Thanks for your very helpful comments and suggestions. Please find below our answers for each general and technical comment. Just to clarify, we didn't use CO observations from Amazon vertical profiles in our inversions. For CO inversions using TOMCAT model we used MOPPIT data.

General Comments.

1.The model setup needs to be described in more detail to help readers visualize the experiment setup. The spin-up used for simulations, and any other relevant details should be provided. Additionally, since vertical profiles are being assimilated, discussing and providing validation plots regarding vertical transport would be beneficial. It is important to consider how much uncertainty in vertical transport might affect the results. The uncertainties and impacts associated with the coarse resolution of the inversion on the results should also be discussed. Additionally, it would be useful to know if all sites used in the inversion have full data coverage or if some have discontinuous data. The information on the data period should also be included in Table A1.

Authors: As with all CO_2 inverse model studies, our ability to assess and quantify flux uncertainties associated with transport errors is very limited and still represents a major deficit in our field. Nonetheless, we appreciate the reviewer's concern and point out the following:

- A previous study with simulations of sulfur hexafluoride (SF_6) and other species comparing different transport models investigated some of the large-scale transport characteristics (Patra et al., 2011), and shows that TOMCAT in general performed well slightly overestimating the SF_6 inter-hemispheric gradient compared to observations, but within the bounds of other transport models. We included this point in the text (lines 159-162):

"A previous study with simulations of sulfur hexafluoride (SF_6) and other species comparing different transport models investigated some of the large-scale transport characteristics (Patra et al., 2011), and shows that TOMCAT in general performed well, slightly overestimating the SF_6 inter-hemispheric gradient compared to observations, but within the bounds of other transport models."

- We've performed cross-validation analyses using tall tower (data from ATTO tower) and aircraft data from the Amazon Basin (vertical profiles near Manaus, MAN), not used as observational constraints on CO_2 flux. The figure A 17 and A18 shows the monthly mean bias between model (prior or posterior) and the ATTO observations. Measurements from ATTO are hourly and here we used the daily mean based on the measurements between 13h-17h UTC. Although the ATTO tower measurements were for 80m height, in general we found a good agreement between model and observations, with a reduction of the bias after the inversion from 0.9 (range of -3.9 to 7.7) ppm to 0.3 (range of -5.3 to 4.7) ppm (t-test: $p < 0.05$). We highlight that the ATTO timeseries started in 2012, but the measurements in the first two years have some gaps to constrain the monthly means. Also, for the year 2015 we remove from the comparison the months without vertical profile data assimilated in the inversion. In addition, we compare the model concentrations to the aircraft vertical profiles in MAN above 3.5km and below 1.5km, as showed in the figure below. The data record for the same period of our inversions is short (MAN vertical profiles data are available for 2017 and 2018), but in general we found a reduction in the bias between model and observations after the inversions (for the mean below 1.5km height: from -0.3 [-6.5 to 6.6] ppm to 0.2 [-4.3 to 5.0] ppm and t-test: $p = 0.17$; and for the mean above 3.5km height: from -0.1 [-3.1 to 2.1] ppm to -0.4 [-1.9 to 0.5] ppm and t-test: $p = 0.13$). We also found a reduction on the mean bias of the difference between the mean below 1.5km and the vertical profile free troposphere (from -0.2 [-5.4 to 7.6] ppm to 0.6 [-4.2 to 5.6] ppm and t-test: $p = 0.08$). We added in the text a new topic to discuss the comparison with the independent measurements (subsection 3.4) and the figures below in the Appendix (figures A17 and A18).

- Regarding the uncertainties due to the coarse resolution, we have not formally investigated how spatial resolution affects uncertainties of flux estimates and it would exceed the remit of this study. Independently with regards to spatial resolution of the transport model underlying the inversions: it is not clear whether a resolution which exceeds the spatial density of the data will reduce uncertainties. Previous CH_4 inversion estimates using TOMCAT model with inversions at 2.8° and 5.6° resolution and with GOSAT data (Wilson et al., 2021), and the authors reported that the results were robust at both resolutions. Also, we previously investigated the effects of resolution in the inversions and the authors found that they are smaller than the observation uncertainty in most cases (Wilson et al., 2014). We included this point in the text (lines 164-166):

"Although we did not investigate the uncertainties of the coarse resolution in our estimates, previous CH_4 inversion estimates using TOMCAT model with inversions at 2.8° and 5.6° resolution and assimilating GOSAT data showed that the results were robust at both resolutions (Wilson et al., 2021)."

We have quantified and documented the uncertainties of the approach, with uncertainties including representation uncertainty, which in our view is key for this study.

