Response to the reviewers of the paper **"The water vapor self-continuum absorption in the infrared atmospheric windows: New laser measurements near 3.3µm and 2.0 µm" by Loic Lechevallier et al.**
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REVIEWER 1

The manuscript "The water vapor self-continuum absorption in the infrared atmospheric windows: New laser measurements near 3.3 and 2.0 microns" by Lechevallier et al. presents the latest water vapor self continuum measurements from the Grenoble group, which has been steadily advancing in their quest to perform high-quality self continuum measurements in all near-IR windows of consequence to global energy balance. This new paper analyzes measured values at the high energy end of two windows, regions in which no measurements of equivalent accuracy have been performed previously.

The authors ably present the measurement approach employed and compare their results to previous measurements and the MT_CKD model. The analysis is solid and the paper will make a useful addition to the literature on this subject. Acceptance is recommended, although the authors should implement the improvements suggested below, as well as improve some instances of awkward language (further below).

Answer: The English has been revised all along the text of the new version. Most of the corresponding changes are in orange in the revised version. The changes related to the suggestions of the first and second reviewer are written in blue and green, respectively.

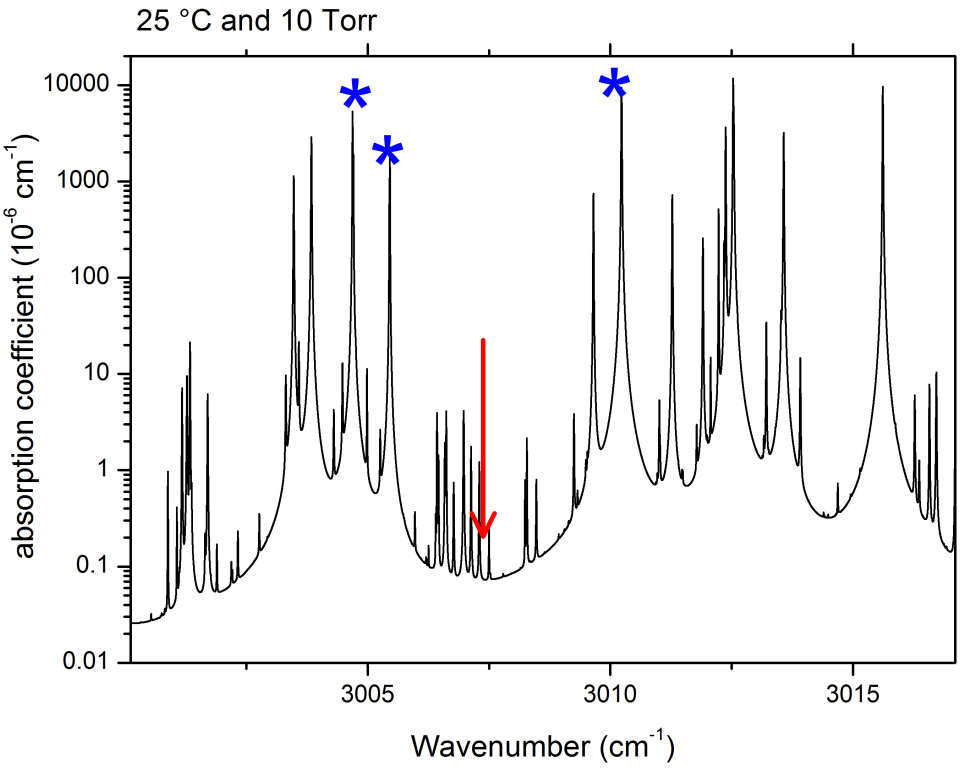
Issues:

