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Atmospheric Measurement Techniques Discussions

Interactive comment on "Characteristics of the Greenhouse Gas Concentration Derived from the Ground-based FTS Spectra at Anmyeondo, Korea" *by* Young-Suk Oh et al.

Anonymous Referee #2

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The manuscript "Characteristics of the Greenhouse Gas Concentration Derived from the Ground-based FTS Spectra at Anmyeondo, Korea" by Oh et al. describes the setup and first results of the only Korean observation site in the Total Carbon Column Observing Network (TCCON) which has been fully operational since 2014. Compared to other TCCN stations, the main technical difference is the addition of the OASIS system which compensates solar intensity fluctuations during the measurement.

Unfortunately, I am not happy with the manuscript in its present form. Even for a site description paper, it lacks depth. Technical details about the unique OASIS system and its performance are not provided. The description of standard TCCON procedures is

repetititve and could be left out for most parts. And the analysis of the existing time series is kept very simple with little interpretation. More sophisticated tools like model or other TCCON data comparisons are not used at all. Especially, I do not understand why the other species like CH4, CO, N2O measured by the same instrument are hardly mentioned and not used in the analysis.

In its current state, the manuscript remains a technical description of the Anmyeondo site but lacks important details and analyses about its most important technical innovation: the OASIS system. This could easily be improved and should be. For the analysis of the actual observation data, there is a a lot more than can be done. The authors could use the Darwin site paper (Deutscher et al., 2010) as an example. For a good site paper, it would be important to put the results of the site in context with the rest of the TCCON network. If the authors want to stick to a technical description of the site only, the paper might be better suited for the Copernicus Journal Geoscientific Instrumentation, Methods and Data Systems (GI).

Suggested revisions:

Section 2.2:

- what exactly does "operation is semi-automated" mean and how does it affect e.g. the number of measurements as opposed to fully autmated like many other TCCON instruments?

- the many details in the FTS and solar tracker description are only useful for TCCON experts. For the general reader, you should mention that the part described here is a standard setup for a TCCON site (except for OASIS).

Section 2.3: OASIS

I think this is the most interesting technical part of this TCCON site but the description and analysis is not thorough enough. Especially, I miss a detailed discussion of the pros and cons of a system like OASIS. For example:

- what is the dynamic range of OASIS?

- how large is the quality difference of clear-sky spectra with OASIS compared to without?

- how does this spectral quality difference translate into retrieval quality inprovement?

- in the example in Fig. 5, why is the signal with OASIS lower than without? Does the better stability with OASIS compensate the loss in intensity and hence in signal-to-noise?

- do you log what OASIS is doing? Can you still distinguish between observations with truly clear sky and such with thin clouds or other intensity fluctuations? Maybe some would better be dropped rather than compensated.

- is a system like OASIS worth the effort? How many more spectra do you get compared to the TCCON approach of dropping ones with SIV>5%? In Fig. 5, it looks like there were only a few events with strons drops in intensity. And I wonder if they could actually be corrected by OASIS. Certainly, a thick cloud moving in from of the sun cannot be compensated.

- how does OASIS affect the pointing accuracy of your solar tracker?

Section 2.4:

This whole subsection only describes standard TCCON retrieval procedure without any obvious site-specific adaptions. I think the whole subsection can be left out and be replaced by a single sentence and a reference to Wunch et al. 2015.

Section 3.1:

- you should explain a little better what Xair is and how it can be used as an indicator of stability.

- what are the plots in Fig. 8 showing? Obviously not single retrievals! Are these daily

means or medians or something else?

- Plotting and discussing CO2 and O2 separately here is a poor choice. The whole idea behing TCCON is to remove airmass-related effects to produce high-precision observations. What we see here is simply the change in airmass probably due to the seasonal change of the sun's position in the sky (and a small part from ground pressure changes). All carbon-cycle related effects are completely hidden by this effect.

Section 3.2:

- I don't aunderstand the argument about the comparison between between g-b FTS and OCO-2. A priori profiles and averaging kernels are available for both observations. What CO2 profile do you mean with "... since we do not have the CO2 profile that reflects the actual variability over the measurement site."?

Section 3.3:

- Is this really all you can see: XCO2 variability because of photosynthesis? Are there no in-situ observations nearby so one could separate CO2 in the Planetary Boundary Layer (PBL) from CO2 in the free troposphere or at least look for differences in PBL and total column?

- Especially in this section, the other observed species like CH4, CO, and N2O might have been really useful. I doubt that all you can see at your site are local effects and maybe some seasonal background variation. There must be transport from other regions which would probably show up in CH4 or CO.

