

## ***Interactive comment on “MIPAS IMK/IAA Carbon Tetrachloride (CCl<sub>4</sub>) Retrieval” by E. Eckert et al.***

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The authors thank the Reviewers for their revision of our manuscript and their helpful comments. In the following the original comments are inserted in *italic face* while our replies are printed in normal face.

### **Reviewer 1:**

*Page 3, Line 87: Figures should be referenced in numerical order: the first reference to a figure in the text should be to figure 1. (I would not re-order the figures to correct this, rather, I would remove the reference to figure 3 in this line.)*

**Reply 1:** Agreed. This will be changed.

*Figure 1 and Figure 3: The figures are really too small. They might be just about OK if made the full width of the two columns in the final version, but I am not sure about*

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*this. Text on figures should be a similar size to the text in the figure caption. The legends in these figures are particularly hard to read; it would help if they were not on top of the curves.*

**Reply 2:** Agreed. Figure 1 and figure 3 will be split up into two individual figures which each span the whole width of the page. The text will be changed accordingly.

*Figure 2: It is good that the two panels have the same colour scale for easy comparison. But the scale should go down to the lowest values shown in the left panel. As the figure stands, the colour white is used to represent two distinct things: negative values, and areas where there are no data. The “no data” areas should be left white, and the (white free) colour scale should extend so that it applies to the negative areas. The figure title “PAN, 200807” is not needed to distinguish the two panels and tells the reader nothing that is not in the caption. It should be removed. The contour lines should be in a colour (or colours) that allow them to be seen against the colour scale. With these changes made, Page 3 Line 113 will need to be changed (and can possibly be simplified). Many of these comments also apply to figures 4, 5 and 6.*

**Reply 3:** Agreed. The colour scale will be changed to cover the whole range of values of both figures. The titles will be removed. A decision on whether or not the contour lines will be changed to white or left black will be made depending on how dark the background colours will be. The text will be changed accordingly to reflect the changed colour scale.

*Page 6 line 118: “setup” should be “set up” because it is a verb. (Note that on page 7 line 140, “setup” is a noun and should be left as it is.)*

**Reply 4:** Agreed. This will be corrected.

*Page 6 line 131: “The spectral region [...] could be narrowed to [values]” Narrowed from what?*

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**Reply 5:** The gap could be narrowed down to 791.0 to 792.0  $\text{cm}^{-1}$  from 790.5 to 792.5  $\text{cm}^{-1}$ . Additional information on this will be given in the revised version of the manuscript.

*Figure 7: This figure is probably OK if shown at the full 8.3cm width of a journal column. The title "Rows of A" on each panel should be removed.*

**Reply 6:** We will change the figures to better reflect the altitude region of interest. The titles will be removed and the figures are intended to span the entire width of the page.

*Page 11 sec 5.1.1: It would be nice to add a figure showing the mean ATMOS profiles and a suitably-averaged MIPAS profile for the same time of year.*

**Reply 7:** We intend to provide the suggested figure in the revised version of the manuscript. Average MIPAS profiles of the respective region and time of year will be used. The text will be changed accordingly.

*Page 11 line 212: Remove comma after "profile".*

**Reply 8:** Agreed. The comma will be removed.

*Page 13 figure 9: It is again marginal whether this figure is large enough. It is probably OK at the full two-column width of the journal page. It would be a great improvement if the five panels were labelled (a) to (e) so that the text could refer to "panel (e)" rather than "second panel to the right". (I think this means "second panel from the right" but I am not sure; letter labels would remove this kind of confusion.)*

**Reply 9:** Agreed. This will be changed. The text will be changed accordingly.

*Figures 10 and 11: I again have concerns about the sizing of the figures. The text in the captions is unreadably small at the size of the review article. The title on Figure 11 is not needed.*

**Reply 10:** Agreed. This will be changed. The figures will each span the full width of

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the document. Fig. 10 will be split up into two individual figures. The text will be changed accordingly.

#### **Reviewer 2:**

##### **Major comments**

*The last sentence of the abstract should be removed, it states "The decline in CCl<sub>4</sub> abundance during the MIPAS Envisat measurement period (July 2002 to April 2012) is clearly reflected in the retrieved distributions?". I agree that information on (and a proper quotation of) the CCl<sub>4</sub> trend would have been a very valuable addition to this study, BUT only a subset of the observations is presented, the periods shown do not cover the 10-year time interval (09/2003 ? 04/2011 instead of 07/2002 ? 04/2012) and the reader has no element to gauge the CCl<sub>4</sub> rate of change and to judge about the validity of this assertion*

**Reply 1:** Trends have now been estimated from the full data set and was included in the paper. A subsection will be added to discuss the results of the trend estimation. The according text is going to state good agreement with the trends estimated by Valeri et al. (2017).

*Figure 2 shows that the PAN product jointly retrieved with CCl<sub>4</sub> is superior to the standard PAN data available thus far from the MIPAS team, it would be equally important to have an idea of the impact of retrieving versus neglecting PAN on the quality of the CCl<sub>4</sub> product! In particular, is there a systematic impact on the CCl<sub>4</sub> mixing ratios, allowing to close the well-known gap between in situ and remote-sensing data (see e.g. Chipperfield et al., ACP, 16, 2016)? This information would be very valuable for the community and I suggest adding two panels to Fig.2 dedicated to CCl<sub>4</sub> with/without*

**Reply 2:** We believe there is a misunderstanding here. None of the two figures show the PAN results for CCl<sub>4</sub> being left out entirely in the retrieval. CCl<sub>4</sub> was accounted for in the MIPAS retrieval before the gas was an actual target of the retrieval itself.

