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Atmospheric Chemistry and Physics Discussions

Interactive comment on "HDO measurements with MIPAS" *by* J. Steinwagner et al.

J. Steinwagner et al.

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Below the comments and questions of reviwer 1 are answered on behalf of all co-authors.

RC 1
Page 932, line 5: I think the meaning of 61540;D should be explained also in the abstract. This notation may not be clear to readers not familiar with isotope fractionation terminology.

AC
The following sentence will be added to the abstract: "Variations in the deuterium content of water are expressed in the common 61540; notation, where 61540;D is the deviation of the deuterium/hydrogen ratio in a sample from a standard isotope ratio."

RC 2
Page 934, line 5: In order to avoid ambiguities I would specify here that you are speak-

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ing about the FWHM of the unapodized and apodized instrument line shapes respectively.

AC
This information will be added to the revised version.

RC 3
Page 934, line 10: I suggest to provide here the exact definition of the MIPAS scan range and sampling step (e.g. give directly the tangent altitudes as 6, 9, ...,42, 47, 52, 60, 68 km).

AC
This information will be added to the revised version.

RC 4
Page 934, line 23: The most recent update of the MIPAS - dedicated spectroscopic database is described in J.-M. Flaud et al. 'MIPAS database: Validation of HNO3 line parameters using MIPAS satellite measurements', Atmos. Chem. Phys., 6, 5037-5048, 2006. I think this is relevant because later (Page 936, line 1) you state that you also retrieve HNO3 to minimize the error due to its spectral interference.

AC
For the processor used a dedicated spectroscopic database is maintained. This is in some details different from the official MIPAS spectroscopic database and is best referenced with the papers already cited in the original version of the paper.

RC 5
Page 935, line 16: please state explicitly what type of regularization matrix R you are using. Are you constraining the profile values or only the shape? Or both? If you constrain the profile shape, which operator do you use? Discrete first derivative? (i.e. R = Lt 1L1?)

AC

ACPD
7, S1161–S1167, 2007

EGU

L is a first order difference operator. This information will be added to the final version.

RC 6
Page 935, line 9: There is no nominal MIPAS tangent point at 11 km. Maybe you meant 12 km?

AC
12 km was meant. This will be corrected in the final Version.

RC 7
Page 936, lines 19, 20: time and geolocation of the measurements selected for testing are already given at line 11, same page.

AC
This will be removed in the revised version.

RC 8
Page 936, line 27: Figure 3. It would be nice if you could include an additional panel in Fig. 3, showing the vertical resolution (FWHM of the averaging kernels (AKs)) as a function of altitude, for both HDO and H2O profiles. The plots of the AKs are quite crowded and it is difficult to establish how similar are the two sets (in fact they seem quite different ...). I understand that this is a critical issue, as the subsequent analysis of 61540;D errors is based on the assumption that the AKs of H2O and HDO are identical. However, even if the two vertical resolutions are not identical, if you add the mentioned plot one can at least judge on its own what can be achieved with your approach.

AC
Additional panels, showing the height resolution, will be added.

RC 9
Page 939, Eq. (6): the 'transpose' operation should be applied to the rightmost term in parenthesis (not to the parenthesis on the left as it is now).

AC

ACPD
7, S1161–S1167, 2007

Equation (6) will be corrected accordingly.

RC 10

Page 939, lines 21, 24: The sensitivity test of Sect. 5.2.4 shows for a particular case, the smoothing introduced by the broad averaging kernels of the inversion system. Sect. 5.2.4 does not address the smoothing error, simply because (as you state above) Se is not known. I would rephrase the first part of this sentence.

AC

For the final version the sentence will be changed to: As we do not accurately know the variability of the true atmospheric state (represented by matrix Se) we are not able to statistically evaluate the smoothing error. Instead, the effect of smoothing is addressed in our sensitivity study Ě.

