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Discussions

Interactive comment on "Impacts of H$_2$O variability on accuracy of CH$_4$ observations from MIPAS satellite over tropics" *by* Temesgen Yirdaw Berhe et al.

Anonymous Referee #1

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1   General Comments

This paper examines the variability in MIPAS CH$_4$ data, ascribing some of its variability to interference from water vapour and noting that this problem with the data has been at least partly corrected in the current release. The paper reports useful progress in the understanding of the quality of this important dataset. It should therefore be published. However, I am of the opinion that it requires a great deal of revision first.

Some of the work which the paper requires is merely technical corrections. The standard of written English, referencing and technical typesetting is patchy; I make many

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Discussion paper

suggestions for improvement below, but these are by no means exhaustive; it is not the task of the reviewer to do a complete copy-edit on the paper. And there are many ways in which the figures could be improved.

The main issue that I have with the paper is more structural: it needs to be clearer and more explicit about its aims and about how (and whether) these have been achieved. The paper feels like a collection of plots that have been produced while investigating a data set, which have all been thrown into a document without sufficient thought as to which figures are really needed to explain the point the authors are trying to make. To be published, it really needs a thorough re-organisation, and the authors need to explain what they did in some more detail and far more clearly.

2 Specific comments

- Page 1 line 11 "Moreover, the correlation coefficient between MIPAS CH4 220 and MIPAS `V5R_N2O_220` is 0.32 in the upper troposphere and lower stratosphere over tropics and larger than the modest value 0.5 in mid and high latitudes." This is odd wording; it is not clear what the specific relevance is of the value 0.5, nor how much greater than 0.5 the correlation coefficient is in mid/high latitudes.

- Page 5 line 18 : "The altitude range of the comparison [between MIPAS and FTIR] has been restricted to 18-21 km". Does it make any sense to do that, given that the vertical resolution of a FTIR instrument is far worse than 3 km?

- Page 8 figure 2: This figure shows nicely how CH_4 version 224 agrees better with FTIR than CH_4 version 220. However, there are a number of fixes needed

  – The text on the figure may be a little small, especially on the colour bar. Text on a figure should end up about the same size as the caption text in the final

version of the paper.

– The colour bar does not match the colours in the dots. In particular, the dots include an orange colour which does not appear in the colour bar.

– The cyan and green colours in the colour bar are not easy for the eye to distinguish. The yellow is very distinct from the other colours, but can be hard to see on a white background. Selecting a suitable colour scale is not trivial, and one should never be satisfied with the default colours in a plotting package.

– The caption says that both upper and lower panels are version 220. It is clear from the text that the lower panels are version 224, so the caption needs correcting.

– The altitudes in the colour bar are clearly in km; the caption should say so.

– There is a linear fit line of some sort shown in the figure, but it is difficult to see and the caption does not say what it is for. Either the line should be made clearer and the caption should explain its purpose, or the line should be removed.

– In plots such as this, where the two axes are for two estimates of the same quantity, and in the same units, the scale of the axes should be such that the 1:1 line is at $45°$ to the axes.

– It is good practice to add labels (a), (b) etc. to panels of a multi-panel figure so that they can be referred to from the caption.

• Page 8, last two lines, running on to page 9: It seems very odd to do such a limited comparison of MIPAS and MLS H_2O. Either the two instruments are known to agree well (in which case, why do a comparison at all?) or they are known to differ (in which case, how much can we learn from such a limited comparison?).

• Page 9 Lines 10–14: I am struggling to understand all this from the explanation given. We can see from figure 2 that CH_4 has only a very small range of possible

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values at a given height in the tropical lower stratosphere. This will also be true of any chemically-stable tropospheric source gas, including N_2O. The measurements could be unbiased and with relatively small random measurement error and you would still find them to have little correlation in a small altitude/latitude range. So the low correlations do not necessarily indicate large uncertainty, they may just indicate small true variability in both species. (Of course, both species decrease with height, so the correlation between them will appear good if you include data from a wide range of altitudes.)

• Page 9 lines 16–20: I do not understand what is meant by "subtracting the standard variability of water vapour from profiles of MIPAS CH4 220 and MLS methane" The authors need to explain what they did in more detail. A reader is supposed to be able (at least, in principle) to go away and repeat the work in a paper for himself. Based on this description, I would not be able to do so.

• Page 11 figure 4: If the authors decide to retain this figure, there are several improvements that could be made:

  – The title above each panel should be removed.
  – It is good practice to add labels (a), (b) etc. to panels of a multi-panel figure so that they can be referred to from the caption.
  – In general it is good practice to use a diverging (two-sided) colour scale such as that used here for a quantity which tends to be equally spaced about zero. But in this case there are no cells which have a negative correlation. The figure would therefore be clearer if a good single-sided scale were used, showing values only between zero and one. The caption could confirm that there are no negative correlations.

• Page 11 lines 7–9: I am concerned as to the validity of the results obtained by this procedure, given the very small sample size which the authors note earlier in

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the paper. Why not use the MLS and MIPAS data over the full time for which the FTIR data was available?

- Page 13 figure 6: It is mystifying to me that the red curve in the left-hand panel and the black curve in the right-hand panel stop at 40 and 32 km respectively. Also, the caption needs to explain what the dashed lines between 15 and 27 km represent.

- Page 12 lines 6-8 and page 13 figure 7: The text says that the figure shows the "natural variability" of the MIPAS H_2O — I am not clear on what this means. But if this figure is obtained from equations (4), as I rather infer, then it shows the actual natural variability of H_2O, inferred from both the MIPAS and MLS data. The authors need to me much more careful to ensure that their writing is clear and unambiguous.