1) The uncertainty in the derived self continuum values due to uncertainty in line widths of neighboring strong lines does not seem to be considered. The analysis presented in both regions indicates that the line contribution to the absorption coefficient is significant – for the 3007 cm-1 line it is even larger than the self continuum contribution. Therefore, any substantial uncertainty in the self-broadened line widths would lead to uncertainty in the derived self continuum coefficients. Unfortunately accurate information about the self-broadened line width uncertainty is hard to come by – the best approach might be to assume that it's similar to the uncertainty in the foreign-broadened widths. To develop the aer_v3.6 line parameter file, high-resolution TCCON observations in the near-IR were used to analyze and, if necessary, modify the foreign widths from three sources: HITRAN 2012, Mikhailenko et al., and one from the Regalia group. The differences between the three compilations and widths modified for aer_v3.6 could be as much as 20%. Therefore, for the present manuscript, I recommend the uncertainty provided for the derived self continuum coefficients should be revised to reflect a self line width uncertainty of _20%.

Indeed, in the present work as in our published papers on the water continuum, the reported error bars on the cross sections values do not incorporate the impact of the uncertainty of the line width parameters of the monomer. To the best of our knowledge, this is also the case of all other cross section determinations available in the literature (e.g. from NIST, CAVIAR etc…). Strictly speaking, in the regions where the monomer contribution is significant, like in the present work, the reported continua are dependent of the spectroscopic database used to subtract the monomer contribution. In our understanding, the default database to be used is the HITRAN database and as far as the HITRAN version used is clearly indicated in the text, traceability is insured and there is no reason to propagate the uncertainty on the monomer line parameters to the error bars on the continuum cross sections. The separation of the monomer contribution and of the continuum contribution is a major issue which remains unsolved today. Not only the uncertainty of the line width should be considered but also other factors like the choice of the Voigt profile which is an approximation, the standard ±25 cm-1 cut off and possibly monomer lines missing in spectroscopic databases (for instance, up to the 2012 version, many significant HDO lines were missing in the HITRAN list of water vapor in the near

infrared transparency windows). In that situation, we prefer to associate our continuum values to the HITRAN2016 line parameters of water vapor which insures traceability than to incorporate the self line width uncertainty.

We have nevertheless examined in more details the situation at 3007 cm^{-1} where the self continuum represents no more than about 25 % of the measured continuum signal. A width uncertainty of 20 % on the monomer lines leads to a range of 10-40 % for the continuum value. In fact, most of the monomer contribution near 3007 cm^{-1} is due to the three nearby very strong lines (*).



In HITRAN2016, the line parameters in this region were taken from Loos et al 2017. In their original paper, Loos et al reported error bars less than 1 % for the self broadening coefficient of the 3 lines (see Table , below). This is far below the 20 % error bar suggested by the reviewer and would not impact greatly the error bar on the reported self cross-section values.

position	intensity	g0s	error on g0s	
			cm-1/atm	%
3004.6863806	2.5192e-22	0.2493	1.5e-03	0.602
3005.4545887	8.1126e-23	0.1964	1.4e-03	0.713
3010.2324498	6.4795e-22	0.4253	2.0e-03	0.470

We have added the following paragraph at the end of Section 2.2:

Let us underline that, in the present situation where the measured continuum signal is dominated by the water monomer contribution, the retrieved C_S values are strongly dependent on the quality of the monomer line parameters, in particular the self broadening coefficient. Following the standard approach the uncertainty in line parameters of neighboring strong lines was not incorporated in our overall error bar. Our C_S values should then be associated to HITRAN2016 line parameters of water vapor to account for the overall absorption of water vapor in this region. Let us mention that most of the monomer contribution near 3007 cm^{-1} is due to three very strong lines at 3004.686, 3005.454 and 3010.232 cm^{-1} with line intensities in the 8×10^{-23}-7×10^{-22} cm/molecule range. HITRAN2016 line list of

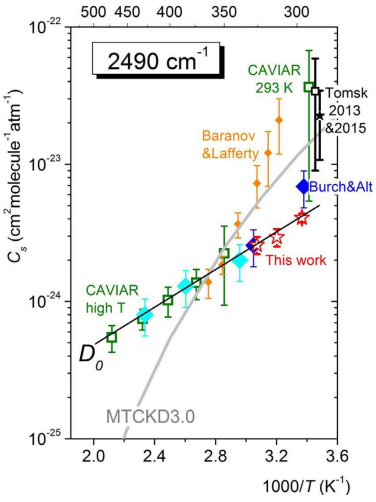
water vapor reproduces the line parameters obtained by Loos et al. (2017) in the region. For the three strong lines, Loos et al. reported an error bar less than 0.8 % for the self broadening parameters. This is significantly less than the 20-25 % error bar on the reported C_S values.

