

Interactive comment on “FTS measurements of column CO₂ at Sodankylä” by R. Kivi and P. Heikkinen

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Received and published: 31 May 2016

We thank the Referee for the very detailed and constructive review. We have addressed each of the comments by the Referee.

Referee: “TCCON can retrieve column abundances of a number of gases, as is mentioned within the manuscript. However, the manuscript only focuses on CO₂. I can see no reason why it should not be expanded to include the other gases and provide a data reference/citation for the Sodankylä TCCON data.”

Authors: We agree that it will be good to add other gases that are in the retrieval. We have therefore included a figure, which shows the time series of CO₂ and also other gases. One of the improvements is that we have also included an additional year of measurements. Also the citations have been updated in the revised version of the

C1

manuscript.

Referee: “There are a few calculations that are described in words. It would be helpful to see the relevant ones expressed as equations, particularly the derivation of the quantity “xAIR” and the calculation of the dry pressure column used within that. “

Authors: The xAIR equation has been included according to the referee suggestion.

Referee: “It would be good to include a plot of comparison of Sodankylä TCCON data with CarbonTracker. CarbonTracker is openly accessible, and therefore could be included rather than referring to other work that is focused on wider-scale comparisons.”

Authors: We have now included the relevant citations (Reuter et al., 2014; Tsuruta et al., 2015). The cited papers have used CarbonTracker and Sodankylä data and have provided CarbonTracker comparisons with our data. However, we would be interested to update these comparisons, when a new version of CarbonTracker becomes available. We have also amended the relevant text in the paper (section 4).

Referee: “Given that network-wide consistency is critical to TCCON’s utility for satellite validation, it is encouraging to know that activities are taking place at Sodankylä to validate the TCCON measurements using AirCore. I feel like presentation of these results is critical to assessment of Sodankylä as a site within the TCCON, and essential to an encompassing description of the data. I do, however, appreciate that they may be reserved for a separate publication - I hope that some compromise can be found to at least show some example profiles as measured by the AirCore”

Authors: This is a very good point. AirCore activities have been very successful in Sodankylä. We have performed the AirCore flights during each season and are further developing the AirCore system. We have included more information on AirCore in the revised version. Also there are now several papers in preparation, which make use of our AirCore measurements. For example, one of the ongoing initiatives is to use AirCore to measure additional stratospheric gases.

C2

Specific comments: Page 3, line 27: "Is the HCI cell also in place for solar measurements, like at many other TCCON sites? If not, why not?"

Authors: Prevailing understanding is that the ILS measured from the lamp is not significantly different from the solar ILS. In all normal conditions ILS changes very slowly. Hence it is thought that monthly lamp measurements represent ILS sufficiently well (Hase et al., 1999).

Page 4, line 1: comment on the modulation amplitude.

Authors: Modulation amplitude for a well-aligned FTS should be in the limits of 5% variability over the 0 to 45 cm OPD. This is needed to keep the measurement within TCCON error limits (Wunch et al., 2011a).

Page 4, line 6: "According to' is not the right wording here. The figure shows the LINEFIT derived modulation efficiency at maximum OPD has remained relatively stable over time, indicating that the alignment has been maintained."

We have changed the wording accordingly.

Page 5, line 2: "You need more information on the differences between the boards (ECL02, ECL04 and ECL05), and to briefly describe what the different operation/effects are from the different boards."

Authors: We have added a table to provide details on the laser board settings and measurements. The table provides information on the ghost to parent intensity ratio (GPR) and the ratio of the spurious signal to primary signal intensity (SPR) at different scanner velocities.

Page 5, line 14: add a reference.

A relevant reference is added (Washenfelder et al. (2006)).

Page 5, line 16: "Large differences in xAIR values compared to the network wide mean are a sign of instrument problems. Is this always true? E.g., an error in the pressure

C3

readings at a site could result in xAIR differences that are not a result of instrument problems of the FTIR. Also, you can learn something about the instrument from the relative stability of the xAIR values at one site; xAIR serves as a proxy for the instrument stability."

Authors: We suggest a modification as follows: "Large differences in xAIR values compared to the network wide mean are a sign of instrument problems. The problems may be related to several factors, such as a poor optical alignment, spectral ghosts or faulty pressure sensor."

Page 5, line 25: "Difference of GGG2014 versus GGG2012."

Reference to Wunch et al. (2015) has been added.

Page 6, line 3: "You could (should) use the method of Dohe et al. (2013) to try to assess the LSE during the period without Si measurements."

Authors: This is a very good point. We will perform these calculations in the future. Meanwhile we have provided our own correction, as described in the paper. Since the period is relatively short (6 February-15 May 2009), we haven't used these data for trend calculation or the calculation of the seasonal cycle.

Page 6, line 16: "You should include the exact DOI here."

Authors: This is provided in the revised version of the paper.

Page 6, line 20: "How is this calculated and what are the uncertainties?"

Authors: The trend was calculated using monthly means. Detrended monthly values were then used to calculate the seasonal cycle. We find standard errors of 0.025 ppm in average.

Page 6, line 26: "This requires better description. Wunch et al. (2013) found that the magnitude in seasonal cycle are correlated with the surface temperature anomalies in boreal regions. "

C4

Authors: The text has been amended as per the suggestion.

Page 6, line 32: "I don't think it is 100% correct to refer to CarbonTracker as a model. TM5 is the model, CT is a data assimilation product that estimates CO2 fluxes. These flux estimates combined with the model can simulate xCO2"

Corrected in the revised version of the paper.

Please also note the supplement to this comment:

<http://www.geosci-instrum-method-data-syst-discuss.net/gi-2015-38/gi-2015-38-AC1-supplement.pdf>

Interactive comment on Geosci. Instrum. Method. Data Syst. Discuss., doi:10.5194/gi-2015-38, 2016.