RC 11

Page 940, lines 17,18: I would expect the retrieval of H2O made in this work to be more precise than the conventional H2O retrieval. This is because in this work the vertical resolution of H2O is degraded (wrt to the conventional case) to match the resolution of the HDO retrieval. Is this correct? Therefore, I would expect dedicated water retrievals to have a smaller smoothing error and a larger noise error.

AC

This expectation would only be true if the same microwindows had been used. Actually, the set of microwindows for dedicated water retrievals is different from what was used in this paper.

RC 12

Page 942, line 2: Figure 5a. Here is my main concern. The behaviour of 61540;D versus altitude reflects the 'W'-shape of the retrieved HDO profile (Fig. 2a). Are you sure that this 'W'-shape is not an artifact introduced by the combined use of an extremely fine (overambitious) vertical retrieval grid (1 km step) and a relatively strong regularization (maybe with the L1 discrete first derivative operator) leading to 6-8 km

ACPD

7, S1161–S1167, 2007

vertical resolution? I would have used a coarser retrieval grid (e.g. 3 km step similar to the MIPAS sampling) or, alternatively, a high-order regularizing operator, extending the smoothness constraint over large altitude ranges. This puzzling doubt could be removed with a sensitivity test (like the ones presented in Sect. 5.2.4) in which both the HDO and H2O profiles are perturbed smoothly, so that the retrieval is in principle able to recover properly the true profiles. In this test, differences between retrieved and true profiles within error bars would definitely rule out the hypothesis of artifact. If you have already done such a test you could just mention it somewhere in the paper.

AC

The sensitivity study was carried out following your suggestion. We applied an extreme perturbation (+40We have not found any evidence for better performance of higher order Tikhonov retrievals.

RC 13

Page 942, Eq. (15): the linearization cannot be operated about x = 0 as in this point there is a singularity of Eqs. (13) and (14). I guess here you meant to do an expansion about the retrieved values of HDO and H2O and you actually used these values for the calculation of the expressions in Eqs (13) and (14). Therefore both in Eq. (15) and at line 20 you should replace x with the related increment with respect to the retrieved value.

AC

We have not claimed to linearize about x=0. However, for clarification the sentence in line 16 will be changed to: "The linearization around the retrieved profile x in matrix notation then yieldsĚ"

RC 14

Page 943, Eq. (15): the 'transpose' should be applied to the rightmost J, not to the leftmost, as it is now.

AC

ACPD

7, S1161–S1167, 2007

This will be changed in the final version.

RC 15
Page 943, Eq. (18): I tried to derive this expression and a factor f multiplying everything seems missing. Please make sure that you used the correct expression for the calculations shown in the paper.

AC
The factor f was lost but the calculations made for this paper definitely contain the factor f. It will be corrected in Eq. (18) in the revised version.

RC 16
Page 944, lines 25, 26. Here I feel again the need of an additional panel in Fig. 3 showing the vertical resolutions of the retrieved profiles.

AC
See above. A reference to this panel will be included in the text.

RC 17
Page 945, lines 9, 10: please specify whether you apply the perturbations to the atmosphere used to generate synthetic observations or to the initial guess profiles.

AC
The perturbations were applied to the atmosphere used to generate synthetic observations. This information will be added in the final version.

RC 18
Page 947, Eq.s (19) and (20): both ens and $mean$ depend on the altitude index i, therefore I suggest to make explicit this dependence also in the symbols used (e.g. you could use ens, i and $mean, i$).

AC
This will be corrected in the final version.

ACPD
7, S1161–S1167, 2007

RC 19
Page 951, line 9: 'δ values ...' please make sure to use the same symbol 'δ D' throughout the whole paper (see also caption of Fig. 7).

AC
This suggestion will enhance the readability of the text and be included in the final version.

RC 20
Page 952, line 24: 'Lopez-Puerta' 8722;8722; > 'Lopez-Puertas'

AC
This will be corrected in the final version.

RC 21
Page 953, line 28: Reference incomplete.

AC
This will be completed in the final version.

RC 22
Page 965, caption of Fig. 6. Please state explicitly the meaning of both solid and dashed lines.

AC
This will be included in the final version.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 931, 2007.