Dear anonymous referee#1,

The authors appreciate your constructive comments. We would respond to the reviewer's comments as follows. The reviewer's comments are written in *Italics* and the corresponding author's response is followed. The modified or added parts in the manuscript are highlighted in red.

Best regards,

Yu Someya

I wonder if the forward radiative transfer model has been updated since Yoshida et al. (2011). If so, please provide some discussion on that aspect of the algorithm.

There are no updates for the radiative transfer model from Yoshida et al. (2011). If you mean the radiative transfer model is replaced with that used in the GOSAT-2 retrievals, that is not done.

Figs. 1-4: can the authors clarify if the residuals shown here were calculated before or after the post-processing quality control? Also, can the authors provide some metrics (other than visual inspection) based on which conclusions were drawn, for example, on the fitting quality for V2 and V3 in lines 160-165?

The averaged residuals shown in the figures are calculated from the scans after post-screening. The sentence was modified as follows.

Line 155: Figure 1 shows the averaged spectral residuals after the post-screening at each sub-band obtained in April 2009 and April 2020 over land from V02.90.

You may have reviewed the manuscript before addressing technical comments against the submitted version of the manuscript. The root mean squares of the averaged residuals are shown in Table 4 and that is mentioned in line 165 – 167. Here, we conclude that the RMSs are reduced except for the SCO_2 sub-band over the ocean.

Can the authors provide more thorough analysis on the potential causes for the residuals in the strong CO2 band? Also, what measures are being considered to mitigate the negative bias in xCO2 over the ocean?

The residuals in the SCO_2 sub-band are probably due to the inconsistency of baseline between the old and new solar irradiance spectra. The figure of solar irradiance spectra is added to supplementals and the summary of the sensitivity test retrievals are added as Appendix A. The following statement is added to the body text.

Line 182: This is introduced by the update of the solar irradiance spectra because there are some inconsistencies in the spectral baseline between the old and updated spectra particularly in Band 3 (see Appendix A and supplementals).

Line 187: Therefore, we need to precisely evaluate the calibration data such as obtained in the Railroad valley campaign using the updated solar irradiance spectra to improve the fitting accuracy especially on the SCO_2 sub-band.

Figure 6: can the authors elaborate on what may have caused the changes in these parameters, in particular, AOT? Is there a time dependence in these changes?

The summary of the sensitivity test retrievals is added as Appendix A in order to investigate the effect of each update. The temporal trends of the monthly averages of the retrieved ancillary parameters are added as Fig. 10. Based on Appendix A and Fig.10, the following sentences are added to the body text.

Line 237: Although the updated items do not independently affect the retrieval results and it is difficult to evaluate separately, the large causes of the change in the retrieved ancillary parameters are as follows from the sensitivity test retrievals (Appendix A). Temperature shift is increased globally by the update of the gas absorption coefficient tables. Surface pressure seems to be impacted by the replacement of solar irradiance because ΔPs was changed by this update over land. The changes in surface pressure should contain two effects. One is the direct impact of the change in spectroscopy on the O_2 A sub-band. The other one is the impact through the change of XCO_2 introduced by the inconsistency of the spectral baseline in the SCO_2 sub-band. The behaviors of changes in AOT differ for land and the ocean. The changes in AOT are mainly affected by the addition of cirrus properties to the state vector over land. On the other hand, those over the ocean seem to be affected multiply by the updates. Figure 10 shows the time series of the ancillary parameters. V02.90/91 has a long-term temporal dependency on the retrieved surface pressure overland, temperature shift, AOT over the ocean. The pointing system of TANSO−FTS was switched from the primary system (PM−A) to the backup system (PM−B) on January 26, 2015. The trends differ for PM−A or PM−B, and they are larger in PM−A. For V03.00, those in surface pressure and AOT almost disappeared whereas that in temperature shift remains in PM−A.

Figure 9: can the authors provide some details on how the differences were calculated between in situ measurements and GOSAT? In particular, given that the surface and airborne in-situ measurements can be quite different, what measures were taken to ensure that a coherent time-series can be constructed?

The trends shown in Fig.13 in the revised manuscript are calculated by the monthly averaged CO_2 concentrations for each area from GOSAT and the in situ measurements. One plot corresponds to the difference/month/area/platform. We did not perform the specific operations to consider the differences between the platform and the averages of the observed data are directly compared. In case we investigate the spatially and temporally detailed comparisons, the analysis using the transport model should be needed. In this manuscript, we did not use the models because we estimate that the decadal growth rates for all the latitudes show similar trends even by the different platforms. The following sentence was added to the body text.

Line 320: The monthly averaged values in each area from GOSAT and the in situ measurements are directly compared to investigate the difference in the decadal growth.

Line 282: can the authors provide some details on how the growth rate were derived from a noisy time series (and the uncertainties of the growth rate)?

The differences in the decadal growth are simply estimated by the least-squared linear regression using the scatter plots shown in Fig. 10. The following sentence was added to the body text. In addition, the standard deviations were

also added to the estimated differences in the decadal growth.

Line 323: The trend is estimated by the least-squared linear regression from the scatter plots.