

## **Review of “Satellite observation of atmospheric methane: intercomparison between AIRS and GOSAT TANSO-FTS**

This paper describes a useful comparison between AIRS and GOSAT TANSO-FTS CH<sub>4</sub> retrievals. Neither instrument has great sensitivity to surface levels of CH<sub>4</sub>, and thus cannot provide direct information on CH<sub>4</sub> sources and sinks. However, monitoring the free troposphere levels of this important greenhouse gas is vitally important for evaluating its role in climate change. Different instruments provide different perspectives and sensitivities, and thus estimates of the uncertainty in the retrieved species.

The paper is well organized and includes useful and relevant figures, but needs further work, both to expand and clarify some sections, and to correct numerous problems with wording and plots.

### **Content comments:**

The authors state that since AIRS CH<sub>4</sub> has already been validated and cite Xiong et al. (2015). It would be helpful to the reader if they briefly summarized the validation results, in order to provide context for the AIRS TANSO-FTS comparisons.

A reference and a brief definition of the AIRS cloud clearing would be helpful.

Orbit information on GOSAT should be included, as it was for AIRS.

A companion difference plot to Figure 2 would be helpful.

Provide equation 14 from Rodger and Connor, and explain why the RMS and chi\_square results indicate good consistency.

The authors compare the AIRS and TANSO-FTS level mixing ratios and column averaged mixing ratios using the Rodgers and Connor approach, state that the differences are smaller when the smoothing is applied, then decide not to smooth the data in the rest of paper. This seems rather pointless; the fact that the smoothed results are in better agreement is not surprising, as this process removes, or at least reduces, various sources of difference (vertical sampling, different a priori, different constraint). As another reviewer 1 has already stated, it would be much better to show all results using both methods.

More detail on obtaining the total column for the TANSO-FTS should be provided, as using surface pressure alone is not sufficient.

The comments on the source of the uncertainties over the high southern latitudes need to be justified. When does the snow/ice coverage peak? Are the data south of 60S taken mostly over ocean? What do the authors think is the source of the differences between AIRS and TANSO-FTS at these latitudes? Surface emissivity? View angle? Different a

priori? Given the low DOFS the latter is probably very important, and the Rodgers and Connors approach would probably show this.

**Specific comments:**

Page 10550

Line 9: The results show that between 300-600 hPa ...

Line 15: in the tropics

Line 20: and the instruments themselves...

Line 22: than that of AIRS which also ...

Line 27: in most periods and regions.

Page 10551

Line 1: long life greenhouse gas

Line 7: Mainly due to ...

Line 13: at limited stations.

Line 17: measurements of CH<sub>4</sub>

Page 10552

Lines 4-15: Rewrite with more information on Xiong paper.

Line 26: noise equivalent differential temperature (NedT)

Page 10553

Line 1: ranges from 0.14 K at 4.2  $\mu\text{m}$  for the lower tropospheric sounding lengths, to 0.35 K at 15  $\mu\text{m}$  for the upper tropospheric sounding region.

Lines 15-16: water vapor profiles are retrieved using appropriate channels in previous steps.

Lines 16-17. Thus the quality of the CH<sub>4</sub> retrievals depends directly on the quality of the retrieved temperature and moisture profiles, as well as on the surface temperature and emissivity products.

Page 10554:

Line 10: in the 7-8  $\mu\text{m}$  band...

Line 27: errors resulting from the time ...

Page 10555

Line 1: ..., since CH<sub>4</sub> has a long residence time and is a well-mixed gas

Lines 5-22: I think that this information would be more useful if placed directly in the relevant sections.

Page 10556

Line 1: Figure 2...

Line 2: from one day of global data (September 4, 2010)

Line 7: ...kernels provide

Line 9: Don't you mean rows instead of columns (see Rodger, 2000, page 47)

Page 10558

Lines 25-27: at high latitudes

Page 10559:

Line 1: GOSAT-TIR

Plots

Figure 2: Add second panel with difference

Figure 3: Add legend for pressure levels; use same pressure range, thicker lines.

Figure 4: Vertical axis is wrong

Figure 6: X-axis name? Still one day of data?

Figure 7: smoothed and unsmoothed data ? One day of data?

Figures 9 and 10: How are the differences defined :  $(\text{AIRS-TANSO})/\text{AIRS}$  or something else?

Figure 11: 15 degree zonal means of relative error

Figure 12: Time series of 15 degree zonal means monthly averages ...