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Atmospheric Measurement Techniques Discussions

Interactive comment on "Validation of water vapour profiles (version 13) retrieved by the IMK/IAA scientific retrieval processor based on full resolution spectra measured by MIPAS on board Envisat" *by* M. Milz et al.

Anonymous Referee #1

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General comments:

The paper presents a very extensive validation of the water vapor profiles obtained with the newest version of the scientific retrieval processor at IMK/IAA. With no doubt the presented results are of great interest for MIPAS data users. The paper is good structured and the results are mostly well presented. However, a little bit work is still required to extend the algorithm description which in the present form of the manuscript is too sparse not explaining some important details. As pointed out below in the specific comments, the presentation of results is not always optimal, some of the plots are

too small, the number of plots can be slightly reduced. It is also a pity that authors do not use color plots. Further issues are listed in the specific comments below. I think, my suggestions require rather a minor revision of the manuscript. Thereafter, the manuscript will certainly be suitable to be published in AMT.

Specific comments:

1. Page 494, lines 7 to 9: Please explain why the exact knowledge of the hydropause altitude is required to regularize the retrieval of the VMRs and not required to retrieve logarithms of VMRs. How does this lead to a better vertical resolution?

2. Page 494, lines 25 to 26: "This is explained by non-local thermodynamic equilibrium emissions in some of the spectral regions selected in the new retrieval setup." - Please explain why an inclusion of spectral intervals with non-local thermodynamic equilibrium emissions is expected to improve the retrieval results. Otherwise, if no improvement is expected, explain the reasons to include these intervals into the retrieval.

3. Page 495, Table 1: Please explain the sign of the displacement.

4. Page 495, Sec. 3: The description of the retrieval in Sec. 3 needs to be extended providing the formulas for $\mathbf{A}$ and $\mathbf{G}$. According to the variable description presented in Sec. 3 the measurement vector $\hat{\mathbf{x}}$ contains the water vapor profile (most probably in VMR but this is not stated here) which is in contradiction with the description in Sec. 2 where the logarithms of VMRs are stated to be retrieved. Assuming the description in Sec. 2 to be correct, authors have to explain how to rewrite Eq. 1 for $\ln \hat{\mathbf{x}}$. Furthermore, authors should describe here how a priori and noise covariance matrices are set up.

5. Pages 495 - 496, Sec. 4.1: Please explain why for satellite instruments a stronger coincidence criterion than for ground based measurements and non-satellite platforms is applied.

6. Pages 496 - 497: the terms "statistical uncertainty of the bias" (as given by Eq. 3),

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"precision", and "de-biased mean squares difference" seem to have the same meaning. If it is true, please always use the same notation or explain the difference if not true.

7. Page 497, Eq. 4:

- What is the meaning of "$\langle\rangle$" ?
- Formally, a dependence of χ^2 on n should be also indicated.
- From line 23 "calculated on basis of the number of measurements used for each altitude gridpoint" one can also assume that the number of comparison pairs, K, depends on the altitude. This should be stated more clearly in the text.
- According to von Clarmann (2006) χ^2 should be equal to the number of the comparison pairs, i.e., K, why do you have $K-1$ instead?
- The provided description does not describe the procedure for the validation of the precision. Authors should provide the formulas explaining how the quantities shown below in the validation sections are calculated.
- The description of the random error components is a bit misleading. First, all errors needed to be included are listed then authors present the components of the MIPAS random error. Other errors from the "needed" list are not discussed here. These appear only far below in the text where the comparisons with other instruments are discussed. At this point the reader can get a wrong impression that only the MIPAS errors are accounted for in the above discussed total variance.

8. Page 498, Eq. 5: The transformation to the common a priori information is questionable. At least for the instruments measuring the water vapor absorption, the retrieval problem is commonly non-linear. Thus the averaging kernels are changed during the iterative process. Thus, the result of this transformation does not necessary show what

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the reference instrument would produce if the same a priori information as in MIPAS were used, which is strictly true for linear problems only.

9. Page 498, Eq. 6: This equation does not seem to be used below. If so, there is no need to present it. If the smoothing error is used anywhere in the comparisons below this should be clearly stated in the corresponding sections. Furthermore, author have to mention where the climatological covariance for the water vapor is obtained from.

