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**Atmospheric
Measurement
Techniques
Discussions**

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.

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This article describes measurements of total column CO_2 and CH_4 with a small and cost-efficient optical spectrum analyzer (OSA). In two field campaigns, the measurements were compared to TCCON FTS measurements at the University of Wollongong, Australia, and to FTS as well as aircraft in-situ measurements over Tsukuba, Japan.

Major comments:

1. Sect. 3.2: The information about the aircraft measurements is very weak. The authors should provide a lot more information on
   - what aircraft was used?
   - what was the vertical coverage and what were the limiting factors?
   - what instrument(s) were used for the in-situ measurements?
   - how close in time and space were the flights and ground-based measurements?

The items pointed out are revised in the subsection 3.2.

2. Sect. 3.2.2: How is this section related to the aircraft measurements?

The original description was confusing as you pointed out. We made it clear by changing the subtitle to "3.2 Substantiation with GOSAT validation campaign" and revised the following descriptions.

3. In general, the structure could be improved. Aircraft and FTS intercomparisons at Tsukuba would probably be clearer if they were divided into separate subsections.

Please see above.

4. The weakest point in the whole measurement technique is that only the slant columns for CO_2 and CH_4 are measured. To derive column-averaged dry-air mole fraction (xCO_2, xCH_4), one has to rely on pressure measurements and make several assumptions about the atmosphere (e.g. small horizontal gradients). The deficits of this method vs. the TCCON method of using total column O_2 as a proxy for dry air have long been discussed by Washenfelder et al. In the TCCON community, deriving the dry-air column from pressure has been dismissed because of the much larger errors. Still, I see no discussion of these problems - neither in the main text nor in the conclusions. Under these circumstances, at least detailed information about the pressure measurements (sensor, precision, accuracy) and some error discussion would be appropriate.

Basically we admit your comments but we can not use the O_2 column density at this stage in obtaining the mixing ratios. We measured the O_2 absorption and tried to get the column density. However, it was difficult to get reliable results because the resolution of a grating depends on the wavelength: the spectral resolution of the OSA around 1270 nm for O_2 was lower than that for CO_2 (1570 nm) by 2.5 times, i.e., 0.5 cm^{-1} under the present conditions. This resolution was too low. We are planning to get a higher resolution by devising an optical fiber and the results will be presented in near future.

The specification of the pressure transducer employed is given in the Instrumental section.

Minor comments:

• p. 4101, l. 5: please correct "Duetscher et al." to "Deutscher et al."

Thank you.

• p. 4101, l. 8-10: I disagree with the statement that operation of TCCON-type FTS in a remote location requires an highly-educated operator. Several TCCON instruments run fully automated for many months without a specially-trained operator on site. Besides, the parts that typically require maintenance are the ones that are exposed to the elements (like the solar tracker) - not the FTS itself. Other spectroscopic instruments would suffer from the same problems.

We deleted the expressions of “requires a highly educated operator” and “unsuitable under severe climate conditions”.

• p. 4101, l. 10: Please define "portable use under severe climate conditions" better. Geibel et al., Atmos. Meas. Tech., 3, 1363-1375, 2010, describes an FTS that has proved to be very portable for a TCCON instrument (operation in Germany, Australia, Ascension Island). This instrument has been operated in temperatures between -20 and +36 _C and has survived extreme rainfall and wind speeds of more than 30 m/s with no problems. How would you rate your instrument compared to this one?

We understand that the FTS housed in a 20-foot container should be transported by truck, train or ship with a crane to hang it up or down. We think that this is “transportable” but not easy for mobile use at everywhere. The small sun tracker has been used at Showa Station in Antarctica (-40°C) successfully and summer (>35°C) in Japan without trouble. The OSA system is composed of two main parts: an OSA and a small sun tracker the weight of which are less than 20 kg. They are able to be carried by a car and set up by hands of one person within a day to start measurement (one assistant person is desirable if possible). The whole system is automatically operated. Until now (for these 4 years) it has not been necessary to exchange element of the OSA, sun tracker or optics. The normal operation of OSA has been full-automatic. Unexpected accident was sometime sudden electric power off by thunder etc. What we have to do for the accident is only to switch off all the instruments and then switch them on again. After this procedure the OSA system restarts the data accumulation. The most severe circumstance which we have experienced was a huge earthquake of magnitude 9.0 on 11 March, 2011. At JAXA in Tsukuba we had a tremor with an intensity of 6 on the Japanese seven-stage seismic scale. The FTS stopped at the earthquake. Fortunately the electric power at JAXA was alive after the earthquake and the OSA system continued the measurement. However, we had many and large aftershocks and then switched off the OSA on 17 March for safety.

• Sect. 2: Please give some information about the environmental conditions that the solar tracker can sustain. How is it protected from the elements?
See above.

• Sect. 3: Do I understand correctly that your solar tracker was not used for these measurements and that the solar signal was fed from the FTS solar tracker instead?
Original description was not always clear and then revised. We employed two sun trackers for the OSA and FTS, individually.

• p. 4103, l. 5-7: Please provide the extact version of the TCCON software that was used for the retrievals.
Version 4.4.2

• p. 4103, l. 21: Please provide more information on the 3% discrimintaion procedure.
We do not have standard criteria for the discrimination yet. The present 3% is tentative. In near future the OSA users will decide reasonable criteria if needed.

• Sect. 3.2: What sondes were used for the meteorological profiles? What was the upper limit for the relative humidty measurements?
GPS radiosondes as described in the text. 0-100 % RH

• p. 4106, l. 14-17: By what definition do you derive the tropopause altitude? What are the lapse rates above and below derived tropopause heights?
We obeyed the definition of the Japan Meteorological Agency: <2.0°C/km at <500 hPa.