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However, optimizing the retrieval for CCl<sub>4</sub> led to changes in the PAN distributions. The influence of these changes are reflected in the two panels of the figure. Since both species, PAN and CCl<sub>4</sub>, were accounted for in the original PAN retrieval, we do not see a benefit from showing CCl<sub>4</sub> results without PAN. Fig. 2 is supposed to ensure that changes made to the retrieval to optimize it for CCl<sub>4</sub> did not decrease the quality of the PAN results. Fig. 2 proves that, on the contrary, these changes also led to improvement of the PAN results.

*Section 4.2: it is somewhat strange that the FR measurements provide a lower DOF (3.5) than the RR observations (4.0). What could be the reason for this? This deserves a comment.*

**Reply 3:** We don't think that this is strange, because the RR measurements have a finer altitude sampling. Measurements were taken at 27 instead of 17 tangent altitudes during the RR and FR period, respectively. This easily explains the higher DOF of the RR observations. A sentence will be added for clarification.

*Figure 7 is really small and the y-axis unnecessarily goes up to 80 km, I suggest limiting the altitude range to something like 0-50 km to improve readability*

**Reply 4:** Agreed. The altitude range will be limited to 0-40 km and the figure will span the whole page of the journal to improve legibility.

*Section 5.1.1: ATMOS results are used for a qualitative comparison, but still, why did you use profiles retrieved in the mid-1980s by Zander et al, when the CCl<sub>4</sub> spectroscopy was of poor quality? (see Brown et al., Appl. Opt., 35, 1996). Results reported later on by Zander et al. (e.g. GRL, 23, 1996) are very likely more appropriate for a sensible comparison. An alternative would be to use the ATMOS version 3 results available from <http://remus.jpl.nasa.gov/atmos/atmosversion3/atmosversion3.html> and fully described in Irion et al. (Appl. Opt., 41, 2002)*

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**Reply 5:** Agreed. The qualitative comparison will be performed with the results reported by Zander et al. (1996).

*Section 5.2.1: the agreement between ACE and MIPAS is best below 15 km (lines 265-266 on page 13), but this is also mostly where the number of coincidences is the smallest (second left frame of Fig. 9). Could this inconsistent sampling have an impact on the statistics?*

**Reply 6:** Since the comparison is based on coincident measurements, the impact of inconsistent sampling should be negligible.

#### **Minor comments and typos**

*The title is not very informative; it could be edited to inform about the fact that first intercomparisons are included in this work*

**Reply 7:** Agreed. The title will be changed to "MIPAS IMK/IAA Carbon Tetrachloride (CCl<sub>4</sub>) Retrieval and first Comparison with other Instruments".

*Page 2, line 22: "in 1987, when it was restricted": this is incorrect, CCl<sub>4</sub> was not among the first species controlled under the Montreal Protocol, it was added to the list in the 1990 London Amendment*

**Reply 8:** Agreed. This will be changed.

*Page 2, line 28: these top-down emissions were evaluated instead of "reported"*

**Reply 9:** Agreed. This will be changed.

*Page 2, line 29, I think a comma is needed after "unreported"*

**Reply 10:** In case the reviewer is referring to "Even when possible CCl<sub>4</sub> precursors and unreported inadvertent emissions are accounted for..." we don't think a comma is needed after "unreported".

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Page 2, line 35, here, I suggest replacing “considerably” by “now”

**Reply 11:** Agreed. This will be changed.

Page 2, line 37: I would remove the reference to MIPAS here (“besides those of MIPAS...”, it is appropriate to introduce the new measurements later on, after the review of previous works

**Reply 12:** Agreed. This will be changed.

Page 3, line 65, “as reduced” instead of “is reduced”

**Reply 13:** Agreed. This will be corrected.

Page 3, line 85: the information about the actual spectral range fitted to retrieve CCl<sub>4</sub> is not consistent across the manuscript (see table 1, end of section 3.2...), this should be fixed

**Reply 14:** Agreed. This will be corrected.

Caption of Fig.2: I guess that the “Black: measured spectrum, hardly discernible because overplotted by modelled spectra” warning has nothing to do here...

**Reply 15:** Agreed. This sentence will be moved to Fig. 3.

Page 7, line 152: I would edit to “of CCl<sub>4</sub> for different time periods. All of the..”

**Reply 16:** Agreed. This will be added.

Section 5.1.1.: ATMOS also participated to three other shuttle missions, in 1992, 1993 and 1994.

**Reply 17:** Agreed. This will be included in the text.

Section 5.2.: please reword to something like “Since all collocated measurements were retrieved using the spectroscopic data of Nemtchinov and Varanasi (2003)

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introduced in HITRAN 2000, MIPAS Envisat retrievals based on the same spectroscopic dataset were also used for consistency and in order not to mask possible other discrepancies.”

**Reply 18:** Agreed. This will be changed.

## References

- Valeri, M., Barbara, F., Boone, C., Ceccherini, S., Gai, M., Maucher, G., Raspollini, P., Ridolfi, M., Sgheri, L., Wetzel, G., and Zoppetti, N. (2017). CCl<sub>4</sub> distribution derived from mipas esa v7 data: validation, trend and lifetime estimation. *Atmospheric Chemistry and Physics Discussions*, 2017:1–31.
- Zander, R., Mahieu, E., Gunson, M. R., Abrams, M. C., Chang, A. Y., Abbas, M. M., Aelig, C., Engel, A., Goldman, A., Irion, F. W., Kämpfer, N., Michelson, H. A., Newchurch, M. J., Rinsland, C. P., Salawitch, R. J., Stiller, G. P., and Toon, G. C. (1996). The 1994 northern midlatitude budget of stratospheric chlorine derived from ATMOS/ATLAS-3 observations. *Geophys. Res. Lett.*, 23(17):2357–2360.

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