank you very much for taking time to review our revised paper.

Specific comments:

This reference for OMNO2 v4 would be better:

<https://amt.copernicus.org/articles/14/455/2021/amt-14-455-2021-discussion.html>

Thank you for your suggestion. We have updated the reference in the revised manuscript.

Technical comments:

Line 64: Change “it threats” to “it threatens”

Done.

Authors' response to comments from Anonymous Referee #3

General comments:

The authors have put a lot of work in this revision, and have improved on the data, the validation and the presentation. I therefore recommend the manuscript for publication.

Thank you very much for taking time to review our revised paper.

I have however some concerns, and they are about Figure 9.

Comparing the old and the new version of the data, it is surprising to see that even at polluted places such as Xianghe, the new GEMS data differs by up to a factor of two from the previous version. As far as I could see, the only difference in the two versions is the treatment of the diurnal variation of the stratosphere. I'm surprised to see that the stratospheric correction has such a large impact and think that this hints at a larger contribution of this term to the overall uncertainty.

Thank you very much for your comment. In the previous version, the very little diurnal variation of stratospheric NO₂ is actually incorrect because of the insufficient stratospheric chemistry in nested GEOS-Chem v9-02 simulations. After using the stratospheric NO₂ from GEOS-CF v1 dataset, the

retrieval results are much better and also reasonable. Besides, GEOS-CF v1 stratospheric NO₂ spatiotemporally correlates very well with that in the TROPOMI-PAL v2.3.1 product, and also shows similar diurnal variation characteristics compared with previous studies. Therefore, the large difference is caused by the wrong stratospheric NO₂ correction in the previous version.

A second concern I have about this figure is that also the MAX-DOAS values have changed, at least for Xianghe and Dianshan Lake, possibly also for other locations. Please explain why that's the case.

I'm quite sorry that the labels in the original manuscript are mismatched to the corresponding subfigures. In the original manuscript, Figure 9e should be for Xianghe, Figure 9f for Dianshan Lake, and Figure 9g for Chongming, respectively. The MAX-DOAS values are the same as before.

I'm also confused why things have improved so much in Figure 9 with the new data version, while in Figure 8a, which is based on the same data, no improvement is apparent. Please explain.

Thank you for your comment. As shown in Figure 9, the update of stratospheric NO₂ data results in a great improvement in terms of NO₂ diurnal variation, but the normalized mean biases are still site-dependent and don't change very much. Compared with updated POMINO-GEMS tropospheric NO₂ VCDs, MAX-DOAS NO₂ VCDs are still higher at the Xuzhou, Fudan University, Nanhui and Chongming sites, but lower at the Hefei, Xianghe, Dianshan Lake and Fukue sites. Therefore, the improvement of spatiotemporal correlation and normalized mean bias is not very apparent, but the correlation of NO₂ diurnal variation becomes much better.