Response to comments #2:

Thanks very much for your comments, suggestions and recommendation. Our response to all your comments are as follows. There is an extensive discussion among the authors regarding how to revise the content. So the response is delayed, and we are sorry for this.

The manuscript "Sensitivity of instrumental line shape with respect to different optical attenuators and resulting error propagation into atmospheric trace gas retrievals" describes a series of systematic tests to find an optimal way of adjusting light intensity on the detectors of the Bruker IFS125HR high-resolution Fourier transform infrared (FTIR) spectrometer. This instrument type is widely used in the FTIR Network for the Detection of Atmospheric Composition Change (NDACC) as well as the Total Carbon Column Observing Network (TCCON). The results are certainly relevant for the NDACC and TCCON communities but also highly technical and instrument-specific. Like referee #1, I would prefer if the manuscript could be labelled as a technical note instead of a research article.

Response:

As suggested by referee #1, we change the title of the manuscript.

The title is now:

Technical Note: Sensitivity of instrumental line shape monitoring for the ground-based high resolution FTIR spectrometer with respect to different optical attenuators.

This paper has been condensed quite a lot to follow the format of a technical note as your comments and referee #1. Please check the revised paper for details.

In general, the manuscript should be more concise and needs more structure. The individual sections are rather long and contain no subsections! That makes it very difficult to look up individual experiments and results. I also wonder if we really need a 3-page introduction and a whole section on optical background removal.

Response: This paper has been condensed quite restructured. Only the introduction related to the topic of this paper has been remained. The optical background removal was condensed and moved to the section of "Consistency between sun and lamp

ILSs". Please check the revised paper for details.

The manuscript will also need extensive copy-editing at some point as it contains numerous language glitches and awkward formulations. This could as well be done before the next update possibly with the help of some of the co-authors.

Response: Actually, the language problem was also pointed out before AMTD and then we have paid a copy-editing service to improve the language (http://www.horizonproofreading.org) in AMTD. Unfortunately, this company is rather slow and has bad quality. In order to sort out the remaining language problem, the revised version is subjected to a second copy-editing by one of the coauthors with a good command of English. I think this version would be much better. If the revised version still don't fulfill the AMT language requirement, I would like to use the copy editing service offered by AMT.

For the content, I agree with all the points raised by referee #1. In addition, I wonder why the authors did not test the effect of placing an attenuator or aperture into the parallel beam between the sun and the first plane mirror. This is a setup that is used for all the TCCON instruments built by Caltech (fixed-size aperture) as well as the instrument on Ascension Island (iris aperture). As far as I know, the instrument in Bremen is fully operational and such an additional experiment should only take a day or so. It can be done without even opening the instrument.

Response: The setup that fixing the aperture and placing an attenuator or aperture into the parallel beam between the sun and the first plane mirror belongs to the scenario that inserting attenuators # 1~4 in front of the interferometer in this paper. I don't think it is necessary to include this setup in the revised paper.

Actually, with Hefei instrument, we compared the default scenario (aperture is fixed at 1mm size and don't insert any attenuators) with the scenario that inserting the attenuator #2 between the sun and the first plane mirror. The ILS modulation efficiencies and phase errors deduced from the two scenarios are shown as following figure. Consistent ILS retrievals of the two scenarios were achieved. This finding could apply to all TCCON instruments since Hefei run the same instrument as other TCCON site. We did not include these results into the paper to avoid instrument to

instrument bias.

(a)   (b)
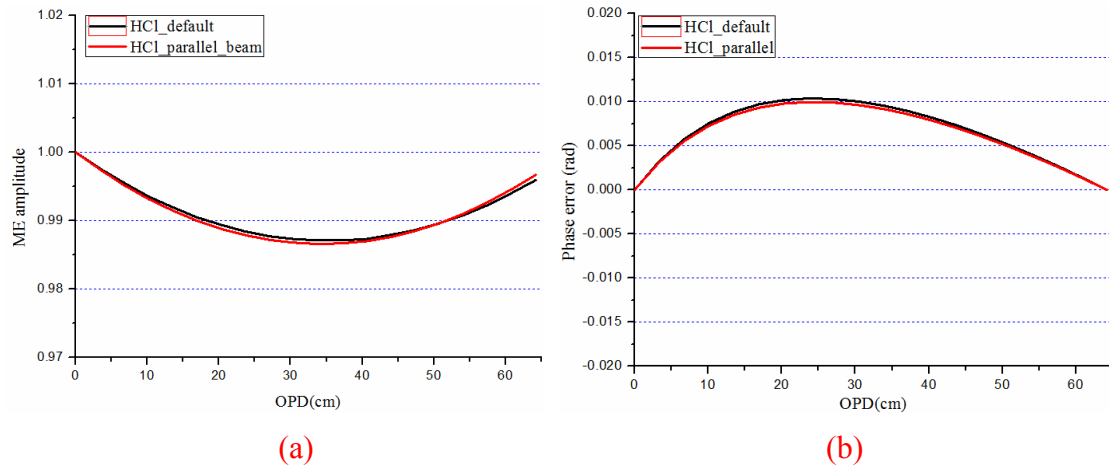
Fig.1 (a) ME and (b) phase error, dark line: default scenario; red line: placing an attenuator or aperture into the parallel beam between the sun and the first plane mirror

All in all, I would consider the necessary changes to the manuscript major. Below is a list of minor revisions that should also be fixed. Note that I did not report language glitches as there are too many:

Response: The revised paper was subjected to a major revision based on your following comments and the comments from referee# 1. A re-copy editing was also performed to sort out the language problem.