2. This paper states (pg. 10, line 5 and pg. 15, line 22) that MT_CKD has not yet taken the Richard et al. measurement into account. That leaves the reader with the wrong impression. The Richard et al. value was considered in developing recent MT_CKD version, but found to not be consistent with the satellite- and ground-based observations analyzed in Mlawer et al. (2012). Therefore MT_CKD was reduced as much as possible in that region to reflect the existence of the Richard et al. value but still maintain agreement with these field observations. This paper does a thorough job comparing the new measurements and the previous ones from the Campargue group with prior ones from other teams, but puzzlingly does not present MT_CKD as being measurement-based in this window. This leaves the reader with a misleading impression. The disagreement between the field observations analyzed in Mlawer et al. and the Richard et al. self continuum measurement will hopefully be resolved based on further observations, such as the foreign continuum measurements planned by the Grenoble team (the foreign continuum impacts the analysis of the field measurements) and additional self measurements in this window.

We thank the reviewer for this useful information and have corrected the text: the erroneous statement "the very recent OFCEAS measurement at 2491 cm^{-1}(Richard et al., 2017) is not yet taken into account" has been deleted and in the Conclusion, we have repeated the information given by the reviewer:

The Richard et al. value was considered in developing recent MT_CKD version, but found to not be consistent with the satellite- and ground-based observations analyzed in Mlawer et al. (2012). Therefore MT_CKD was reduced as much as possible in that region to reflect the existence of the Richard et al. value but still maintain agreement with these field observations. Further observations and foreign continuum measurements in the center of the 4.0 µm window will hopefully resolve this issue.

Let us note that at this particular spectra point, the t dependence of the MT_CKD continuum differs significantly from the measurements reported by Richard et al. This may also impact have an impact on the level of agreement with field observations:



3. On page 18, last paragraph, the authors have a fair amount of text discussing various analyses of atmospheric absorption based on the FTS measurements. Since this paper and the others from the Grenoble group have basically dismantled the possibility of the self continuum in the near-IR windows being as high as the room-temperature FTS measurements indicated (i.e. significantly larger

than MT_CKD), these high estimates of absorptions can be ruled out. Reading this last paragraph, I expected to have this paper culminate in a clear statement that these high estimates can now be assumed to have been in error. Is there a reason why the authors avoid stating this conclusion?

On page 17, we wrote
"*We believe that the high and mostly constant Tomsk and CAVIAR C_s values of about 4×10^{-23} $cm^2molec^{-1}atm^{-1}$ reported for the 4.0, 2.1 and 1.6 μm windows should be considered as an upper limit due to the detectivity threshold of the FTS approach. In general, the retrieval of a very weak water continuum from a single pressure spectrum is hazardous.* "
We believe that these sentences are sufficiently explicit. As concerned the last paragraph on page 18, we agree that we should have been more conclusive. We have now inserted the sentence suggested by the reviewer:

During very recent years, a set of CRDS and OFCEAS self-continuum cross-sections were obtained over four transparency windows with accuracy as good as a few %. ***These high sensitive laser-based measurements dismantled the possibility of the self continuum in the near-infrared windows being as high as the room-temperature FTS measurements.*** We hope that these results and the forthcoming studies of the foreign-continuum will help to reduce significantly the uncertainty of the impact of the water continuum on the Earth's clear-sky radiation budget.

