

## Reply for Referee#1

The quality of the paper improved considerably after revision. I recommend publishing subject to technical corrections:

Thank you very much for reviewing our manuscript carefully. We corrected the words and sentences along your following notes. Some comments were answered individually.

P1,L1: cloud -> clouds

P1,L5: with -> with the

P1,L6: cycle -> repeat cycle for a pointwise geolocation pattern

P1,L11: providing -> enabling

P1,L12: retrieval -> retrievals

P1,L16: the optical thickness of cirrus clouds -> the optical thickness of regularly observed cirrus clouds

P1,L16: Despite ... clouds, -> (remove)

P2,L4: cloud -> clouds (P2, L3)

P2,L10: but has -> but it has (P2, L9)

P2,L16: signal of -> signal of the (P2, L15)

P2,L17: channel -> channels (P2, L16)

P2,L18: test -> tests (P2, L17)

P4,L31(?strange line numbering): is absent -> are absent (P3, L30)

P4,L4: is observed -> is indicative (P4, L2)

P4,L29: meanl -> mean (P4, L26)

P5,L35: at the out of the band-pass filter-> in the out-of-band-pass range (P4, L31)

P6,L1: (2x) shorted -> sorted (P5, L27)

P6,L9: middle latitudes -> mid-latitudes

P6,L24+25: Table1-> Table 1

P7,L14: observation has -> observations have (P7, L15)

P8,L29: avoid error contamination -> avoid contamination (P7, L30)

P8,L32: covers to detect -> covers (P8, L2)

P9,L32: retrieval value -> retrieval (P8, L33)

Fig 1: schematics of spectral shape -> schematics of the radiative transfer effects

Fig 2: mention selected regions (black bars) in the caption

Fig 3: mention ordering in the caption

Reply: All above notes were corrected and/or added in the present manuscript.

P1,L17-20: Phrase 2 somehow contradicts phrase 1.

Reply: The general passive sensor is difficult to detect the thin cirrus clouds, but the MODIS is able to detect the clouds with the optical thickness less than 0.05. The clouds

includes not just cirrus clouds but also lower-level clouds.

P2,L21: TANSO-FTS constructed by the cluster analysis and to validate the detected clouds against the -> TANSO-FTS. The method is based on cluster analysis and it is validated by comparison against the

Reply: The sentence was corrected as follow: “TANSO-FTS constructed by the cluster analysis. The method is validated by comparison against the”

P5,L5: 10<sup>-5</sup> Is there units missing?

Reply: This value, the threshold value for the Euclidian distance between two normalized spectra, has no unit.

P9,second paragraph: I do not understand what you say. Do you mean that the present study helps the gas retrievals by providing an estimate for a priori cirrus optical thickness?

Reply: The cloud contamination in the field of view affects on the gas retrieval generally, especially thin cirrus clouds which is difficult to detect from the space. The coincident cirrus cloud detection is helpful to retrieve the gas amount.

P9,third paragraph: Remove. OCO-2 does not cover the saturated water vapor bands. So, the method is not applicable.

Reply: The cloud information was derived from O<sub>2</sub> A-band of OCO-2.

## Reply for Referee#2

Thank you very much for re-reviewing our manuscript carefully. The English corrections were done along the Referee#1 comments and the necessary explanation was added along the Referee#2 comments. We answered your each comments as follow.

### Major review points

1. The criterion for co-locations of TANSO-FTS and CALIOP is a distance within 100 km. I understand that is difficult to get enough co-locations for just one year if you use a smaller distance, but for a distance of 100 km (or even 400 km as in Fig. 8) a match could be pure random. How do you explain a matching ration of nearly 70 % for a distance of 400 km (Fig. 8)? In my point of view a meaningful evaluation is done for co-locations within the distance of half a grid point and a time of five minutes. What is the reason to use this distance? The agreement with CALIOP looks quite good for distances of 25 km. Why don't you use just a longer period for comparison with a much smaller distance for co-locations?

Reply: When analyzing firstly, we prepared the co-location information between TANSO-FTS and CALIOP to set one year 2010, 400km distance and five minutes because we assumed the anvil and thin cirrus clouds in the tropics which extends to a few hundred km or more, whereas the matching location were mainly limited in the boreal middle latitudes.

The 70 % matching ratio with 400 km distance might mean that the cirrus clouds at the mid-latitudes extended to a few hundred km and more horizontally, and the humidity around cirrus cloud existed more than expected. The former reason should be checked the other data, such as MODIS image, with the wide swath for each cases, however it takes more time and is beyond the scope of this study. The second reason was indicated by the summer case (July) which was worse matching ratio among the year. That means the humidity at the upper troposphere affects on the detection method.

In addition, we want to know the matching ratio with the function of distance, such as Figure 8.

The Level 1B version 161.160 is almost same quality and situation from April 2009 to April 2014. We wanted to understand the seasonal cycle (one year) without inter-annual variation of the detection behavior and cirrus clouds variation, therefore we selected the first year, 2010. After this work, we try to study the other year and to discuss the influence of cirrus clouds inter-annual variability on the detection method.

2. The result from the case study comparison with CALIOP is that TANSO-FTS has a higher revisit time. Could you please quantify things like “was clearer” or “was larger”

in more detail?

Reply: Along the reviewer comments, the sentence was rewritten quantitatively as follow: “The spatial distribution of cirrus fraction derived from the TANSO-FTS water vapor saturated band method was clearer than that from CALIOP due to higher temporal resolution (in other word less missing grid at the 2.5 degree grid size in the 7-days period), and the fraction from TANSO-FTS was larger approximately 1.75 times than that from CALIOP.” (Page 7, Line 25-26)

3. In parts of the manuscript it is mentioned that there is already a retrieval for high clouds from GOSAT. It would be nice to have a comparison against comparable products. At the moment it is hard for the reader to classify the quality of this data record compared to existing products, such as the MODIS cloud product, CLARA-A2 or HIRS cloud data from University Wisconsin.

Reply: If the reviewer suggested here the CO<sub>2</sub> slicing method of GOSAT product which detects the cirrus clouds, we are interested in the comparison of cloud between this method and CO<sub>2</sub> slicing method for the near future work.

#### **Minor review points**

4. The English has to be improved by a native speaker. Especially the usage of the plural.

Reply: We corrected the English along Reviewer #1 suggestion.

5. Will the data be freely available? If yes, in which format, temporal and spatial resolution? What are the future plans for this data record?

Reply: In the future, we consider to provide the data for the research usage.