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Atmospheric Measurement Techniques Discussions

Interactive comment on "A high-level cloud detection method utilizing the GOSAT TANSO–FTS water vapor saturated band" *by* Nawo Eguchi and Yukio Yoshida

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Thank you very much for reviewing our manuscript. The authors understood the major points pointed out by reviewer#1. Following the comments and suggestions from two reviewers, most of them were corrected and modified, including the figures. The English was checked by a native speaker. The major revised points were the following: From the suggestion from reviewers, we did the additional analysis which fixed the program bug. The additional results showed that the water vapor saturated method from the current product of GOSAT and this study were similar, except the middle layer cloud were detected better by the new method by this study (Figure 10 in the revised

manuscript). That means both methods from the current method of GOSAT product and the new method in the present study can detect the thinner cirrus clouds of about 85% cloud frequency compared with CALIOP. Following the above new result, the introduction and summary sections were rewritten significantly. As suggested by the reviewer, some figures were modified or added. The results figures (Figs.6 and 7) were replaced for the 100 km results. Figure 4 was revised; the "Clear and Cloudy supervised data" was added to the part of "Minimum Distance Method" decision. The red line of Figure 7 was corrected; the previous red line was inconsistent with the caption and showed the summation of probability density at each altitude. Figure 10 was added to show the capability (performance) of the new method and to compare the current and new methods. We hope that these revision will be satisfied your comments.

The paper by Eguchi and Yoshida refines and evaluates a detection algorithm for thin cirrus clouds using saturated water vapor bands in the shortwave infrared range measured by the Greenhouse Gases Observing Satellite (GOSAT). Variants of the method have been studied previously for other satellites (and other spectral ranges) and, variants have been used for several years within the GOSAT standard retrievals [Yoshida et al., 2011, their section 3.1] and within alternate retrievals by the science community [e.g. Guerlet et al., 2013, their section 3.2]. In particular, Guerlet et al., 2013 (their figures 4, 5, 6) did cover quite some discussion of the method. Neither Yoshida et al., 2011, nor Guerlet et al., 2013, are referenced by the manuscript. While that might be negligence (Y. Yoshida is co-author here!), the question is whether the paper actually delivers some new insight. This could be argued twofold. First the algorithm is refined compared to the GOSAT standard retrievals. Second, the paper includes a comparison to CALIPSO data which has not been covered before. So, topic-wise, the paper is suitable for Atmospheric Measurement Techniques (AMT). But scientific mass is limited. I would rate the progress compared to Yoshida et al., 2011, and Guerlet et al., 2013, as minor. Most importantly, the study (aiming at a methodological refinement) lacks a thorough quantitative comparison to the standard algorithms ie. there is no clear proof that the progress is actually positive except for some numbers in the introduction with a

"not shown“ attribute. There is the possibility that I just missed this key point because I could not follow the text. The paper requires a major amount of rewording to become useful for the average AMT reader. There is a severe lack of clarity and completeness and, there is also severe language issues throughout the text; some paragraphs I simply did not understand (although I tried repeatedly).

Some detailed comments: P2, L8+: This would be the place to refer to Yoshida et al. 2011 and to discuss the results by Guerlet et al., 2013. I do not understand what the quoted performance values against CALIOP for TANSO and CAI refer to. Is this part of the present work or is it previous work? If it is present, it appears strange to discuss it in the introduction. If it is other work, the respective references are required. Reply: As reviewers suggested, the existing water vapor saturated method by Yoshida et al. (2011) and Guerlet et al. (2013) are described in the revised manuscript (page 2, line 15-19).

P2, L21: How can the method be applied to GOSAT-2, not even launched? Reply: The cloud detection results by this method will be used as one of the pre-screening items of the gas retrievals, although this method is not implemented in the GOSAT-2 operational processing system yet. The sentence was removed from the revised manuscript to avoid the confusion.

P2, L22+: This is a quite unfocused discussion of cirrus occurrence and properties which is far from complete; the number of references is small. I recommend focusing on thin cirrus and their importance because of their ubiquity in general and their impact on gas retrievals from satellites in particular. Reply: As reviewers suggested, the sentences were removed from the revised manuscript. The introduction was revised significantly to focus on the aim of this study.

P3, L1+: It should be made clear that the paper improves and evaluates existing methods; it does not invent the principle. Reply: We discussed the comparing analysis between the current method of the GOSAT product and the present study's method

in the summary section: the present method has the similar performance (capability) to detect the higher level clouds though comparison with CALIOP cloud data. On the other hand, the new method in this study can detect the middle layer clouds better than the current method of the GOSAT product.

P4, L31+: If I understand correctly, the method builds on the existance of a thermal infrared channel to group the shortwave infrared radiances accoring to the thermal brightness temperature of the scene. This must be made clearer, since it implies that it would not be applicable to most of the upcoming greenhouse gas satellites (except GOSAT-2) that lack the thermal infrared. Thermal infrared brightness temperatures are representative for the layer where the remaining optical depth toward top-of-the-atmosphere is about unity. So, grouping according to thermal infrared brightness temperatures should miss thin cirrus clouds. Is this a basic flaw of the method? Reply: No. We don't use the thermal infrared channel for grouping. After the grouping, we checked the median brightness temperature for each group and reordered the groups.

