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Comment

## ***Interactive comment on “Calibration of column-averaged CH<sub>4</sub> over European TCCON FTS sites with airborne in-situ measurements” by M. C. Geibel et al.***

### **Anonymous Referee #1**

Received and published: 14 February 2012

This paper presents the comparison of aircraft and FTS measurements of CH<sub>4</sub> for flights at six sites in Europe. The calibration factor is consistent with results reported previously by Wunch et al. (2010). The authors additionally discuss the bias introduced by the lack of CH<sub>4</sub> data for the stratosphere, and present an alternative mathematical approach that minimizes this bias.

Major 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 - even when they are measuring exactly the

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same physical quantity." Pg. 1526 lines 6 - 8: "Even under ideal conditions measurements of the same air mass with both methods would not produce exactly the same results. For example, even the slightest deviation in the stretch of the spectral line would produce a scaling offset from the in-situ result."

These statements are misleading. Two different, perfect instruments would produce equal measurement values.

The need to calibrate the FTS retrievals is because the spectroscopic line parameters (line strengths and line widths) that are required for the spectral fits are not sufficiently well-known. Wunch et al. (2010) state that systematic biases in the spectroscopy will limit the absolute accuracy of the column measurements to  $\sim 1\%$ , although the precision is much higher. Please change the two sections that contain the sentences above to specifically explain the source of uncertainty in the FTS retrievals.

Additionally, please justify the hypothesis on pg. 1527 line 21 that an independent calibration factor could be needed for each FTS site. Why would that be?

2. Knowing that the agreement between the FTS retrievals and the aircraft measurements is  $0.978 \pm 0.002$  is only meaningful if the reference for the CH<sub>4</sub> 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.

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?

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

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.

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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.

7. Since the purpose of the paper is intercomparison of CH<sub>4</sub> measurements, please briefly describe the in situ instrument and its precision and accuracy.

8. Regarding the stratospheric CH<sub>4</sub> profile: What spectral region was used to retrieve HF? The conclusion states that better knowledge of stratospheric CH<sub>4</sub> is needed to reduce errors – what is the estimated uncertainty for the stratospheric CH<sub>4</sub> profile derived from balloon and ACE-FTS profiles?

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.

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

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

Pg. 1523 line 8: FTS spectral data deliver total column dry air mole fractions if they are calculated by a ratio either to the O<sub>2</sub> column or to the total column corrected for water. Please clarify.

Section 5.1: Change FTIR to FTS.

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

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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.

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

Figures 4, 5: These figures could be eliminated.

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

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

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