References:

- the authors should include their own TCCON data citation reference and DOI in their reference list!

Minor corrections:

- please make sure that all acronyms and abbreviations (liek "g-b") are defined in the

main text, even if they have been defined in the abstract already.

- p. 1, l. 31: "G-b FTS" is not a very good choive for a keyword. Neither is "OASIS" as it is not a unique term and also not a well-established acronym (yet).

- p. 2, l. 15: "TCCON achieves the accuracy and precision in measuring the total column of CO2 ..." -> TCON achieves this precision and accuracy for the column-averaged dry air mole fraction of CO2 (XCO2), not for the total column!

- p. 2, l. 12: you mention "several atmospheric GHGs" but you neither say which nor discuss them in any way in this manuscript. Why?

- p. 2, l. 25: "a new home made OASIS system" sounds as if "OASIS" was an established acronym. It is not, it is just your internal name for your device. It might also be better to define the acronym OASIS in the main text rather than in the abstract. My suggestion for the sentence would be "One of the interesting issues in this work is a new home made addition to our g-b FTS instrument (see Sect. 2.3) that reduces the solar intensity variations from the 5% maximum allowed in TCCON to less than 2%."

- p. 2, l. 25: "SIV" instead of "SVI"! In fact, you don't need this acronym at all. It is TCCON jargon and only used three times in the whole manuscript (and you spelled it out each time!).

- p. 2, l. 27-28: there is no need to provide an outline of the sections and numbers. Scientific papers typically don't have a table of contents. Just drop these two lines.

- p. 3, l- 3: Please replace "G-b" with "g-b" throughout the text unless it starts a sentence.

- p. 3, l. 5: "... Seoul, the capital city of Korea." -> I don't want get into politics here but isn't the country officially named "Republic of Korea"? "South Korea" would probably also be clear, maybe even clearer to the general reader.

- p. 3, l. 22-23: avoid the line break for "A 547". In fact, I believe the tracker model

number is "A547" (w/o space).

- p. 3, l. 23: "... are about 0° to 315° and 10° to 85° degrees ..." -> (1) "°" and "degrees" are redundant, (2) is the elevation range really only 10 to 85 degrees? Does that mean the tracker cannot point to the horizon or zenith at all?

- p. 4, l. 3: "oil-free" -> "vacuum pump" is missing. Is the pump running continuously?

- p. 5, l. 9: "... voltage ranges of approximately 0 to 219 mV." This information is hardly useful for anyone outside your department. Especially since you claim that "... the detail characteristic of the operation is beyond the scope of this paper."

- p. 5, l. 13-14: "the intensity of the incoming light occurred due to changes in thin clouds and aerosols loads or interceptions by any other objects along the line of sight over the measurement site." -> thin clouds is clear but aerosol load should not really change during a 2-minute measurement. And what objects could be passing the line of sight often enough to justify such a system?

- p. 6, l. 13: GGG is not developed "by JPL" even though the main developer works there. But there are also other main developers who work at different institutions even ouside Caltec/JPL. It would be correvt to say that GGG is developed by the TCCON community.

- p. 8, l. 9: "LINFIT" -> "LINEFIT"!

Figures:

- Fig. 1: (1) picture quality is not very good, (2) country borders and maybe the location of Seould would be helpful, (3) For the insets: the upper one is clear but what is the lower one? The labels are Korean only.

- Fig. 2: (1) "server" instead of "sever", (2) you used "solar tracker" throughout the text, so you should not use "sun tracker" in the figure, (3) "Photographs of the automated FTS laboratory."

- Fig. 3: how is signal-to-noise defined here?

- Fig. 4: low quality/resolution

- Fig. 5: (1) low quality/resolution, (2) is this the same day for both plots? (3) why does signal drop off to the right with OASIS even though start time is earlier? (3) better plot this over solar zenith angle than over time!

- Fig. 6: very low quality with obvious JPEG compression artifacts. This should be redone in a lossless compression format like PNG or a vector format like PDF!

- Fig. 7: (1) not referenced in the text at all! (2) Should probably belong to Sec. 2.4 which means it should appear before (!) Fig. 6. (3) I don't know why this Figure is even part of the manuscript. Is this an original figure created by the authors or taken from somewhere else? (4) similar quality problem as with the other figures. The box labels are basically unreadable.

- Fig. 8: (1) low quality/resolution (2) why not just plot XCO2? The variations in column are mostly due to seasonl airmass variation (as can be seen in O2 column). XCO2 would tell you something about carbon-cycle related effects at your site!

- Fig. 9: unlike the other figures, this one has acceptable quality. I would still suggest to plot daily medians instead of means.

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