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Response to Reviewer #3 (doi:10.5194/amt-2017-44-RC1, 2017)

- How do the GMI model results used for the a priori compare to other models such as GEOS-Chem? Prior studies (e.g., Huang et al. 2015) show some differences between GMI and GEOS-Chem with the latter model comparing better to in-situ observations above the boundary layer. This may impact the results shown in this study and should be discussed.

Response to reviewer:

We made comparisons of the GMI *a priori* used in the previous, version 2 OMI retrieval with GEOS-Chem profiles (not shown). We know that the anthropogenic NO_x emissions in our previous GMI simulations were not up to date, and our current simulation, used as SPv3 *a priori*, addresses this issue. Both GMI and GEOS-Chem now use similar anthropogenic emissions. The broad consistency between the two simulations over unpolluted regions (see Figure R1) suggests similarities in lightning NO_x emissions in the free troposphere.

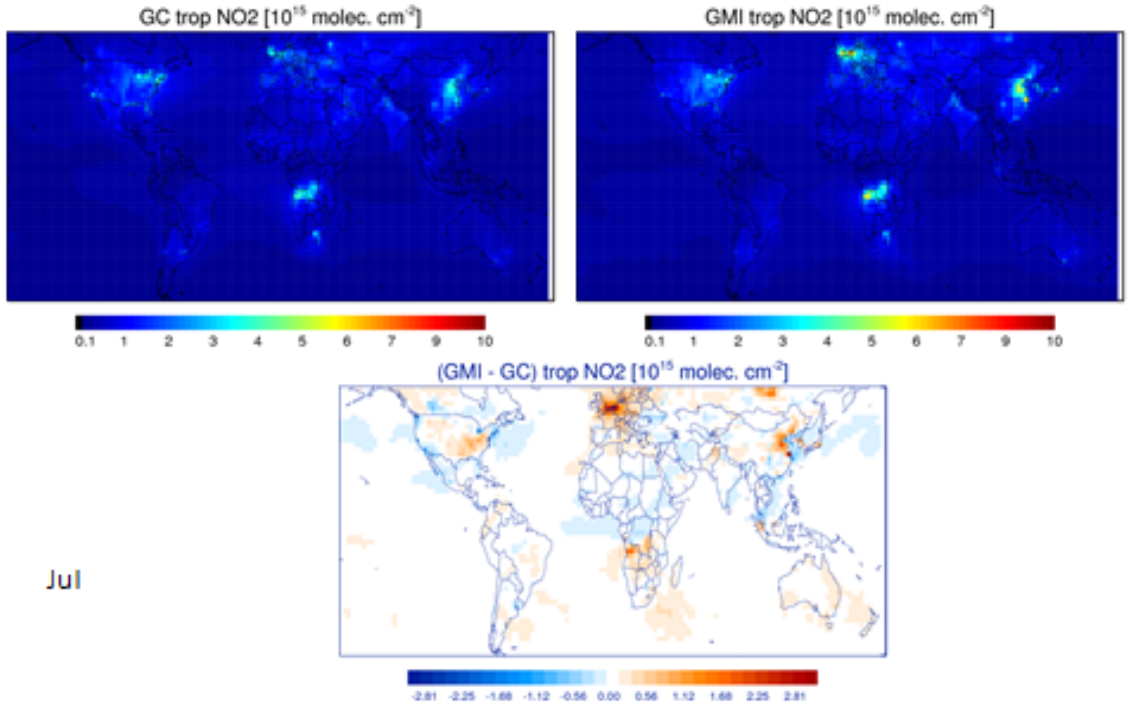

Figure R1. Comparison between a previous version of GEOS-Chem and the SPv2 GMI *a priori* tropospheric NO_2 VCDs.

As noted in section 2.2 of the paper, extensive evaluations of GMI have been made. Further, with the scattering weights (**W**) we publish along with the VCDs, it is possible for a user to re-compute VCDs using any arbitrary profiles, modeled or measured. To emphasize this point, we have added the following paragraph at the end of section 3.2:

"We provide **W** to allow users to derive their own estimates of AMFs and VCDs using improved *a priori* NO_2 profiles, for example from another model or observations."

This is also noted at the end of section 3.3, with references to several studies that have done this to derive alternative versions of the OMI tropospheric NO_2 VCD data.

- What is the justification of reducing J(NO)? This is very significant. While Prather is held in high regard, it is important to offer some further explanation for this. Will this result be published soon?

Response to reviewer:

Prather's recommendation to reduce jNO by 40% is to correct for an underestimation of NOy made in a related chemistry transport model when compared to in situ balloon measurements [Hsu and Prather, 2010]. Incidentally, other models, such as WACCM, that include NO self-absorption and thus have lower jNO, do not show the same discrepancy in NOy when jNO is not reduced. To add better clarification and a published reference to the paper for the jNO reduction, we added the following to section 2.2:

"..., in part based on a discrepancy of a related model and balloon measurements of NOy (Hsu and Prather, 2010)."

- For Figure 3, it would be very useful to not only show the differences in the retrievals but to also show the retrievals themselves for both the stratosphere and the troposphere.

We agree. We updated Fig.3 to add tropospheric and stratospheric VCD maps.

- How are negative values treated in the new retrieval? Are there fewer negative values in SP3?

Due to measurement and retrieval noise we retrieve negative tropospheric VCDs over clean areas, while SCDs and stratospheric VCDs are always positive. Due to reduced SCDs in SPv3 there are slightly more negative V_{trop} values over clean areas (see PDFs in Fig. 2).
We retain all negative values in SPv3 products, so user can obtain unbiased estimates of the spatiotemporal averages of the data.

- Specific comments:
Figure 10. Please add error bars to the figure. It's difficult to interpret this figure otherwise.

We added error bars to all measurements in updated Figure 10.

- Technical Corrections:
-Page 9, line 23 Fig.3 should be Figure 3. If this is the first time it is referenced.

Done

-Page 12, line 1: I believe "North China Plane" should be "North China Plain", the caption of Figure 8. should be modified accordingly

Done