2. It is not clear whether the inversion is performed globally or regionally. If it is performed globally, it would be useful to compare the simulated growth rate with the observed global growth rate as a metric to test the modeled growth. (e.g., Fig. 5d in Chandra et al., 2022: https://acp.copernicus.org/articles/22/9215/2022/).

Authors: We add in line 164 the information that the inversion was done globally:

"The forward and adjoint model simulations were carried out globally at 5.6° x 5.6° horizontal resolution, with 60 vertical levels up to 0.1 hPa."

We also include a comparison between our global monthly mean mole fraction based on posterior flux and the NOAA monthly mean mole fraction from marine surface sites (Figure A1 and lines 313-315).

"Estimated posteriori CO_2 mole fractions have a similar magnitude and positive trend as seen in the observed, also for the global posterior mean mole fraction which follows the global increase in CO_2 global mean observed mole fraction (Figure A1)."

3. The author used the same profiles used in the inversion for the evaluation of atmospheric inversion. However, evaluating the inversion using independent observations not used in the inversion, e.g., HIPPO, AToM, CONTRAIL, or other regular aircraft measurements from other campaigns, would be more rigorous.

Authors: As discussed in the previous comment (please see above discussion), we have performed cross-validation analyses using tall tower (data from ATTO tower) and aircraft data from vertical profiles in Amazon region (MAN), not used as observational constraints on CO_2 flux. We added in the text a new topic to discuss the comparison with the independent measurements (subsection 3.4) and the figures A17 and A18 in the Appendix.

4. It is unclear which fire emissions are used in the calculation. For example, in line#165, it is mentioned that the fire emissions are optimized in the CO2 inversion estimate. Then, Section 2.2.3 discusses the optimization of carbon fire emissions from INVICAT using MOPITT CO. It *is unclear whether these two are independent or the same. Additionally, it is unclear which fire emissions are used in the calculations of the Amazonia carbon budget. A comparison plot of prior and optimized BB will be helpful to visualize the correction in BB emissions.*

Authors: In our CO_2 inversions we estimate the total CO_2 fluxes, we didn't split the CO_2 emissions in NBE and fire using the CO_2 prior fluxes. For estimate the carbon emissions from fires for the Amazon carbon budget we use carbon fire emissions from the optimized CO total flux from INVICAT using MOPITT CO as described in the methodology. These inversions (CO_2 and CO using TOMCAT/INVICAT) are independent. Also, in the CO inversion was not assimilated any vertical profile data in the Amazon region. We added this information in the text to make it clear (lines 111-113, 240-243).

"We also estimate carbon emissions from fires to constrain the Amazon carbon budget using flux estimates from an independent global inverse modeling based on atmospheric carbon monoxide (CO) measured from space, and relate the carbon fluxes (total, fire and NBE) to climate controls."

"To estimate the contribution of biomass burning emissions in Amazon total carbon emissions, we estimated carbon fire emissions with an independent inversion with TOMCAT/INVICAT by assimilating total column carbon monoxide (CO) values from MOPITT radiometer data (V8) on the TERRA satellite (Deeter et al., 2019) globally. Note, that in this inversion was not assimilated any vertical profile data for the Amazon region."

Technical Comments

1. At line#231, the biomass burning emission ratios are given as 16 ppm CO/ppm CO2. IS the unit correct (or ppb/ppm)? And this number is not found in the cited reference.

Authors: Thanks for point this. The units of both CO and CO_2 are correct in ppm, but should be 16 ppmCO_2/ppmCO. We correct that in the text. We decided to use both (CO and CO_2) in the same unit to make easy for the reader. The reference of this number is also correct, since we calculated a mean of the emission ratios reported by Gatti et al. (2021) for each one of the four sites (ALF CO:CO2 = 53.4 ± 9.9 (1σ variability); SAN CO:CO2 = 55.5 ± 14.7; RBA CO:CO2 = 73.2 ± 15.1; and TAB_TEF CO:CO2 = 71.6 ± 17.2, which gives a mean of CO:CO2 = 63.425, which translates into (1000/63.425) = ~16 ppmCO2/ppmCO.

2. The country boundaries in Figure 1 make it too messy. It would be better to remove the country boundaries and include the mask of the Amazon. Including the abbreviation of site names would also be helpful.

Authors: We edited the figure as the reviewer suggested. We add a blue contour for the Amazon area based on Eva and Huber (2005) and the Amazon sites labels. We didn't add the labels for all NOAA stations because will be a lot of information and make harder to read. We also corrected the position (latitude and longitude) of few stations that was wrong in the submitted version of the paper.