

## Responses to the editor

We thank the editor for her comments and suggestions. Each comment is copied below in blue, and our responses follow in black. Line numbers refer to the tracked-changes document.

1. In line with reviewer #2, I stumbled over the sentence (lines 94/95): "On average we obtain (mean  $\pm$  standard deviation)  $19346 \pm 13073$  observations per week over our full inversion domain ( $96^\circ$ – $110^\circ$ W,  $25^\circ$ – $38^\circ$ N), including  $95\ 3062 \pm 2314$  per week within the Permian itself (Figure 1)." This kind of description suggests that the distribution follows a Gaussian shape which, however, is not the case. Fig. 4 shows that you have considerably more observations per week on the lower end. I suggest to express the distribution with other statistical quantifiers like the 5% and 95% percentiles.

Thank you for catching this. We now express the distribution with the 5<sup>th</sup> and 95<sup>th</sup> percentiles (L.86-88).

2. Regarding Fig. 4, you replied to reviewer #2 (their item 3): "Figure 4 currently shows the number of observations and DOFS for each week; ...". I don't think this is correct. Currently, Fig. 4 shows how often a certain range of observation counts was made within one week. The reviewer's intention, however (as I understand), was to see how the inversion behaved in the case that several weeks with low observation numbers occurred. I cannot retrieve this information from Fig. 4 in its current state. I suggest that you, at least, describe if this happened (low observation numbers in several consecutive weeks), and how the inversion behaved in this case.

We now report the number of weeks between the 3 inversions with low DOFS  $< 0.5$  (45 and 7 weeks), and state that we did not observe these weeks consecutively (L. 240-241).

3. Related to this topic is your statement in lines 267 to 269: "The spread around the best-fit line is because the number of DOFS depends also on the absolute uncertainty of the prior emissions, which varies both spatially and temporally, and on the spatial sampling of observations across the inversion domain." I am not convinced that this is fully correct. I suspect that the smaller scatter for smaller observation counts is caused by stronger regularisation towards the a priori. Later you mention the smoothing error which is indeed helpful. However, you might want to re-consider your statement in lines 267-269.

Great point, thank you. We removed the sentence in question.

4. Finally, I have a small technical comment: In Fig. 4, x-axes with scales are missing for the number of observations and DOFs.

We added background grids to the histogram plots to clarify that they have the same axes as the adjacent scatter plot.

In addition to these changes, we made 6 more minor edits:

1. Updated the TROPOMI version retrieval number from “2.2.0” to “02.02.00” as reported in the TROPOMI user guide (L. 84)
2. Updated Figure 6 to include the fifth sensitivity inversion from Figure 3.
3. Updated the caption of Figure 9 to explain why we exclude the fifth sensitivity inversion from that plot (L. 513).
4. Specify that the EPA inventory used by Lu et al. (2023) is spatially biased (L. 518).
5. Added a competing interest statement that co-author Ilse Aben is on the ACP editorial board.
6. Updated the Lu et al. (2023) citation since that paper is now published.