• l. 72–73: the order of the references should correspond to the order of the retrieval algorithms.

Response: This has been done.

• p. 3, footnote: in AMT, footnotes should be avoided (see authors' guidelines).

Response: The footnotes and their content have been removed to condense the paper as well as to fulfill the format of AMT.

• l. 104–114: this summary of the different parts of the manuscript should already be covered by the abstract and is repetitive here.

Response: We removed these parts in the revised paper.

• l. 123–161: the different experiment groups and attenuators are confusing. Rather put subsections here for each group and type of attenuator if necessary

Response: This section was divided into 4 subsections as your comments. The optical

scenarios of each experiment are subsumed into a table to avoid tedious description. Please check section 2 in the revised paper for details.

•l. 162–172: this should definitely be a separate subsection.

Response: We condensed this paragraph and moved it to subsection 2.1

• Fig. 1: I really like this schematic drawing of the instrument with all its mirrors (a). However, part (b) with the different attenuators should really be a separate figure.

Response: This figure has been divided into two figures. Please check figure 1 and 2 in the revised paper for details.

• l. 205–206: the use of quotes here is awkward.

Response: The quotes have already been removed. Please check section 3 in the revised paper for details.

• l. 217: ". . . enforces the use of the interfering gases . . . "? I do not understand.

Response: It means that the optical path in sun cell measurement is much longer than the lamp measurement, the inference caused by interfering gases are more obvious. This discussion is trivial, this sentence has been removed to concise this paper .

• Figs. 2–6: the use of (1), (2), (a), and (b) is confusing. Rather write clearly what (1) and (2) are.

Response: This has been done. Please check Figs. 3-7 in the revised paper for details.

• Fig. 2: the dark blue (?) color and black are hard to distinguish.

Response: Clarified. Please check Fig. 3 in the revised paper for details.

• Fig. 3: cryptic legends!

Response: Clarified. Please check Fig. 4 in the revised paper for details.

• Fig. 4: what is "calc" and "spec"?

Response: "calc" represents the calculated spectrum and "spec" represents the measured spectrum. We have included this clarification in the caption of Fig.5 (.i.e., the original Fig.4)

• Fig. 5: cryptic legends!

Response: Clarified. Please check Fig. 6 in the revised paper for details.

• l. 256: what does ". . . kept at a level of less than 4%. . . " mean?

Response: This section has been removed to concise this paper .

• l. 262: there is no Wunch et al., 2015, in your reference list. At least the year is missing from the entry in l. 606–608.

Response: The year was included in the revised paper. Please check the last reference in the revised paper for details.

• l. 262: start a new paragraph before "NDACC . . . ".

Response: This section has been removed to concise this paper .

• l. 289–290: you need to explain a little more than just writing "The comparison . . . in Fig. 7.".

Response: This section has been removed to concise this paper .

• Fig. 6: units for ME and phase error are missing.

Response: The units are included. Please check Fig. 7 in the revised paper for details.

• Fig. 8: better separate the two plots in (c) a little more and also add a vertical axis and label to the right one. Also: averaging kernels are square matrices. This looks weird in this aspect ratio.

Response: This section has been removed to concise this paper .

• Table 1: E+15 might be ok for computer code but please use 10^{15} here for readability.

Response: This section has been removed to concise this paper .

• l. 314–315: some of the lines in Fig. 9 and 10 clearly stand out from the rest. You should comment this here!

Response: This has been done. Please check the first two paragraphs of section 4.1 in the revised paper for details. Fig. 9 and 10 correspond to Fig.7 and 8 in the revised paper.

• l. 360–362: I do not understand this sentence.

Response: This section has been removed to concise this paper .

• l. 369: "before" is mainly used with respect to time and sounds a little awkward here.

Response: It has been changed to in front of. Even though "before" can also very well be used to locations. All these errors have been corrected.

• Fig. 9 & 10: the colors are hard to distinguish. Try different symbols/line styles or make more subplots with fewer lines. Also: cryptic legends!

Response:
Regarding the legends, "HCl_sun_#3_front" represents the sun HCl cell measurement performed by inserting the attenuator #3 in front of the interferometer. The nomenclature for other plot labels is straightforward.

• Fig. 12: cryptic legends!

Response: In order to condense this paper, this figure has been removed.

• Table 2: E+15 might be ok for computer code but please use 10^{15} here for readability. Also not clear if the % in the relative bias refers to the actual value or is a percentage of the total random/systematic error.

Response: This section has been removed to concise this paper .

• l. 411: "Uncertainty estimation . . ."

Response: In order to condense this paper, this whole section has been removed.

• l. 418–419: too many significant digits on these small percentages.

Response: In order to condense this paper, this whole section has been removed.

• l. 423–425: too many significant digits on these small percentages. Also: what is the 5/21?

Response: In order to condense this paper, this whole section has been removed.

• l. 432–435: too many significant digits on these small percentages.

Response: In order to condense this paper, this whole section has been removed.

• l. 444: the cos(: : :) terms should be written in in-line math mode or as a proper equation.

Response: In order to condense this paper, this whole section has been removed.

• l. 446–449: please do not write exponential numbers as E+. . . !

Response: In order to condense this paper, this whole section has been removed.

•references: you cite some inaccessible key references: Griffith 2010, Hase and Blumenstock 2001. Please check with the authors if they could be included in your manuscript's supplement or the new "Assets" section to make them available.

Response: In order to condense this paper, the content that cited these inaccessible references were removed. These references were removed accordingly.