P5, L2+: What does it mean: "Using these typical spectral shapes as supervised data“? Add a more detailed description of the procedure. What is "supervised data“? Why are the entire band 3P spectra used and not just the saturated micro-windows identified in Fig. 2? Reply: The detail method is described in p.5 l.11-17 (p.5, l.9-16) of the previous (revised) manuscript. To avoid the confusion, several sentences were rephrased. "Mean spectral shapes" shown in Fig. 3 are used as the "supervised data". Then we classify an observed spectrum by the minimum distance method. This classification result is used in Test C. It's hard to identify from only the saturated micro-window signal, therefore, the entire band 3P spectrum is used.

P5, end of section 2: What are the fractional contributions of the tests A,B,C? Is test C actually required? Reply: The below figure shows each number divided by the Test A, B and C by the data which matched CALIOP the distance of 100 km in 2010. The results from the other distance from 25 to 400 km were an almost similar fraction. Test C is required because it treats $\sim$25% of input data.

Figure R1a: The data number at each test by using the data matching with CALIOP with the distance of 100 km in 2010.

P6, L16; Fig. 6: Why do the clear cases dominate? At a footprint of 10 km of the TANSO, the expected clear-sky fraction should be much less than 10 Reply: We are sorry for make you confused. Here, "clear" and "cloudy" cases mean "no elevated scattering particle" and "elevated scattering particle" cases, respectively. As discussed later, this method overlooks low-level clouds, therefore, clear (cloudy) fractions show apparently high (low) values.

P6-7: The whole section 3.1 is hard to follow. I do not really understand sentences such as " The poor matching ratio over the ocean, especially during the boreal summer, seems to be due to the total water vapor amount during summer was approximately three times that in boreal winter (not shown) in addition to the lower clouds could be not detected.“ There is several grammar mistakes and in the end, I got lost. It continues "It is suggested that the reflection by lower clouds below 5 km and the water vapor amount may have an influence on the high–level cloud detection by the water vapor saturated method.“ Isn’t that an obvious statement given figure 2? Reply: Sorry for make you confusing. We rewrote the sentences clearly (p.7, l.11 - 15)

P6-7: The reason why this paper might be worth publishing is that the refined cirrus detection method is superior to the GOSAT standard algorithm. There appears to be an attempt to show that in appendix A but doesn’t it rather show that the old algorithm has similar (or even better) performance as (than) the new one? Reply: The capability (performance) of the new water vapor saturated method was similar to the current method used in the present GOSAT data, although that was defined roughly. These results were added in the summary section of the revised manuscript. We believe that the results and the comparing analysis of both current method of GOSAT product and the new method by this study with CALIOP give new insight.

P7, L32: "It is clear that the TANSO–FTS water vapor saturated band method is

superior for studying cirrus cloud features over a short period.“ A case study for 7 days without any independent validation does not support such far-reaching statements. Reply: The sentence was rewritten as follow: “The TANSO–FTS water vapor saturated band method could be useful for studying cirrus cloud features over a short period.” (p.7, l.33-34) âĂČ

Please also note the supplement to this comment:
https://www.atmos-meas-tech-discuss.net/amt-2018-122/amt-2018-122-AC1-supplement.pdf

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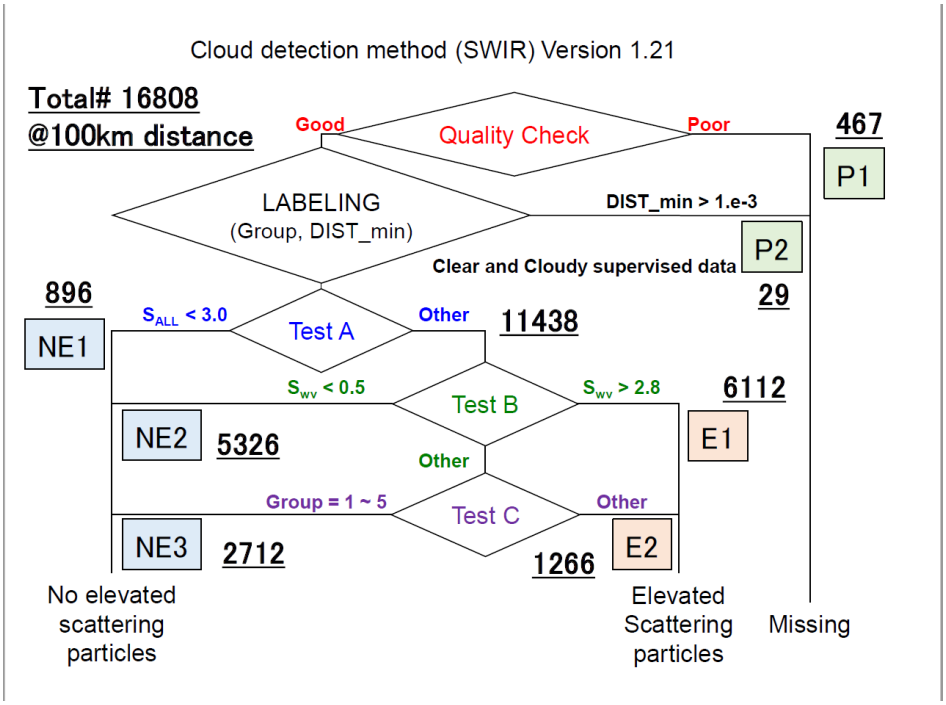

Fig. 1. Figure R1a: The data number at each test by using the data matching with CALIOP with the distance of 100 km in 2010.