

Interactive comment on “Validation of GOSAT/TANSO-FTS TIR UTLS CO₂ data (Version 1.0) using CONTRAIL measurements” by N. Saitoh et al.

Anonymous Referee #2

Received and published: 15 January 2016

General comments

Authors compare GOSAT TIR CO₂ retrievals to carbon dioxide observations by CONTRAIL flights, both to vertical profiles and to level flight data. The comparison study is an important step towards improving the TIR CO₂ retrieval product and should present a valuable source of information to potential users of CO₂ product. However, current version of the manuscript requires revisions that are likely to alter the results and conclusion before the paper can be considered fully suitable for publication.

The reported results include TIR CO₂ comparison with vertical profiles around Narita airport and with level flight data observed around the world. Comparisons for Narita

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profiles are made with averaging kernel (AK) smoothing applied and reveal low bias (Fig. 2) with respect to CONTRAIL data in mid troposphere along with a significant random error at the range of several ppm. This part of comparison looks valid. In the following sections the TIR CO₂ retrievals are compared to the level flight data, but it is done without applying corrections with averaging kernel (as presented in Eq. 5). Comparison without applying correction is, however, of a limited value for this type of remote sensing product. As authors state in multiple occasions the TIR retrieval does show strong dependence on the retrieval prior, indicating large weight of the prior in the retrieval. Potential users of the product for inverse modeling applications have to apply corrections themselves according to established practice, otherwise they would end up using mostly prior model simulation instead of observations by GOSAT TIR. Which is not what they intend. For the same reason there are few or no known published attempts to compare similar TIR product to level flight data that do not resolve vertical concentration profile. Accordingly, revision of the level flight part is strongly recommended. As the manuscript title suggests the comparison at UTLS level making a major contribution to the study results, a major revision is required.

Specific comments:

1. On Page 13006, Line 19 authors state they did not apply “TIR CO₂ averaging kernels to CONTRAIL CME CO₂”, and in the following discussion provide mostly verbal argument that skipping the correction is justified. Instead the reader would expect to see results of numerical tests supporting authors’ position. For products like GOSAT SWIR XCO₂ comparison with uncorrected values produce essentially same result, but in TIR case the value of averaging kernel is well below 1 (Fig. 9) which implies large weight of the prior in the product. As follows from Eq 5, application of the said correction with relatively small values of averaging kernel (in the order of 0.2 or less as shown on Fig 9) may attract the corrected value strongly to prior concentration, reducing difference between CONTRAIL and prior, from what is shown on Figs 6 and 7 by several times and compromising much of discussion in Section 6. From the reviewer’s

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standpoint, revision and improvement of comparison with CONTRAIL level flight data is essential, which could be most easily done by extending the level flight data vertically using modeled or climatological profiles, and applying the averaging kernel afterwards. Importance of the correction given by Eq. 5 is emphasised by its use as a regular practice in the inverse modeling applications, where the model vs observation difference is estimated using same equation. Use of the Eq. 5 by modelers in calculating model to observation misfit effectively implies replacing the retrieval prior by model simulated profile. Comparison with uncorrected data, such as shown on Fig 7, may divert potential users from understanding strong and weak points of TIR L2 data.

2. In the abstract (P12994 L24) and other locations authors mention the retrieval prior CO_2 they use have several biases. Another source of retrieval biases is spectral bias. Its is not clear how large is relative contribution of these two. Comparison of the TIR product made with another prior or bias corrected prior appears desirable, given contamination of the product with prior biases. Also, from the absence of the prior contributors in the coauthors list and acknowledgements one can suspect that there wasn't enough contact between prior developers and retrieval team.

Technical corrections

P12994 L2. The first sentence better to rewrite to avoid using construct as “thermal infrared (TIR) band ...has been observing carbon dioxide ...”. Clearer phrase could sound as “TANSO-FTS has been observing carbon dioxide in thermal infrared (TIR) band”. Similar wording appears later as well. Authors write on P12996 L10 “... (TES) has retrieved CO_2 concentrations ...”. One may argue that TES can measure or observe radiances, but retrieval would be done on the ground. The paper should be checked again to correct places with somewhat tentative language.

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 12993, 2015.