- Page 13 line 15: The sentence refers to a colour bar, but does not say in which figure this colour bar is to be found. The section is discussing H_2O — CH_4 correlations, but there is no figure in the paper showing such a correlation with a colour scale.

- Page 14 lines 7–10 and page 15 figure 8: It is not stated whether this figure is for a single location, an area of the globe, the entire world. Furthermore, it is not explained why one figure has many more points on it than the other (about 106 vs about 39). As the data are stated to be monthly data for three years, 39 points is approximately correct, 106 points is clearly wrong.

3 Technical corrections

- Page 1 Lines 9-11 and elsewhere: Is it usual to put a space between a number and the % sign? If it is, it should be a non-breaking space (\, or ~ in LaTeX) in

order to ensure that the % is on the same line as the number.

- Page 2 Lines 5-6: It is not good style to start two consecutive sentences with "However, . . . ".

- Page 2 line 14: "on the upper troposphere" should be "in the upper troposphere".

- Page 2 Line 22: "been improve" should be "been improved"

- Page 2 line 25-26: This sentence repeats itself and should be shortened.

- Page 2 line 28: "revealed in (Payan et al., 2009; Errera et al., 2016)" should be EITHER "revealed (Payan et al., 2009; Errera et al., 2016)" OR "revealed in Payan et al., (2009) and in Errera et al., (2016)". Elsewhere in the paper, the authors should also be careful when citing a paper as to whether the author's names are part of their sentence (in which case only the year is in parentheses) or whether the author's name is not part of the sentence (in which case both the name and year are in parentheses).

- page 2 line 31: "did not quantified" should be "did not quantify".

- page 3 lines 2–4: This sentence is quite long and involved. The points could be made in a clearer and less ambiguous way, possibly with more, and shorter, sentences.

- Page 3 line 5: "sections 3" should be "section 3".

- Page 3 lines 9–11: This sentence is badly worded, in particular, "along with" should simply read "with".

- Page 3 lines 24–25: Another example of wrongly-placed brackets in a citation. "Lambert et al. (2007)" should be "(Lambert et al. 2007)".

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- Page 3 line 26: ...and another: "Minschwaner et al. (2015)" should be "(Minschwaner et al., 2015)".

- Page 3 Line 26 "The vertical resolution of MLS CH_4 is between 4 and 5 km and 4 to 6 km for N_2O". This is another example of the odd wording prevalent in this paper. The sentence would be better worded as "The vertical resolution of MLS CH_4 is between 4 and 5 km; the vertical resolution of N_2O is 4 to 6 km.". While I am looking at this paragraph, why do the authors state the vertical resolution of CH_4 and N_2O, but not for H_2O?

- Page 4 line 6 and elsewhere: "NyÅlesund" should be "Ny-Ålesund"; it is two words with a hyphen between them.

- Page 4 Line 13 and many places elsewhere: "CH4" should be "CH_4". The only exceptions should be where the symbols form part of the name of a MIPAS product, e.g. V5R_CH4_224

- Page 4 line 29: sigma^2 should be σ^2 and the letter M should be in italics.

- Page 4 line 30 It is better style to define some symbols in order to avoid using words such as *true* and *error* in equations. If you must use words, then they should be in non-italic type. So you could go for

$$\sigma^2(M_i) = \sigma^2(X_{\text{true}}) + \sigma^2(\text{error}_i)$$

but it is preferable to write:

$$\sigma^2(M_i) = \sigma^2(X_t) + \sigma^2(\epsilon_i)$$

where X_t is the true value of the measured quantity and ϵ_i is the measurement error of the i-th instrument.

- page 5 lines 3, 9 and 14: The mathematical symbols in the text need fixing.

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- page 5 line 11: Again, it is better to define some symbols and then use them than to have long words in the equations. Everything to the right of the = signs is fine, but the various σ^2s to the left of the = signs could be improved a great deal.

- Page 5 line 18, and probably many other places: A non-breaking space should be used between a number and its unit in order to avoid the number being at the end of one line and the unit at the start of the next. In LaTeX, use \, between a number and a unit to get a thinner space. Use ~ between "figure" and its number to get a normal-sized space. In word processors, use Ctrl-Shift-Space for a non-breaking space.

- Page 8 table 1: Is it not usual to use R for a correlation coefficient? Whatever symbol is used it is a symbol, so it should be in italics.

- Page 10 figure 3: In the caption "Addid Ababa" should be "Addis Ababa". Also, the range 1.8–3.0 ppmv appears on the plot, but is not used. The plot would be clearer if the axis went from 0.0 ppmv to 2.0 ppmv.

- Page 11 line 7: "at least two or more" should be "at least two". You do not need the "or more".

- Page 13 figure 6: Remove the words "MIPAS over" from the caption.

- Page 13, figure 7: The letter Åhas not reproduced correctly in the legend.

- Page 16 Line 24: "R" is a symbol so it should be in italics.

- Page 17 Line 7: Samuel Takele's name should have capital letters.

- Page 18 line 20: All ACP papers have a DOI — references should all include a DOI where it is available.

- Page 19 line 35: Not a complete reference, and part of it is incorrectly in ALL CAPITALS.

- Page 19 line 37: The authors should avoid referencing grey literature like this.

- Page 20 line 16: Some xml or html tags have crept into the reference.

- Page 20 (line numbering gone mad in draft) The reference to Randel and Jensen (2013) is not done correctly.