Interactive comment on "Usability of optical spectrum analyzer in measuring atmospheric CO_2 and CH_4 column densities: substantiation with FTS and aircraft profiles in situ" by M. Kawasaki et al.

Anonymous Referee #1

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The topic of the paper is the comparison of a small spectrometer for the measurement of the column abundances of CO2 and CH4 with TCCON measurements as well as with aircraft in situ profiling.

A small spectrometer for the measurement of the column abundances of GHG is scientifically very interesting. However, it has to be demonstrated that the retrievals from such a spectrometer have sufficient precision and that no bias is introduced by an instrumental drift of the small instrument. Only if the precision and the drift are well

characterized such spectrometers should be employed. Otherwise they are not useful for satellite validation and source sink estimates derived from them will be distorted. In my opinion the following points have to be addressed before publication in AMT:

1) Overall remarks:

a) TCCON-comparison: Different retrieval codes are used for the TCCON-retrievals and the OSA-retrievals. Besides that the spectral regions for the retrievals are different. Both certainly introduce a bias. I would suggest using the same retrieval code (preferentially the TCCON code) to do the retrievals in the same spectral region. If the difference between the retrievals still exists, reasons should be discussed. In addition an investigation of the impact of the resolution on the retrievals is needed. This could be done with the existing TCCON-spectra, either during the retrieval of by cutting the interferograms.

FTS measures the absorption spectra in wide spectral region with high resolution and the spectra are retrieved by the GFIT algorithm in the TCCON standards. On the other side the OSA in the present

study is a grating-based instrument with low resolution and slow scanning rate. We understand that the FTS and OSA instruments have been developed by independent concepts and technology. Thus we do not think that there is an inconsistency between the FTS and OSA in measuring different wavelength regions and retrieving the data by the individual algorithms. It may be better that the absorption spectra in the same wavelength region are measured by both of the FTS and OSA instruments and retrieved by the same algorithm, but this is a task of extreme difficulty in actual fact.

b) Aircraft comparison: It is important to do a careful estimation of the error, which is introduced by assumptions on the profile above the aircraft ceiling. This has to be shown to introduce a significant error (e.g. Messerschmidt et al., Atmos. Chem. Phys., 11, 10765-10777, 2011)

We estimated the uncertainty for the aircraft measurement by using the method which you have suggested. The uncertainties were 0.21 – 0.25 ppm. The details are described in the revised manuscript.

3) Specific remarks

Title: I would re-think the use of "Substantiation" P1 line 18-20: "The first involved a long term measurement in parallel with a high resolution Fourier transform spectroscopy (FTS) studies at the University of Wollongong in Australia." Sentence needs re-phrasing.

Changed to "The first substantiation was obtained by a long term measurement in parallel with ….."

P2 line 1: "Carbon dioxide and methane have the highest and the second highest contributions of _64 and 3 _18 %, respectively, to overall global radiative forcing from major greenhouse gases (WMO 2011)." Anthropogenic should be added, because of water.

Changed to "overall global radiative forcing from major anthropogenic greenhouse gases (WMO 2011)"

P4 line 17-20: "The profiles of temperature, pressure and relative humidity against

altitude are available from the database of National Centers for Environmental Prediction/ National Center for Atmospheric Research (NCEP/NCAR) to calculate the column of H2O." Why is the water not retrieved from the spectra?

We did not measure H_2O absorption. The wavelength regions for CO_2 and CH_4 in Fig. 2 were selected because contamination of H_2O is very small. We do not think that usage of the NCEP/NCAR database is invalid for estimating the H_2O column in the present work since the spectra only on clear sky days or intervals were retrieved.

P5 line 1-2: "The averages between 10:00 - 14:00, while the solar intensity is stable, were plotted with the standard deviations." Why limit only to these times? The intensities should be stable during the scan, but there is no reason that the intensities are comparable between the retrievals.

Non-resolved sunlight intensities (the NIR intensity in Fig. 1) at mornings and evenings were unstable while those at 10:00-14:00 were almost constant. The sunlight intensity before 9:00 or after 15:00 was often weaker than that in midday by 10% or more. The retrieved values, of course, did not directly depend on the sunlight intensity but we believe that the data between 10:00-14:00 at smaller solar zenith angles are more reliable.

P6 line 19-21: "The column density of (8.339 ± 0.061) × 1021 molecules/cm2 measured by the OSA at UoW (34.406 S, 150.879 E: 30 m a.s.l.) in the same period is thus directly comparable with that at JAXA in Tsukuba:. . ." This is not true. The column density varies due to pressure and therefore only the XGas values should be compared.

We agree with you and deleted the description from the line 25 on p.4105 to the line 6 on p.4106 in the open discussion paper.

Figures: The figure captions should always state, which scaling factor has been used.

The scale factors (SF) were interpolated in the figure captions of the revised paper.

Figure 3: Add error bars to OSA-data

We assigned the uncertainties of the OSA measurement, and Fig. 3 and Table 1 were revised.

Figure 6: Add error bars to the aircraft data

done

Two papers were newly cited:

Machida, T., Matsueda, H., Sawa, Y., Nakagawa, Y., Hirotani, K., Kondo, N., Goto, K., Nakazawa, T., Ishikawa, K., and Ogawa, T.: Worldwide measurements of atmospheric CO_2 and other trace gas species using commercial airlines, J. Atmos. Ocean. Tech., 25, 1744–1754, doi: 10.1175/2008JTECHA1082.1, 2008.

Messerschmidt, J., Geibel, M.C., Blumenstock, T., Chen, H., Deutscher, N.M., Engel, A., Feist, D.G., Gerbig, C., Gisi, M., Hase, F., Katrynski, K., Kolle, O., Lavrič, J.V., Notholt, J., Palm, M., Ramonet, M., Rettinger, M., Schmidt, M., Sussmann, R., Toon, G.C., Truong, F., Warneke, T., Wennberg, P.O., Wunch, D., and Xueref-Remy, I.: Calibration of TCCON column-averaged CO_2: the first aircraft campaign over European TCCON sites, Atoms. Chem. Phys., 11, 10765-10777, doi:10.5194/acp-11-10765-2011, 2011.