

## Reviewer #2 response

*We thank the reviewer for their thoughtful comments, which have improved this paper. Please find our responses below in blue.*

- Line 185-187. This line needs more evidence, as without an averaging kernel this retrieval seems to be too heavily reliant on strong vertical mixing to be able to detect these species. These species are likely not most sensitive at the surface so any location with a high P90 value is probably missing a significant amount of information.

*In these lines we are simply stating that the P90 gives us a compact (i.e. succinct) way to represent the dependence of the HRI-column relationship on the height of the absorber in our retrieval framework. The reviewer is correct that the sensitivity will be decreased when the P90 value is high (i.e. closer to the surface), but this is reflected in the lower HRI values for a given column amount under these conditions. We have changed the word “captures” to “accounts for” in case the former word overstates our ability to remove uncertainties associated with vertically-dependent sensitivity and mixing.*

- Following the previous comment, it would be helpful to explain how the P90 is applied from the GEOS-Chem grid to match the gridded HRI values. This would likely create problems in regions with strong elevation gradients or strong emissions sources.

*The GEOS-Chem simulations employed in our analysis are at  $2^\circ \times 2.5^\circ$  resolution, so we use the closest gridbox to match the P90 with the corresponding gridded CrIS HRI. We have added some text to Section 3.2 to clarify this. We agree with the reviewer that using a P90 from a coarser simulation will lead to some errors in the vicinity of strong gradients and/or localized sources. We have added text to Section 5 to note that this is something to consider in our model-measurement comparisons, and note that higher-resolution simulations would yield finer-scale information in future studies.*

- Section 4 could explain more how the NDACC measurements are synced to the CrIS overpass time. Also, are the concentrations being compared via the 1 grid cell that contains each site? If so is there any meteorological screening applied to avoid abnormal conditions? Needs to be explained more thoroughly.

*Yes, the FTIR data are compared to the CrIS data for the gridbox containing the FTIR site. We have updated the text to note this. We do not apply any meteorological screening to the comparison, but neither dataset includes measurements under cloudy conditions.*