Dear Mr/Mrs,

We thank the referee for the constructive comments and helpful suggestions to improve this manuscript. We respond to each of the review comments. The original comments made by the reviewer are numbered and typeset in italic font, whereas our response is printed in normal format.

1. *In Section 1 in the second paragraph, you mention how aircraft can be used to make measurements of CH4 vertical profiles, which I inferred to mean via in situ sampling. However, it would also be prudent to note that recent advances, such as the ARIES instrument on the UK's Atmospheric Research Aircraft can also retrieve profiles as well as total columns of CH4 using remote sensing techniques.*

We added ARIES with corresponding reference to our description on aircraft measurements of CH_4 in the second paragraph of section1.

2. *In Section 1 in the final paragraph, you talk about DOFs and information content as if they are two separate entities (Which they can be). However, the context in which you use them in the paper is the same, and this sentence is misleading. Having read this I was expecting further comments on the information content (e.g., Shannon information content etc.) of the measurements rather than simply the DOFS.*

To make it that clear the information content we discussed is different from the Shannon information content, we specifically added in the context that the information content is "characterized by the DOFs".

3. *In Section 1, in the final paragraph you mention the over-constraint in the GOSAT retrieval algorithm without reference, do you mean in terms of comparison to AIRS? This needs to be clearer.*

Yes, according to the intercomparison, including the comparison of DOFs with AIRS. We

infer that there may be over-constraint in GOSAT retrieval algorithm.

4. *In section 2.2 you do not mention how much of the globe is covered on a daily basis by the GOSAT instrument, as you did do for the AIRS instrument. I would advise including this to aid in the comparison.*

We added more detailed description on GOSAT and instruments in the context.

TANSO-FTS on board GOSAT makes global observations, including both nadir and off-nadir measurements, of approximately 56,000 ground points every three days.

5. *In Section 3.2 you mention that the AIRS a priori is 'simple' what do you mean by that ? Simple in comparison to what?*

We modified the sentence as "the first guess of AIRS is simply a regression-based function of latitude and longitude". Compared to the use of model data as the priori in GOSAT retrievals, it is easier/simple to use the AIRS AK and first gases to smooth GOSAT data.

6. *In Section 3.2, in the last sentence of the second paragraph you claims that the RMS difference to the error of the chi-square ratio, combined with the correlation coefficient indicate good consistency. Why is this the case? You need to provide evidence (e.g. from another study) to indicate why these figures are supportive of your claims.*

Since it is hard to get the common xc, Sc, the a covariance matrix S_{AIRS} and $S_{GOSAT,}$ we used the Averaging Kernel and first guess of AIRS CH4 to calculate a smoothed version of GOSAT profile based on Eq.(4), where we treated GOSAT profile as the true profile. Then we calculated the difference between AIRS profile and the smoothed version, and the chi-square. And the correlation coefficient R^2 between RMS differences and chi-square is 0.51. So we think they have good consistence

7. *I think that there needs to be a larger discussion in Section 3.2 about the nature of smoothed*

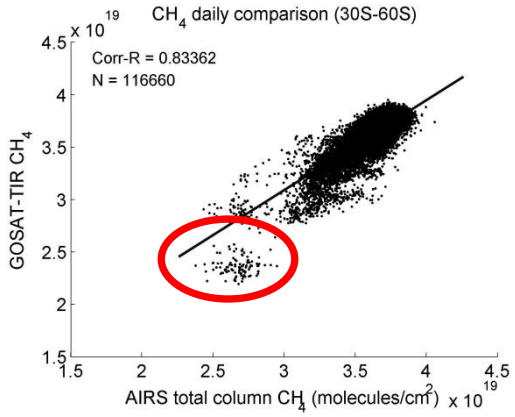
profiles and retrieved profiles vs. the truth. For example, how does this study tell us which of the products is closer to the absolute truth? I know that it doesn't, and that the future aircraft validation study will show this, but this needs to be made clear. What this study is doing is showing how similar two retrieval products are to one another, however there is no guarantee that either one is correct, and this should be mentioned.

We added it in the start of section 3.2

Since the comparison made in this study is to show how similar two retrieval products are to one another, it is important to take into account the skill of the CH_4 retrievals, which is usually made by applying the averaging kernels. This comparison cannot tell us which of the products is closer to the absolute truth, which is the work of validation through comparison with the future aircraft data.

