

Interactive comment on “In situ measurement of CO₂ and CH₄ from aircraft over northeast China and comparison with OCO-2 data” by Xiaoyu Sun et al.

Anonymous Referee #2

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The manuscript by X. Sun et al. describes aircraft in-situ observations of CO₂ and CH₄ taken over Jiansanjiang, Northeastern China, between August 7 and 10, 2018. The authors used a turboprop aircraft which was limited to 0.6–7 km flight altitude. Therefore, the profiles only covered the upper part of the planetary boundary layer (PBL) and only part of the free troposphere.

In general, I greatly appreciate the efforts of taking aircraft in situ observations of CO₂ and CH₄ and I understand their usefulness and limitations well. However, I think the focus of the manuscript is not balanced. Due to the limited altitude coverage, the results would be most useful for validating the performance of Tan-Tracker, Carbontracker,

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CAMS or any other profile-based greenhouse gas data set. However, this is done only very briefly for Tan-Tracker and without much discussion about the obvious shortcomings of the model in the specific situation (active vegetation uptake of CO₂ and CH₄ emissions from rice fields) - especially near the surface. Instead, they spend most of the analysis and discussion on the comparison with the column-averaged OCO-2 XCO₂ product - even though they correctly state that the largest error in this comparison comes from the unmeasured (extrapolated) part of their profiles.

My suggestion would be to rewrite sections 5.2 and 5.3 and put more emphasis on the profile comparison. This should include a more detailed analysis how biases near the surface influence the column-averaged XCO₂ and XCH₄ values.

Major issues:

- concerning the profile to column comparison, the authors should also have a look at

1) J. Messerschmidt et al.: Calibration of TCCON column-averaged CO₂ : the first aircraft campaign over European TCCON sites. *Atmos. Chem. Phys.*, 11(21):10765–10777, 2011. doi:10.5194/acp-11-10765-2011.

2) M. C. Geibel et al.: Calibration of column-averaged CH₄ over European TCCON FTS sites with airborne in-situ measurements. *Atmos. Chem. Phys.*, 12(18):8763–8775, 2012. doi:10.5194/acp-12-8763-2012.

Especially Geibel et al. discuss the effect of limited flight altitude on the column uncertainty due to extrapolation of the observed profiles in more detail than Wunch et al., 2010.

- in Section 5.3, the authors should use the OCO-2 prior profile for extrapolating to the bottom and top of the atmosphere. The use of any other profile will create additional biases when comparing to OCO-2 data.

Minor issues:

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- p. 2, l. 41-42: it is not true that passive satellite observations of GHGs can provide all-weather, all-day global coverage.
- p. 2, l. 51: the quantity X_{gas} as provided by TCCON as well as the satellite instruments is column-averaged dry-air mole fraction, not volume mixing ratio. Please check the definition of mole fraction vs. volume mixing ratio and replace "volume mixing ratio" throughout the text.
- p. 3, l. 75: if possible, please provide references for all 3 satellites mentioned here.
- p. 4, l. 100: can these standard gases be referenced to the WMO GHG scale? And could you tell the nominal concentrations of CO₂ and CH₄ in these standards? Is isotopic composition of the standards an issue for the aircraft measurements?
- p. 4, l. 105: should be: "Aircraft measurements were carried out ..."
- p. 4, l. 109: are the mentioned times local or UTC? Please also provide the year for the dates!
- p. 4, l. 118: be consistent in the use of mixing ratio vs. mole fraction.
- p. 5, Eq. 3: all numbers should have units in this equation!
- p. 5, l. 138-151: can you derive the planetary boundary layer height from your meteorological data, e.g by calculating the Bulk-Richardson number or some other indicator?
- p. 6, l. 160: the use of the word "accurate" here is misleading. If Tan-Tracker has been validated for accuracy, please provide a number. Or just drop "accurate". Besides, the aircraft observations show that the accuracy of Tan-Tracker here is limited.
- p. 8, l. 219: why is one given in ppm and the other in percent?
- p. 8, data availability: it would be nice if at least the 3 profiles were provided as a supplement to the paper. The amount of data should be rather small.

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- Fig. 1: the black-and-white map of China is not very appealing. Also, a close-up of the target region, potentially as a terrain map or satellite picture would be illustrative.
- Figs. 3-5: an indication of PBL height would be useful on all these figures.
- p. 15/16, Table 2: I assume that the numbers are for CO₂ but it is not actually mentioned in the table captions. If so, a similar table for CH₄ would be useful. I would also appreciate an estimate of the total resulting uncertainty.

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2019-363, 2019.

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