Response to Reviewers for manuscript 'Inferring and evaluating satellite-based constraints on NOx emissions estimates in air quality simulations' (https://doi.org/10.5194/acp-2022-435)

We would like to thank the reviewers for their valuable comments. Below we address each of the reviewers' comments. Author responses are in blue. Line numbers refer to the track-changes version of the manuscript.

Referee comments

Lines 585-588: Nevertheless, the framework shows the potential to improve air quality model predictions using satellite-derived emissions updates, in particular for regions with highly uncertain emissions inventories. Are the authors suggesting that the uncertainties of emissions for polluted regions are more uncertain than in other regions here? I'm not sure about it since the uncertainty of natural emissions is large as well. Please cite a solid reference for such a claim.

We have modified the statement to be more specific and to include a reference to Elguindi et al. (2020). In that study, authors demonstrate that in regions where emissions factors and activity information are uncertain and in regions where emissions are rapidly changing, top-down satellite inferences provide an opportunity to complement uncertain bottom-up inventories and improve emissions estimates. Our study further demonstrates an improvement in air quality simulations with top-down emissions inferences.

Lines 573-574 now read: Nevertheless, the framework shows the potential to improve air quality model predictions using satellite-derived emissions updates, in particular for regions with uncertain emissions inventories or undergoing rapid emissions changes (Elguindi et al., 2020).

Uncertainty about using the early version of TROPOMI data. Thanks for including the additional 1-month assimilation. You may want to point out that the impact of changing the date version is limited if that is the case.

We have enhanced our discussion of the additional 1-month assimilation with updated TROPOMI retrievals. Lines 411-416 now read: *We conduct an inversion using the reprocessed TROPOMI NO_2 version 2.3.1 (Van Geffen et al., 2021) to infer NO_x emissions for January 2019, and find that the updated data increases the TROPOMI posterior inference by 17% over the U.S. and 4% in China relative to version 1.2.2. While using the updated retrievals shrinks the gap between OMI and TROPOMI inferred emissions, it does not change the overall trend of smaller posterior emissions using TROPOMI NO_2 (Figs. S10 and S11).*

References

Elguindi, N., Granier, C., Stavrakou, T., Darras, S., Bauwens, M., Cao, H., Chen, C., van der Gon, H. A. C. D., Dubovik, O., Fu, T. M., Henze, D. K., Jiang, Z., Keita, S., Kuenen, J. J. P., Kurokawa, J., Liousse, C., Miyazaki, K., Muller, J. F., Qu, Z., Solmon, F., and Zheng, B.: Intercomparison of Magnitudes and Trends in Anthropogenic Surface Emissions From Bottom-Up Inventories, Top-Down Estimates, and Emission Scenarios, Earths Future, 8, 10.1029/2020EF001520, 2020.