

Interactive comment on “On-orbit radiometric calibration of SWIR bands of TANSO-FTS onboard GOSAT” by Y. Yoshida et al.

Anonymous Referee #3

Received and published: 3 September 2012

This paper describes revised estimates of the radiometric throughput degradation of the SWIR bands of the GOSAT TANSO-FTS instrument. This is an important topic, because errors in the radiometric performance of this instrument can contribute errors in estimates of XCO₂ and XCH₄ from its data. While the degradation of the throughput of the TANSO-FTS SWIR bands has been described by others (e.g. the papers by Kuze et al. cited here), this paper contributes new insight into the wavelength- and polarization dependence of the throughput degradation of each channel. It also introduces the possibility that the throughput might have actually improved at the long wavenumber end of Band 3.

This paper is appropriate for publication AMT. However, the author should consider the revisions proposed by anonymous referees 1 and two. In addition to those issues, the authors should also address following small issues:

=> Thank you for your careful reading of our paper. The followings are our reply to your comments. The revised part is **marked** with "double line (—; removed)" or "under bar (___; added)".

p. 4712: line 10: “parameter to be retrieved” → “parameters to be retrieved”

=> Done.

p. 4713: Line 17: “retrieve accurate XCO₂ and XCH₄” → “retrieve accurate estimates of XCO₂ and XCH₄”

=> Done.

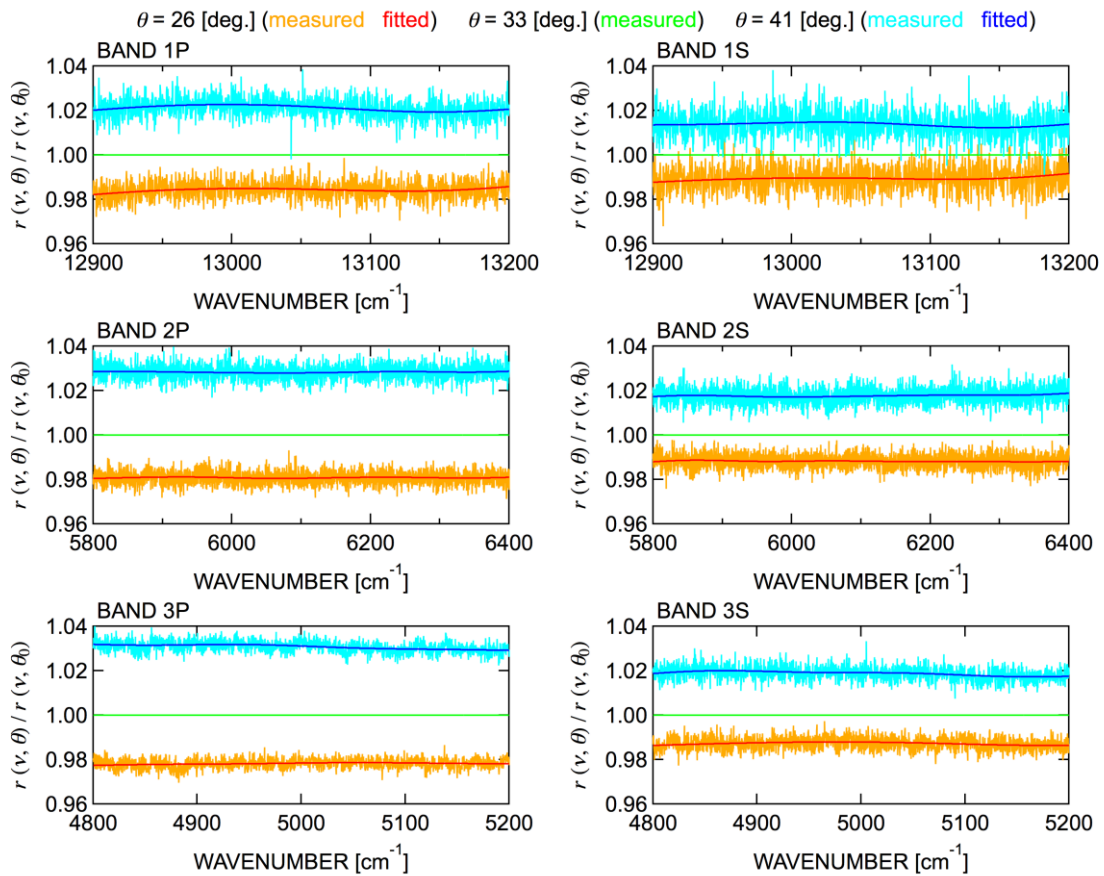
p. 4714: Line 5: “baseline shape”. Is the “baseline shape” the same as the continuum?

