

Evaluation of version 3.0B of the BEHR OMI NO₂ product

Response to Anonymous Referee #2

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We thank the reviewer for their positive comments. We acknowledge that there is a large volume of information presented here, and believe that the suggestions we have incorporated should help make the major points more apparent to the reader.

Responses to specific comments follow. The reviewer’s comments will be shown in red, our response in blue, and changes made to the paper are shown in black block quotes. Unless otherwise indicated, page and line numbers correspond to the original paper. Figures, tables, or equations referenced as “Rn” are numbered within this response; if these are used in the changes to the paper, they will be replaced with the proper number in the final paper. Figures, tables, and equations numbered normally refer to the numbers in the original discussion paper.

Section 4. The comparison of VCD should include some scatterplots. Presenting the comparison as a table (Table 2) only is a bit difficult to follow. Especially, the results with separated Pandora and aircraft VCDs should be shown. Some of these plots could go in the supplementary material.

Scatterplots with separate aircraft and Pandora data were already included in the supplement. Figures S1-S6 show separate aircraft and, where available, Pandora comparisons for each of the 6 campaigns used for validation. We have added a figure showing scatter plots for the combined aircraft and Pandora data to the main paper (Fig. R1).

You use a quite precise spatial collocation criteria (pandora site within the OMI pixel, so no spatial smoothing in practice) and then you time average Pandora observations ± 1 h from the OMI observation, which is quite large time frame. Can you open a little bit about this choice? How does the results change with a shorter time interval?

The ± 1 h averaging is the same as done in Goldberg et al. (2017). Part of our reason for using that averaging window is to make our results comparable with that study. Given the average wind for cities where the DISCOVER-AQ campaigns took place (4.5 m/s, from WRF simulations), a shorter averaging time window, e.g. ± 0.5 h, might make more sense as this means an air mass would travel ~ 16 km, which is similar to the length of an OMI pixel at nadir in either dimension (13 or 24 km). However, no slope changes by > 0.05 (max $\sim 8\%$) using the shorter window, so we prefer to be consistent with Goldberg et al. (2017) so that readers can compare our results. We have added a sentence to sect. 4 explaining this:

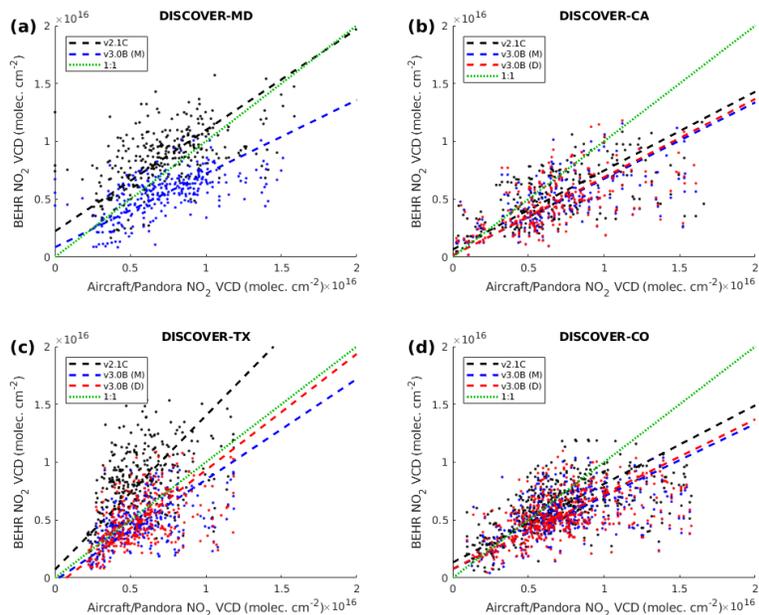


Figure R1: Scatter plots of the BEHR v2.1C, v3.0B (M), and (where available) v3.0B (D) VCDs against coincident aircraft and Pandora VCDs. All Pandora VCDs are used for these plots. Each panel is one campaign: the (a) Maryland, (b) California, (c), Texas, and (d) Colorado DISCOVER-AQ campaigns. For slopes, see Table 3; for intercepts and R^2 values, see Table S3.

