

Interactive comment on “Validation of TANSO-FTS/GOSAT XCO₂ and XCH₄ glint mode retrievals using TCCON data from near-ocean sites” by M. Zhou et al.

Anonymous Referee #1

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General comments:

Manuscript "Validation of TANSO-FTS/GOSAT XCO₂ and XCH₄ glint mode retrievals using TCCON data from near-ocean sites" from Zhou et al., submitted for publication in Atmos. Meas. Tech., presents results from a new study aiming at validating GOSAT XCO₂ and XCH₄ retrievals using TCCON ground-based XCO₂ and XCH₄ retrievals focusing on glint-mode retrievals over the ocean. Previous validation publications primarily focused on retrievals over land. The manuscript therefore presents new results, is very well written and covers a topic appropriate for Atmos. Meas. Tech. I therefore

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recommend publication of this paper after the mostly minor comments listed below have been carefully considered by the authors.

Specific comments:

Page 10900, line 11 and following: Statement "The column-averaged dry-air mole fraction measurements (XCO₂ and XCH₄) are sensitive not only to the surface but also to the free troposphere, which allows a better distinction between transport and local emissions." Please add a reference which supports this statement.

Page 10900, line 15 and following: It is written that "A large set of studies used the total column or column-averaged dry molar fraction observations to improve the precision of atmospheric inverse models". What is "the precision of atmospheric inverse models"? Please explain. I guess you mean the quality of the surface fluxes obtained by inverse modelling where quality refers to reduced (better) uncertainty considering random and systematic errors.

Page 10900, line 21 and following: Sentence referring to GOSAT "It is the first space-based sensor designed specifically to measure greenhouse gases from high-resolution spectra at SWIR wavelengths." NASA's OCO has also been designed to achieve this pretty much at the same time than GOSAT (or even earlier). I recommend to modify the first part of the sentence as follows: "It is the first space-based sensor in orbit . . .".

Page 10901, line 3: For completeness I recommend to also add the BESD algorithm and to cite Heymann et al., 2015: Heymann, J., M. Reuter, M. Hilker, M. Buchwitz, O. Schneising, H. Bovensmann, J. P. Burrows, A. Kuze, H. Suto, N. M. Deutscher, M. K. Dubey, D. W. T. Griffith, F. Hase, S. Kawakami, R. Kivi, I. Morino, C. Petri, C. Roehl, M. Schneider, V. Sherlock, R. Sussmann, V. A. Velasco, T. Warneke, and D. Wunch, Consistent satellite XCO₂ retrievals from SCIAMACHY and GOSAT using the BESD algorithm, Atmos. Meas. Tech., 8, 2961–2980, 2015.

Page 10901, line 7 and following: It is written that "the satellite products should reach a

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demanding precision of 2% or better ($< 8\text{ppm}$ for XCO_2 and $< 34\text{ppb}$ for XCH_4), in order to improve the precision of inversion models (Buchwitz et al., 2012)". As highlighted in Buchwitz et al., 2012, achieving low biases (high relative accuracy) is even more important (and more demanding) than precision to obtain reliable surface fluxes via inverse modelling. This needs to be mentioned here and needs to be considered when discussing the validation results presented in this manuscript. See also page 10912, line 23.

Page 10902, line 4: It is written that SRON/KIT product v2.3.5 has been used. On http://www.esa-ghg-cci.org/sites/default/files/documents/public/documents/GHG-CCI_DATA.html, where this product is available for download, it is written for v2.3.5 products: "Minor bugs detected -> please use v2.3.6". Please confirm that v2.3.5 products have been used and not v2.3.6. Do these bugs influence the results shown in the manuscript or has a workaround solution been developed and used to avoid the impacts of the reported problems?

Page 10904, line 15 following: Sentence "Thanks to all these efforts, TCCON has already become a reliable source to validate the satellite retrievals." The first part of this statement sounds a bit strange taking into account that TCCON colleagues are co-authors. Furthermore, I recommend to add that improvements are still ongoing, see: Kiel et al., Improvement of the retrieval used for Karlsruhe TCCON data, Atmos. Meas. Tech. Discuss., 8, 12203-12242, 2015.

Page 10905, line 28 following: "this meets the precision requirement of the ground-based measurements". What are these requirements? Please list them and give a reference.

Page 10906, line 14 following: "hi corresponds to the normalized airmass-weight function of layer i". What is a "normalized airmass-weight function of a layer". Please add explanation.

Page 10908, line 11 following: "we always apply the correction factor to the satellite

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product, not to the TCCON product". It sounds a bit strange that the satellite data need to be modified (significantly) for comparison with reference data and not the reference data. Is there a good reason for this?

Page 10909, line 20 following: "This is due to the strong fluctuation in near-surface CO_2 concentrations of the a priori CO_2 profile of the ACOS algorithm." The effect is quite large. It would therefore be interesting for the reader to get more information on the ACOS priori CO_2 profile. Does it depend on latitude, longitude and time and if yes, what is the spatio-temporal resolution and sampling?

Page 10911, line 12: " 0.33 ± 0.018 and $0.13 \pm 0.013\%$ for NIES": In Tab. 3 nearly all numbers are negative but these numbers are positive. What do positive numbers mean? A high bias or a low bias of the satellite data relative to TCCON? According to Eq. (11) "TCCON-satellite" has been used to compute biases. If this equation has been used consistently in the paper a positive value means a low bias of the satellite data (i.e., satellite values below TCCON values). Please check. I recommend to use "satellite-TCCON" in Eq. (11) but this is only a suggestion (not mandatory). But it needs to be made clear what positive / negative difference mean.

Page 10915, line 10 following: Number given in brackets, e.g., "NIES (-0.02 ± 0.032 vs. $0.35 \pm 0.019\%$)". Please add which numbers refer to ocean and which to land.

Figure 1: Please enlarge and better center the region shown as it appears that parts of the data for Wollongong are not visible.

Figure 8: Very difficult to see the details and the colors in a printout. What is the meaning of the colors? Please add this information.

Technical corrections:

Page 10903, line 21: I recommend to change this sentence as follows: "ACOS v3.5 products have been bias corrected using TCCON GGG2014 products."

Caption Fig. 4: Use plural "data pairs". Same for Fig. 6.

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