10. Page 500, Fig. 3 and all χ^2-plots below:

- As pointed out above the testing procedure is not clear. An example χ^2 distribution and its 95% confidence interval has to be illustrated. Why is the 95% confidence interval altitude dependent? Most probably because the number of matching pairs changes with the altitude but this is never mentioned in the text.
- The axes have to be labeled
- What exactly is shown in the plot? From the description in the text one expects to see the result of Eq. 4 but this should be around $K - 1$ whereas the "95% confidence interval" surrounds an area around 1.

11. Page 500, line 24: "altitudes between 19 and 57 km and above 55 km" - this interval specification is a bit strange

12. Page 501, line 11: "...indicates overestimation of the precision..." according to the terminology introduced in Sec 4, precision is characterized by the remaining difference between two sets of the measurements after the bias is subtracted. Thus, this is a value obtained from the comparison and it can be neither over- nor underestimated because it is a result of a calculation. Using the same words as for Fig. 3 one should say that the assumed errors are overestimated, not the (actual) precision.

13. Page 501, line 12: "For altitudes above 48 km and below 21 km the assumed errors

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appear to be realistic." - this contradicts the previous sentence and does not agree with the results shown in Fig. 5.

14. Page 504, Fig. 8/10 and 9/11 and all similar plots below: The results for smoothed and unsmoothed profiles would be better comparable if they were shown in one plot. I suggest to join figures 8 and 10 as well as 9 and 11 using lines of different colors for smoothed and unsmoothed profiles.

15. Page 504, lines 21-22: "...suggests underestimated random errors or disregarded error sources" - of MIPAS or ILAS?

16. Page 505, lines 3-4: "Between 15km and 40km both instruments agree very well with a relative bias below 3%, which lacks significance." - at 40 km the measurements disagree by at least 15%. May be you mean 26 km as the upper limit?

17. Section 5.1.3: At the beginning of the subsection you write that the comparisons with ILAS-II were already performed using a precursor version of the MIPAS retrieval. At the end of the section you should provide a short remark how the new results compare to the previous studies.

18. Page 507 lines 1 and 17 - 19: The following statements are in contradiction. "The maximum mean difference is approximately 0.75 ppmv (15%) at around 23 km" (for unsmoothed profiles) and "The prominent bump at 23 km is weaker... The maximum difference of 1 ppmv or 20% is found at 23 km."(for smoothed profiles). The bump is weaker but the maximum difference is larger, something is wrong here.

19. Page 510, Fig. 28: the figure would be better readable if it was plotted in color. Axes have to be labeled.

20. Page 510, line 20: "For the southward viewing scan, additionally the PV values at reference altitudes were considered..." - in which sense were the PV values considered? What this information was used for?

21. Page 511, line 1-2: "...for altitudes where similar airmasses were observed ac-

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cording to the PV." - which altitudes are these? Please, indicate these altitudes in the plots.

22. Page 511, line 6: "...the two closest coincidences agree very well for altitudes below 25 km." - actually it is rather 21 - 23 km, e.g., in the right panel of Fig. 29 the profiles are quite different already at 22 - 23 km.

23. Pages 510 - 511, Fig. 28 and 29: The PV values have to be provided to support the discussion.

24. Pages 511 - 512, section 5.3.2: please discuss shortly the comparison results obtained in previous publications (Müller et al., 2008; Feist et al., 2007) and how these compare to the new results.

25. Page 512, lines 4 - 5: the statements "inside the range of the confidence limits for all altitudes" and "slightly smaller than the lower confidence limit for all altitude between 15 an 50 km" are contradictory. In the second statement "altitude" → "altitudes"

26. Page 512, lines 12 - 13: "This may indicate that the smoothed error budget for MIPAS is overestimating the total random error." - Why for MIPAS and not for AMSOS? Does "smoothed error budget" mean random error budget for smoothed profiles?

27. Page 513, Fig. 34: The plots are unreadable. Rearrange the plots showing 3 panels horizontally and 2 panels vertically, enlarge the panels, plot in color. Axes have to be labeled. Legends must not be covered by the curves.

28. Page 513, Fig. 35: Plot would be better readable if it was plotted in color. Axes have to be labeled. Legends must not be covered by the curves.

29. Page 513, Fig. 36: Rearrange and enlarge the panels, the plot would be better readable if it was plotted in color. Axes have to be labeled. Legends must not be covered by the curves.

Technical corrections:

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Page 500, line 29: word “indicating” occurs twice in “...limit indicating indicating that...”

Interactive comment on Atmos. Meas. Tech. Discuss., 2, 489, 2009.