“As stated in sect. 2.3, we average all data within 1 hour of OMI overpass (i.e. 13:30 local time ± 1 h) to be consistent with Goldberg et al. (2017). A shorter averaging window (± 0.5 h) was tested; the maximum effect on the slope was $\sim 8\%$ with most of the “matched” data showing differences of $\leq 5\%$ and the “all” data changing by $\leq 3.5\%$ in all but one case.”

You mention several times in the text that changes in emission information as input have a role in the discrepancies you observe between different versions of the algorithm. Could you actually show them? For example, plotting or mentioning the quantitative the emission changes over the areas of study.

While the emissions files used in the original BEHR product are no longer available, we have reproduced their likely value based on the description in Russell et al. (2011) and Russell et al. (2012) and added a figure to the supplement (Fig R2).

Fig. 1: the plot is quite small, it could be a bit bigger so that the the different lines can be better separated? Also, the legend can be shown only once.

We have done our best to enlarge this figure within the space constraints of the AMT template.

P12 L11 only Pandora data that has a coincident aircraft profile is include -i only Pandora

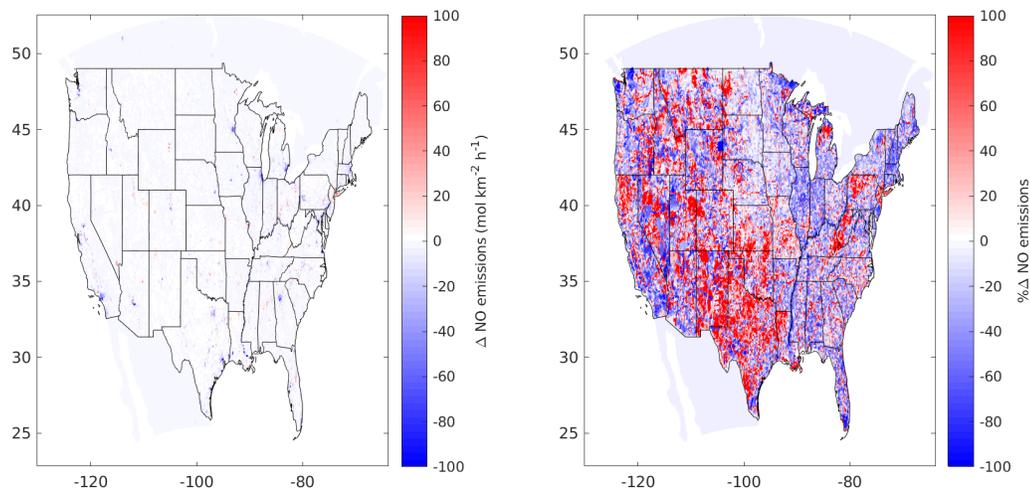


Figure R2: Absolute **(a)** and percent **(b)** change in WRF-Chem NO emissions between the EPA NEI 2005 inventory, unscaled, and the EPA NEI 2011 inventory, scaled to 2012 levels.

data that have a coincident aircraft profile are included
Corrected, thank you.

Conclusions P17 L12 I think you refer to Sentinel 4, as Sentinel 5 is not planned on a geostationary orbit.
Yes, thank you for the correction.

Figure 1 and 3: the different panels would benefit from a title mentioning the different sites considered in the plot
Added.

References

- Goldberg, D. L., Lamsal, L. N., Loughner, C. P., Swartz, W. H., Lu, Z., and Streets, D. G.: A high-resolution and observationally constrained OMI NO₂ satellite retrieval, *Atmos. Chem. Phys.*, 17, 11 403–11 421, doi:10.5194/acp-17-11403-2017, URL <https://doi.org/10.5194/acp-17-11403-2017>, 2017.
- Russell, A. R., Perring, A. E., Valin, L. C., Bucsele, E. J., Browne, E. C., Wooldridge, P. J., and Cohen, R. C.: A high spatial resolution retrieval of NO₂ column densities from OMI: method and evaluation, *Atmos. Chem. Phys.*, 11, 8543–8554, doi:10.5194/acp-11-8543-2011, URL <https://doi.org/10.5194/acp-11-8543-2011>, 2011.
- Russell, A. R., Valin, L. C., and Cohen, R. C.: Trends in OMI NO₂ observations over the United States: effects of emission control technology and the economic recession, *Atmos. Chem. Phys.*, 12, 12 197–12 209, doi:10.5194/acp-12-12197-2012, 2012.