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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Calibration of column-averaged CH_4 over European TCCON FTS sites with airborne in-situ measurements" *by* M. C. Geibel et al.

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Reply to individual comments:

1. I disagree with the following statements regarding the intercomparison of the measurements: Pg. 1519 lines 13 - 15: "Different measurement techniques do not necessarily produce equal measurement values ...

Agreed, this is misleading. The paragraph will be rephrased along the lines of the statements by Wunch et al. on the accuracy of the spectroscopic parameters.

Additionally, please justify the hypothesis on pg. 1527 line 21 that an indepen-

dent calibration factor could be needed for each FTS site. Why would that be?

Site-dependent biases that have an influence on the calibration factor could not be excluded a-priori. However, none were found in this study (nor by Messerschmidt et al. or Wunch et al.).

2. Knowing that the agreement between the FTS retrievals and the aircraft measurements is 0.978 +/- 0.002 is only meaningful if the reference for the CH_4 linelist is given. Is it identical to the linelist referenced in Wunch et al. (2010)? Where can it be obtained? Add this information to the text.

Yes, the same line list was used but this was not mentioned in the text. This will be added to Sec. 5.1.

The linelist is included in the stable GGG repository (changeset 8:8e9808768f7f, 2010-10-06). At the moment, access to the repository is limited to registered users of the TCCON wiki (https://tccon-wiki.caltech.edu/).

3. What solar zenith angles do the overflights correspond to? Please add this information either to the text or to Table 1. What is the correlation between SZA and calibration factor? Is it statistically significant?

The flight plan was set up to overfly most sites around local noon. However, most of them were sampled only once. Bialystok and Orleans were sampled twice, once around local noon and once at a lower SZA. However, the number of overflights and SZAs covered is too small for any statistical analysis. An indicative SZA will still be added to Table 1.

4. Indicate the distance (radius) between the FTS site and the aircraft profiles (for example, in the abstract and on pg. 1520 line 11).

The distance between aircraft and FTS site depended mostly on altitude and limitations imposed by air traffic control. Typically, above 5000 m the distance would be in the range of tens of km. Below 3000 m, the distance was typically within 1-2 km. The

notable exception was the profile at Karlsruhe, which was taken during a landing at a nearby airport. Since the distance cannot be expressed as a single number for each profile, plots similiar to Fig. 2 will be added as supplementary material.

5. Section 3: What does the uncertainty estimation of GFIT include? Also, add one or two sentences to Section 3 explaining that GFIT is a nonlinear least-squares spectral fitting algorithm that scales the a priori profile to best fit the measured spectrum.

Appendix B of Wunch et al. 2011 contains a detailed error budget. This and a sentence about how GFIT works will be added to Sec. 3.

6. Is there a cloudiness criteria for rejecting data, based either on solar radiance or the solar tracker signal? Or is that part of the total fitting error criteria? Figures 4 and 5 showing the solar intensity correction are probably unnecessary to the paper, since this has been previously demonstrated.

Removing all cloudy spectra would have severly reduced the number of available spectra (often to zero). Therefore, basically all spectra that were taken within $\pm$ 30 minutes of the overflight and accepted by the IPP software after solar intensity correction were processed by GFIT. In a second step, all spectra for which GFIT reported more than 10 ppb total column error were removed. The procedure is described on page 1526.

7. Since the purpose of the paper is intercomparison of CH_4 measurements, please briefly describe the in situ instrument and its precision and accuracy.

This is best described by Chen et al., Atmos. Meas. Tech., 3, 375–386, 2010. A short summary and a reference to Chen et al. will be added to the end of Sec. 2.

8. Regarding the stratospheric CH_4 profile: What spectral region was used to retrieve HF? The conclusion states that better knowledge of stratospheric CH_4 is needed to reduce errors – what is the estimated uncertainty for the stratospheric CH_4 profile derived from balloon and ACE-FTS profiles?

GFIT retrieves HF near 4038 cm^{-1}.

Better knowledge of stratospheric CH_4 – as stated in the conclusions – would imply measurements of stratospheric CH_4 rather than using a climatology.

We estimated 1% of the scaled and weighted a priori profile. Details are listed in Table 2 and the procedure is explained on page 1525. The resulting number is very close to the error estimate used by Wunch et al. 2010.

Reply to other comments:

Pg. 1520 lines 21 - 22: "The FTS instruments at these sites were Bruker IFS 125 HF spectrometers and were equipped according to TCCON standards." Add one sentence describing the instrumental configuration and add a reference.

A reference to Messerschmidt et al., their Table 2, will be added.

Pg. 1519: Define GOSAT and OCO-2 acronyms.

Done.

Pg. 1519 line 5: "volume mixing ratios" should be "column-average volume mixing ratios"

In fact, it should rather be dry-air mole fraction (DMF) to be consistent with other TCCON publications and slight differences in the definition of DMF and volume mixing ratio (VMR). The text will be changed to use DMF throughout.

Pg. 1523 line 8: FTS spectral data deliver total column dry air mole fractions if they are calculated by a ratio either to the O2 column or to the total column corrected for water. Please clarify.

It is definitely dry-air mole fraction as it is written in the text. After changing all references from VMR to DMF (see above), this point should be clear.

Section 5.1: Change FTIR to FTS.

Done.

Pg. 1531 line 26: Regarding retrieving a partial column to match the aircraft profile, the authors state that "This method is not currently possible since the GFIT software for the retrieval of the FTS DMFs does not yet allow a partial column retrieval." I disagree. The limitation lies not in the retrieval software, but in the spectra themselves, which do not contain sufficient vertical information to retrieve selected partial columns that would result in a comparison with improved accuracy over what the authors have reported here.

Other FTIR retrieval packages life SFIT or PROFFIT have options for retrieving (limited) vertical profile information/partial columns. There is also a new GFIT development branch that addresses this issue. However, without a thorough investigation of the quality and limitations of such a retrieval, it is difficult to speculate on what one may or may not gain from a partial-column approach. The sentence will be changed in a way that makes clear that this it is not only a software problem and that the amount of vertical information in the spectra is limited.

Figure 1: Spell out the site names on the map.

The map would be very crowded with spelled-out site names. The two-letter IDs are used throughout the text and Table 1 contains the details of each site. Therefore it does make sense to have them on the overview map. However, a reference to Table 1 will be added in the caption of Fig. 1.

Figures 4, 5: These figures could be eliminated.

Following the comments by the other reviewer, the whole section on the SIV correction will be shortened and Fig. 4 will be deleted. Figure 5 might still be considered helpful as it illustrates the effects of preprocessing on the retrieved xCH_4 column.

Figures 3, 6: Replace altitude with pressure or show pressure on the right axis.

Figure 6 will be removed according to comments of the other reviewer.

For Fig. 3, there is hardly enough room for showing both scales without blowing up the figure by at least a factor of two. Fig. 2 and 3 both belong to the discussion of flight tracks and flight altitudes, which is more naturally expressed in altitude than in pressure. Therefore, Fig. 3 should rather stay as it is.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 1517, 2012.