=> Yes. To make it clear, we revised "baseline shape" => "baseline shape **(continuum)**".

p. 4716; Line 16: “showed clear [theta] dependency (Fig. 6)” Yes, while this figure apparently shows clear theta dependence, it is otherwise poorly explained. What exactly is being shown here? Is the red line a fit to the gold line? Why is theta=33 degrees called out twice in the legend at the top? Should we be looking for a black line? The next sentence indicates that “the degree of [theta] dependency varied with wavenumber and polarization.” However, while Fig. 6 clearly shows wavenumber dependence, there is no direct evidence that it shows polarization dependence. This is confusing.

=> To avoid the confusion, we remove the following sentence (p. 4716, Line 18). Also, we revised the legend and caption of Fig. 6 as follows.

~~"In addition, the degree of θ dependency varied with wavenumber and polarization."~~



"Figure 6. Incident angle dependency of the reflectance spectrum of the diffuser plate. Plotted data is normalized with the reference reflectance spectrum obtained at $\theta_0 = 33$ [deg.], therefore, green line ($\theta = 33$ [deg.]) becomes a unity. Orange and light blue lines show the measured data while red and blue lines show the fitted spectra (Eq. 4)."

p. 4717: Line 16: “: : except in the higher wavenumber region (> 5050 cm $^{-1}$) of Band 3P.” This is a new result. No previous studies that I am aware of indicate any increase the radiometric throughput of the TANSO-FTS. To make this discovery even more obvious, the sentence should state: “: : except in the higher wavenumber region (> 5050 cm $^{-1}$) of Band 3P, where our analysis shows that the sensitivity increases with time.”

=> Done.

p. 4718, Line 2: “Therefore, we do not discuss this Band 3P issue further in this paper.” Because this is a new result that has not been seen in other studies, it might be good to note that “this spectral range cannot be calibrated using surface based vicarious calibration techniques because of uncertainties in the water vapor absorption in the Earth’s atmosphere.”

=> According to your suggestion, we added the sentence as follows.

"Because both cirrus screening methods utilize the relationship between the

observed signal level at this wavenumber region and the noise level, the priority of accurate radiometric calibration in this spectral range is not so high. Also, this spectral range cannot be calibrated using surface based vicarious calibration techniques because of uncertainties in the water vapor absorption in the terrestrial atmosphere. Therefore, we do not discuss this Band 3P issue further in this paper."

p. 4718, Line 18: "showed slightly large deviation" → "showed slightly larger deviations"

=> Done.

p. 4719: "We do not discuss the retrieved XCO₂ and XCH₄ values because this subject is beyond of the scope of this paper, and the impact of the degradation correction on the retrieved XCO₂ and XCH₄ depends on the retrieval setting." This statement is valid, but I agree with anonymous referee 2, that there should be some estimate of the impact of the radiometric uncertainties on XCO₂ and XCH₄ estimates. Do they introduce 1% errors or 0.1% errors in these properties? Crisp et al. (Atmos. Meas. Tech., 5, 687–707, 2012) find that ignoring the radiometric degradation altogether introduces errors of 1.5 ppm in XCO₂, but smaller corrections (like those introduced here) produce smaller (0.5 ppm) errors. Even if the errors are small, they are still important to flux inversion studies, because they will introduce spatially correlated biases that will vary with the surface albedo and aerosol optical depth.

=> The main scope of this paper is the improved degradation model. So we just added the differences in XCO₂ and XCH₄ at the end of section 4.3.

"Difference in the retrieval results by using previous/improved degradation models changes with time, and difference in XCO₂ and XCH₄ for our retrieval (improved - previous) are about -1.3 ppm/yr and -6.7 ppb/yr, respectively."

Figure 2b: As referee # 2 noted, "systematic structures are mostly related to shortcoming in the spectroscopy of O₂." This point could be made stronger by mentioning that these residual structures are seen other investigators analyzing GOSAT and TCCON data (c.f. Fig. 6 of Crisp et al. 2012).

=> According to your comments, following sentence was added at the end of p.4714, Line 5.

"Note that the systematic structures in the residual spectra are probably due to the shortcoming of the spectroscopy of oxygen, because other GOSAT retrieval algorithm and retrieval using other instrument show similar residuals (e.g., Fig. 6 of Crisp et al., 2012)."

Figure 6: The figure caption needs to be expanded to explain what is being shown in the figure. Four different angles are cited along the top, using different colors (black, red, green, and blue), but the first color (black, 33 degrees) is used as a reference, and is not shown. There is no legend for the gold and light blue lines. Are these the actual data for 26 and 41 degrees? Are the other curves smoothed fits to these data? Why is there both a black and a green line for 33 degrees? Is one simply redundant? Is there any polarization dependence in the wavelength-dependent values?

=> Done. See above response.