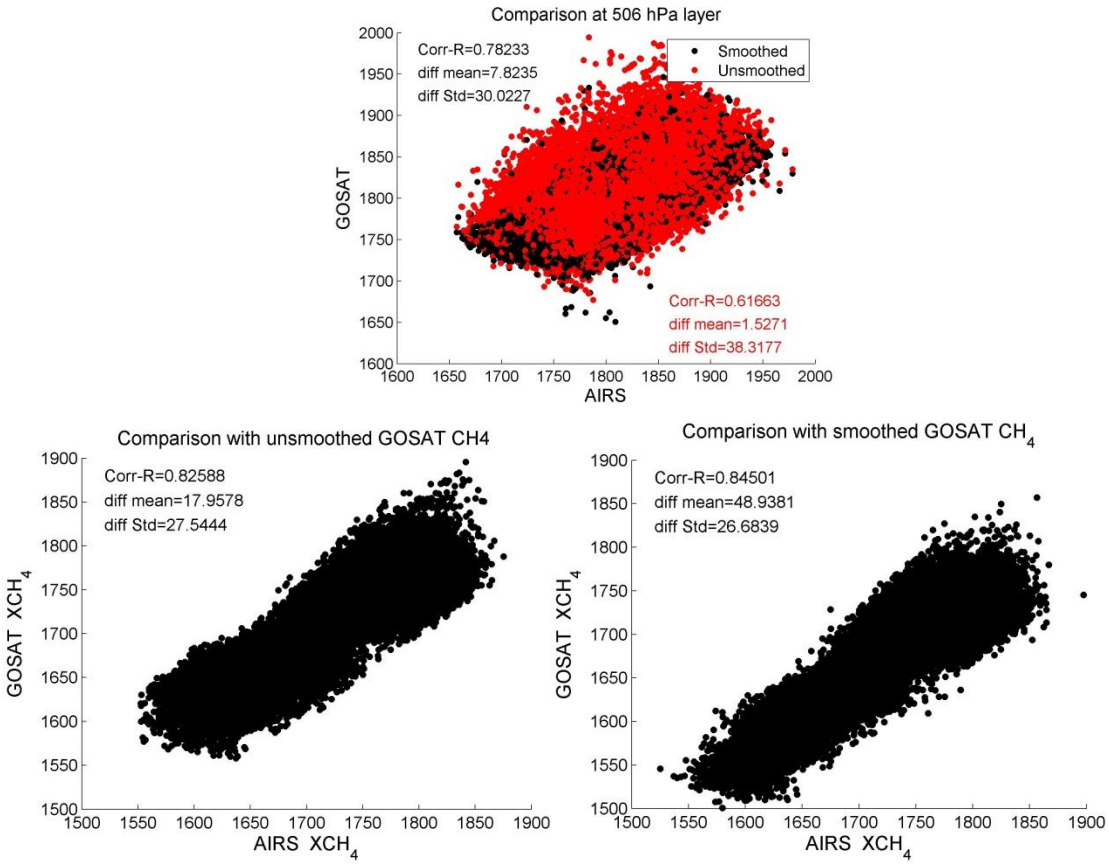
8. *In Section 3.3 you talk about the least correlated case, but you make no comment on why the data in Fig. 9 and 10 look like they do. You need to provide further comment and possible explanation for some of the inconsistencies in the data. For example, in Fig 9 why is the daily comparison if CH4 in the 30S – 60S region split like it is? Exploring these differences and similarities further may even yield more information as to why the retrievals differ in certain situations.*

Examination to the outliers in the red circle shows these data are located in the high mountain between Chile and Bolivia in South America. The difference of seasonal variation of CH_4 in 30-60 S between AIRS and GOSAT is significantly reduced after removing these data. This reflects that a larger uncertainty in the mountain or coastline regions for AIRS, or GOSAT, or both of them. Also we recognized in 30-60 N the seasonal variation is relatively small shown in Fig.12, and it looks large in that plot for 30-60S is because the range of y-axis we plotted is much smaller. To avoid miss-leading, we replot this figure and use the same y-axis range with 30-60N.



9. *In Section 3.3 and Section 4 I am unsure as to why you did not also compare the AIRS-smoothed GOSAT columns with the AIRS columns of CH4. Having laid out the rationale for doing so with the profiles in Section 3.1, you then ignore this for this part of the study. I think that it would be very constructive to compare these 'like-for-like' differences with the ones that you already have, as again it may reveal further information about the differences in the retrievals. At the moment any real differences are masked by the differences in the retrieval algorithms and DOFs.*

Based on this suggestion, we tried to use AIRS averaging kernels to smooth GOSAT CH4 profiles (2010.Aug~Sep), then compared the CH4 total columns calculated from the smoothed GOSAT profiles with AIRS. We found that, not like the comparison in the most sensitive layer that shows the difference is much smaller and correlation is much better using the AK smoothed profiles, the total column using the smoothing is just slightly better than without smoothing. This is understandable since the amount of CH_4 in the troposphere constitutes most of the total column, but both AIRS and GOSAT FTS have little sensitivity in the troposphere. Here, we can show the comparison of smoothed GOSAT data to AIRS using two months' data. Considering the smooth with AIRS averaging kernels make little difference comparing to the unsmoothed data, we did not add smoothed total columns in section 3.3 and thereafter.



10. *In Section 4 in the last sentence, you say that there are a lot of data points with a very low total column of CH4. Is this for AIRS,GOSAT, or both?*

There are many data points from both AIRS and GOSAT-TIR with very low total column of CH4. We added it in the context

11. *Further comment is needed on some of the differences in Figure 12, especially the lag in peak column amount seen in the 30-60S plot at around July- October. In relation to the above point, this may be because the retrieval algorithms are doing something wildly different here, for example the way that they treat sea ice.*

We checked the data, and it was found the large difference is in the high mountain or the coastline in South America near Chile.

12. *There is absolutely no mention of retrieval errors. It would support your findings to see how*

the differences compared to the errors of the retrievals, and also how the errors of the two products compared.

We added some description of AIRS-V6 validation results. Comparing results with aircraft profiles show that the mean biased of AIRS CH4 at layers 343-441hPa and 441-575 hPa are -0.76% and -0.05%, and the RMS errors are 1.56% and 1.16% respectively.

In order to show whether the differences between GOSAT and AIRS CH4 retrievals are consistent with their error characteristics and vertical sensitivity, we used formalism in Rodgers and Connor (2003) to calculate the RMS differences and error chi-square, showed in Fig.6.

13. *All of the graphs need correct labels on all of the axes please.*

According to revision comments, we have modified all the graphs.

Technical Corrections:

Texts have been revised following referee's comments.

A copy of the manuscript with tracked change as well as a clear version is submitted.

Best Regards,

Mingmin Zou and all co-authors.