Typos, minor items:
pg1 line 11 – "in the recent years" should be "in recent years" line 19 – MT_CKD3 should be MT_CKD
Corrected
pg2 line 2 – A fairly small fraction of the solar radiation in the earth's atmosphere is absorbed by water vapor (or absorbed at all). The authors likely mean that 60% of the solar radiation that is absorbed is absorbed by water vapor.
Corrected
line 3 – Since there are all sorts of water vapor absorption bands moving into the visible from the infrared, with weaker vibrational bands spaced with not perfect regularity, the authors might ;want to qualify "located every 1500-2000 cm-1" with a word like ""roughly" or "more-or less".
line 4 – Suggested change for clarity: "These are formed by multitudes of narrow rovibrational absorption lines that are...."
Corrected
lines 18-19 - Suggested change: "This model, which is basically a far-wing line shape model in the window regions, involves a number of ad hoc parameters that have been..." line 20 – "long-infrared" is not typically used.
Corrected
line 22 – The comma after "recently" should probably be removed.
Done
pg3 line 2 – The word "windows" should follow "4.0, 2.1, 1.6 and .25 microns" line 7 –"baseline" is usually one word line 21 – A period is missing at the end of the sentence.
Corrected
pg 4 line 21 – "upstream of" line 31 – Add "with pressure" after "absorption lines".
Corrected
pg 5 line 5 – The reader will have no idea when reading the caption to Figure 1 what is meant by "spectral fit" since its meaning is only clear (the absorption coefficient calculation) when reading about the calculation on page 6 – for example, they might assume it refers to some sort of curve fitting from the data. Perhaps change it to "corresponding spectral fit, as described in the text" or "corresponding absorption coefficient calculation, as described in the text".
Caption modified
pg 9 line 15 – For clarity, add the word "the" between "OFCEAS" and "CAVIAR".

The text has been modified.

pg 10 lines 17-19 – Since 5000 cm-1 is not between 4250 and 4725 cm-1, the wording of this sentence should be changed.

Correct. It is now modified: … sampling of the window by OFCEAS and CRDS from 4250 cm^{-1}.

pg 15 line 10 – The use of "law" here implies that the exponential expression is some sort of physical law that the values plotted in Figure 7 should obey. A word like "expression" might be more consistent with the intended meaning.

It is now modified: Nevertheless, near room temperature, the MT_CKD variation is close to the $\exp\left(\frac{D_0}{kT}\right)$ function at the three considered spectral points

line 13-14 – "new frequencies of" should be "new frequencies in" (note the missing letter "e")

Corrected

line 15 - V3.2 version is redundant since "V" stands for "version"

Corrected here and everywhere in the text

pg 18 line 5 – It's unclear why there is a reference to Ptashnik et al. here.

According to the MT_CKD web page, the recent modifications to the MT_CKD foreign continuum in the near-IR are due to "Foreign continuum coefficients from 1800-3000 cm-1 were modified to improve agreement with Baranov and Lafferty (2012); in the 1900-2150 cm-1 region, attention was also paid to IASI measurements (Alvarado et al., 2013)....

Foreign continuum coefficients at wavenumbers greater than 4000 cm-1 were modified based on Baranov and Lafferty (2012) and Mondelain et al. (2014) measurements. "

Our statement was not correct. Ptashnik et al., 2012 reported foreign–continuum typically between one and two orders of magnitude stronger than that given previous versions of the MT_CKD model but the recent modification of the MT_CKD coefficients rely on other sources.

The new text is the following:

FTS measurements by Ptashnik et al., 2012 indicated that the foreign-continuum in the near-infrared windows was typically between one and two orders of magnitude stronger than that given in previous versions (2.5 and before) of the MT_CKD model. In the more recent versions, foreign continuum coefficients were increased in the 4.0 and 2.1 µm windows on the basis of measurements by Baranov and Lafferty (2012), IASI (Alvarado et al., 2013) and Mondelain et al. (2014).