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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Validation of XCO_2 derived from SWIR spectra of GOSAT TANSO-FTS with aircraft measurement data" *by* M. Inoue et al.

Anonymous Referee #2

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Dear authors, dear editor,

please excuse the delay. This was not an easy task.

The manuscript by M. Inoue et al. describes an intercomparison of the GOSAT XCO2 data product (Ver 02.00) with airborne and CO2 measurements that have been augmented with tower in-situ measurements in some locations. The effects of including or neglecting the influence of the GOSAT column averaging kernels (CAK) as well as the missing stratospheric and mesospheric CO2 in the aircraft profiles on these intercomparisons are discussed in detail. Due to a lack of direct matches between satellite overpasses and aircraft measurements, the authors also try to interpolate aircraft XCO2 estimates in time to compare with GOSAT XCO2 retrievals.

1 Major issues

- As an attempt to truly validate the GOSAT XCO2 data product (Ver 02.00) the methods are not adequate. A validation effort for a dataset should try to use different methods to compare the data being validated against other data sets to establish credibility and define error bars. This manuscript only provides a mere intercomparison of the GOSAT retrievals with airborne in-situ measurements. Thus, the title should not be "Validation of . . . " but rather "Comparison of . . . ". From a real validation paper I would expect more, for example comparison to other obvious reference data sets like the ground based FTIR measurements from the Total Carbon Column Observing Network (TCCON) or other satellite measurements. In the current form, I can only assume that at some later time, there will be a GOSAT XCO2 (Ver 02.00) vs. TCCON comparison and possibly comparisons against other data sets. However, this would only provide individual biases and error bars. Instead, a consistent data quality assessment using several valdiation sources would be much more useful for the new GOSAT XCO2 (Ver 02.00) data product.

- The aircraft measurements that were used are certainly not everything that was available during the GOSAT era. Namely, aircraft CO2 measurements from various campaigns like BARCA (Chen et al., 2010), the TCCON calibration campaigns (Wunch et al., 2010; Messerschmidt et al., 2011), or the various HIPPO campaigns (Wofsy, 2010) were not used. There are also regular low-altitude aircraft measurements at the Bialystok tall-tower site (Messerschmidt et al., 2012) and possibly other tall-tower sites in Europe that were part of the CarboEurope project. I understand that there might not have been enough overlap with these measurements and GOSAT retrievals but that should at least be mentioned.

- I am not happy with the curve fitting method that has been employed to extend the number of available comparison points. Though I understand that the number

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of direct GOSAT/aircraft matches was too low for a meaningful comparison, I do not think that this is a valid approach – at least not in the form it was done here. One issue that should definitely be addressed is the error contribution that results from this interpolation. This could have been estimated by comparing measured and interpolated XCO2 values to datasets generated by transport models like Carbontracker. This way one would get a feeling for the expected interpolation errors. An even better way would have been to use a well-known data product like Carbontracker to provide interpolated values in the first place.

In its current form of a mere intercomparison, the manuscript is rather technical and would be better suited for publication in AMT. For ACP, I would suggest major revisions as described above.

2 Minor issues

- p. 3204, l. 21–23: I am not sure if "agree well" is appropriate with a standard deviation of 1–3 ppm and a bias of 1–2 ppm. This is certainly a big improvement since the previous GOSAT XCO2 product but still quite a lot.
- p. 3204, l. 4: You should also mention the tower measurements.
- p. 3204, l. 11: $\pm$0.1 ppm
- p. 3205, l. 21: $\pm$1%
- p. 3205, l. 28: In-situ measurements are not the only form of validation data.
- p. 3206, l. 1–16: The introduction is too detailed and too lenghty. It could be cut by about one third. This part would be a good start.

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- p. 3206, l. 28: Let us know why you are ignoring TCCON data.
- p. 3207, l. 6–22: This part does not really belong in the introduction.
- p. 3207, l. 7-9: First the authors tell us that aircraft profiles have to be convoluted with the CAK, then they tell us that this is not necessary. This needs to be better explained. This might be resolved by moving this part out of the introduction (e.g. into Section 3).
- p. 3208, l. 1–18: Again, this is very lengthy.
- p. 3210, l. 5–7: Explain why you have not used any of the other available aircraft measurements.
- p. 3210, l. 16: There are more tower measurements available word-wide than the ones you have used. Explain why these were not considered.
- p. 3210, l. 25–27: As mentioned above, there are also aircraft and tall-tower measurements at the TCCON station at Bialystok, Poland. Please explain why these have not been used.
- p. 3214, l. 2: A figure showing the shape of the CAK with respect to SZA would be useful.
- p. 3214, l. 9: Should read: “GOSAT a priori profiles have some effects . . .” (not “make”).
- p. 3215, l. 24: $\pm 10^{\circ}$ is a huge area!
- p. 3219, l. 13–14: Please rewrite the sentence with “. . . were underestimated . . .”. It is not clear from that sentence if the GOSAT or reference data were lower.

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- p. 3220–3221: I have already stated that I find the whole approach too simple. The least that would be necessary would be a figure or a table that shows us how far in space and time the interpolated measurements were from actual GOSAT measurements. If the interpolation only bridges a few hours it might be ok. With days or weeks I would not trust it.
- Table 2: The table does actually not tell anything about the effects of using or not using the CAK on the aircraft profiles even though the caption says so.

3 References

- Chen, H., et al.: High-accuracy continuous airborne measurements of greenhouse gases (CO2 and CH4) using the cavity ring-down spectroscopy (CRDS) technique, Atmos. Meas. Tech., 3, 375-386, doi:10.5194/amt-3-375-2010, 2010.
- Wunch, D., et al.: Calibration of the Total Carbon Column Observing Network using aircraft profile data, Atmos. Meas. Tech., 3, 1351-1362, doi:10.5194/amt-3-1351-2010, 2010.
- Messerschmidt, J., et al.: Calibration of TCCON column-averaged CO2: the first aircraft campaign over European TCCON sites, Atmos. Chem. Phys., 11, 10765-10777, doi:10.5194/acp-11-10765-2011, 2011.
- Messerschmidt, J., et al.: Automated ground-based remote sensing measurements of greenhouse gases at the Bialystok site in comparison with collocated in situ measurements and model data, Atmos. Chem. Phys., 12, 6741-6755, doi:10.5194/acp-12-6741-2012, 2012.
- Wofsy, S. C.: HIAPER Pole-to-Pole Observations (HIPPO): fine-grained, global-scale measurements of climatically important atmospheric gases and aerosols,

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Interactive comment on Atmos. Chem. Phys. Discuss., 13, 3203, 2013.