Firstly, we apologize for any misunderstanding in our response to the previous reviews. In this revision, we have tried to make sure that we have clarified any uncertainties in the manuscript and responses. We thank the referees and editor for their patience, as well as their comments.

Following the correspondence about my review I have analyzed the whole discussion to find the origin if our misunderstanding regarding General point 2 of my review, which had to do with the impact of the scaling of the tropospheric and stratospheric sub columns that is applied.

In my opinion the discussion is confused because the authors do not distinguish between the following:
1) The contribution of the modelled tropospheric sub column to a bias in the total column averaged mixing ratio
2) A bias in the modelled tropospheric sub column averaged mixing ratio

If scaling is applied [as mentioned in the caption of figure 3] this is appropriate for 1) but not for 2). However, in the language that is used in the paper there is no distinction between 1) and 2). In many instances the language suggests 2) [e.g. in the abstract: 'the tropospheric model biases show a latitudinal gradient for all models'], referring to numbers that are derived using the scaling method, which doesn't apply to that case and therefore causes confusion.

Following these comments we have modified the text (highlighted in red color) to clarify if we refer to 1) or 2). We refer to the tropospheric partial column of CH_4 only in Figure 3 where we want to evaluate the contribution of the modelled tropospheric partial column to a bias in the total column-averaged mole fraction. At all other places the tropospheric column-averaged mole fraction is used, e.g. the vertical gradient in Figure 4 and the FTS and HIPPO case in Figure 6.

Special care should be taken when comparing results of 1) to comparisons of the model with in situ data. In situ data can only represent local CH4 mixing ratios. If they are compared to 2) this is problematic already because of the vertical gradient in the troposphere as pointed out by the coauthors. However, they cannot be compared to 1).

We are aware that the results of 2) can not be directly compared to the results of 1). In Figure 4 we qualitatively represent the vertical gradient of CH_4 in the troposphere as the difference between the tropospheric column-averaged mole fraction and surface mole fractions. The vertical gradient is shown to reveal the possible reason for the latitudinal dependence in the model biases of the tropospheric column-averaged mole fraction. In the previous discussion there is much concern on how the scaling approach influences the latitudinal gradients. The following Figure shows the latitudinal distribution of the model biases in both the tropospheric partial column and column-averaged mole fraction.

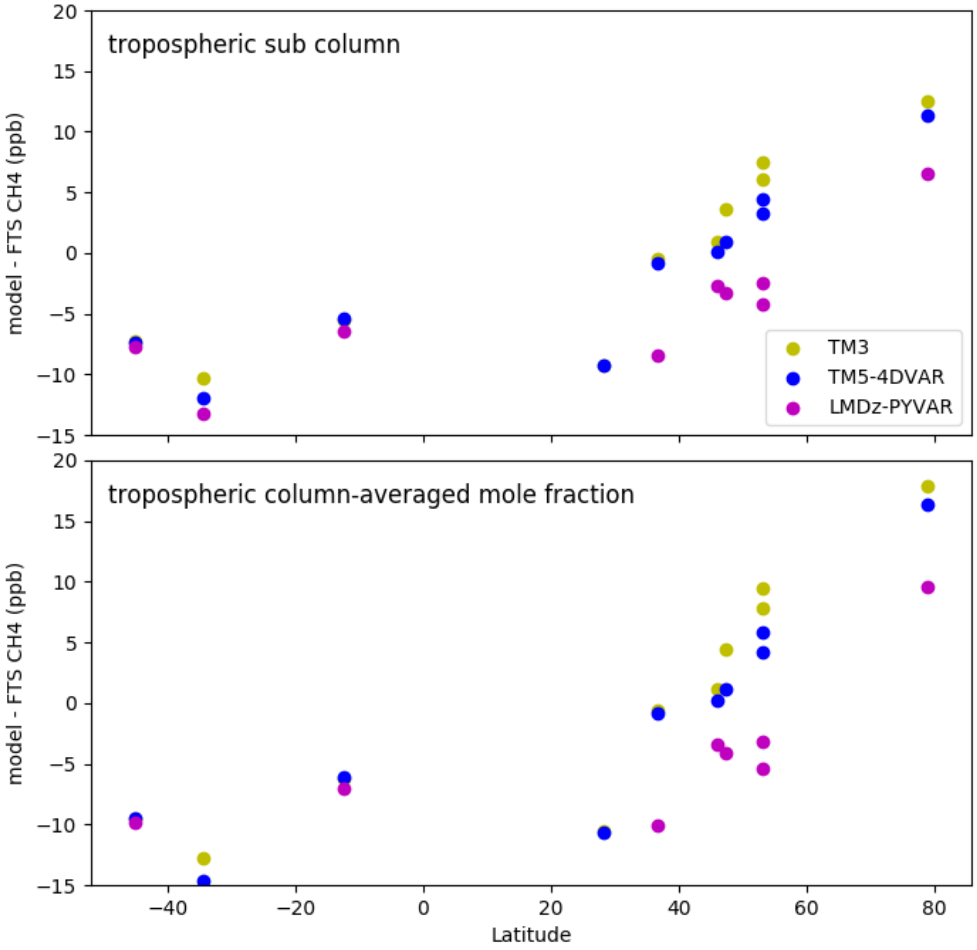

Figure R1. Latitudinal dependences of yearly averaged model biases in the tropospheric sub column (upper panel) and the tropospheric column-averaged mole fraction (lower panel). The three models are represented by Yellow (TM3), Blue (TM5-4DVAR) and Purple (LMDz-PYVAR) respectively.

In my original review I tried to explain this point using an example of how the mixing up of 1) and 2) could go wrong: "According to the caption of Figure 3, the tropospheric and stratospheric model biases are scaled with the corresponding contributions of the troposphere and the stratosphere to the total column air mass. However, there is a danger in doing so. Suppose that the model had a latitudinally and seasonally uniform offset in the tropospheric concentration. Then the scaling with the seasonal and latitudinal varying tropopause pressure would introduce a seasonal and latitudinal variation in the bias >>here I meant in XCH4<<. In that case, when you look for varying biases within the troposphere in comparison with in situ data you wouldn't find any. This is exactly what seems to be happening here."

Previously we did indeed misunderstand the meaning of this comment. It is possible that the tropopause variation could cause latitudinal dependence in the model biases of the XCH4. However from the results in this study the latitudinal dependence of the model biases does not mainly come from the tropopause variation (see Figure R1).

A good way (and even necessary I would say) way to analyze whether or not the troposphere has a latitudinal/seasonal bias would be to assess the bias between the model and the tropospheric columns derived from TCCON (e.g. in a way similar to what is done in Figure 3, but for tropospheric columns and therefore without scaling).

The suggestion is exactly what we have tried to implement in Figure 3. The scale factors are used to convert from the FTS measured tropospheric column-averaged mole fractions to the tropospheric partial column.