

Interactive comment on “Reviewing the development of a ground-based FTIR water vapour profile analysis” by M. Schneider and F. Hase

Anonymous Referee #3

Received and published: 5 June 2009

This paper presents the development of the setup of the retrieval of water vapour from FTIR measurements by the IMK-ASF. The measurements are exclusively performed at the Izana Atmospheric Research Center. The paper is able to convince the reader why the discussed features of the retrieval are important. This paper is relevant to the FTIR community and should be published after revisions suggested below.

Major comments:

The language is often unprecise and unscientific. The amount of formulations including the first person (we and our) must be reduced. A lot of the specific comments below refer to language and formulation.

Results are shown up to 20 km. Regarding the averaging kernel and the sum of its

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rows shown in Figure 1, measurements above 12 km are dominated by the a priori. At least, this must be very clearly stated in the text. But I would strongly suggest to skip the altitude range between 15 and 20 km. Also, the very strong focus on the log-scale inversion is only justified if the altitude range from 10 to 20 km is deemphasized. Showing the difference profiles on a scale ranging from -100 to 200% is not very convincing. I would like to encourage the authors to use a smaller scale for the three bottom right hand plots in Figure 4.

Specific comments:

Abstract

1. p1222,l5: The sentence starting with "We review ..." is not well written. The features that are listed later on are not required for water vapor monitoring, but they certainly improve the retrievals. I suggest something like "... required for an effective retrieval of water vapour profiles from ground-based FTIR measurements."

Introduction

2. p1222,l23: It is stated that ground-based remote sensing experiments have the potential to observe upper-air trace gases in a continuous and consistent manner. It should be mentioned why this is the case despite the fact, that the variety of remote sensing sensors is certainly as large as in the variety of balloon sensors. Furthermore, also radiosondes have the potential to observe upper air water vapour, given that they always use the same sensor, that provides reliable measurements in this altitude range.

3. p1223,l9: Unprecise language: Going from a water vapour profile to a spectrum is the forward calculation, and going from a spectrum to a water vapour profile is the inversion. Water vapour amounts can not be inverted. I suggest to write "However, the retrieval of atmospheric...". More examples: p1226,l6; p1231,l13,l23,l25; p1233,l13,l14,l17;

4. p1223,l11: Can the approach described in this paper really be called a "non-

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standard retrieval method" as implied by the text? I think that the retrieval method used by the authors is standard, namely OEM as described in Section 2, but that the retrieval setup is novel and can be called non-standard.

General setup of a ground-based FTIR analysis

5. p1224,l15: What is the instrumental line shape?

6. p1225,l4: "The maximum value of ... " This is true under the assumption of Gaussian statistics. This should be mentioned here.

7. Equation 6 defines the averaging kernel, A . Regarding the iterative approach, we also get an averaging kernel A_i for each iteration step. To which i refers equation 6?

8. p1225,l17: A does not only account for the smoothing but also for the sensitivity (a priori contribution) of the retrieval (Schneider et al. 2006). This is important and must be mentioned here.

9. In equation 7 appears A_{hat} without any explanation.

10. It is not obvious why there should exist a linear relation between the real variability and the measured variability (Equation 7 and 8) given that the retrieval process is non-linear. Some discussion on this issue is needed considering also the fact, that all RS92 data have been convolved with the averaging kernel. Why didn't the authors do a forward calculation based on RS92 profiles followed by an inversion to get $x_{\text{hat_RS92}}$, as suggested in Schneider et al. 2006?

Particularities of a water vapour analysis

11. p1227,l16: Again, it has to be mentioned that not only the vertical resolution is the same between $x_{\text{hat_rs92}}$ and x_{ftir} , but also the contribution of the a priori profile.

Simultaneous fit of weak and strong lines

12. p1228,l6: I would not use satisfactory here, as the authors don't say what this

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is judged on. One could provocatively ask, whether a DOF between 2 and 3 can be satisfactory at all.

13. p1228,l11: Figure 5 appears in the text before Figure 4.

Logarithmic scale inversion

14. p1229,l2: "The log-scale inversion ... " From a close look at Figure 4 I would say that this is only true below 8 km. Above 8 km one must get the impression that a log-scale inversion does not improve the results. The authors need to comment this.

15. p1229,l14: A very short description of how PWV is derived from FTIR measurements should be given, i.e. whether PWV is derived from the retrieved profiles or directly from the spectra.

16. I am not able to follow the calculations in the paragraph starting at p1229,l14. Obviously, the precision of the FTIR PWV data obtained by a log-scale inversion can not be calculated because $19.5 < 19.6$. The conclusion that FTIR PWV data are "extremely precise" is very unsatisfactory. A quantification is needed in the context of the other calculations performed in this paragraph. But, the fact that the precision can not be calculated for the log-scale inversion, makes the result obtained for the linear-scale inversion (2.0%) very questionable. Also, biases between the three experiments should be included in the discussion as well. This paragraph needs a major revision.

HDO/H₂O ratio profiles

17. p1230,l15: "Since H₂O and HDO..." insert "profiles" after HDO.

18. p1230,l24: I would not use "observed" in this context, as it is often synonym to "measured". Use "seen" or "is shown" instead. The same comment for p1232,l1.

Joint inversion of temperature profiles

19. p1233,l7: I suggest to use "meteorological reanalyzes" instead of "reanalysis calculations".

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20. p1234,l9: I suggest to write "more consistent".

Conclusions

21. The systematic errors or biases are not adequately addressed in the conclusions. The authors discuss only the benefits with respect to the scatter of the differences between sondes and FTIR. But there is also a benefit in terms of the bias.

22. p1234,l18: Skip the sentence starting with "Then the produced..." or at least omit the word "useless".

23. p1234,l27: Why not use "water vapour lines"?

24. p1234,l27: Start a new paragraph before "Applying ...". I suggest to move this new paragraph to the end of the paper and to finish first the listing of the innovations in the retrieval.

25. p1235,l11: The indicated precision for RS92 seems to be much too large. According to Vömel et al. (2007) the precision of corrected RS92 up to 7 km is <10% (Figure 9 in Vömel et al. (2007)).

Figures

Figure 6: There is no explanation of the shaded area and the grey line in its center.

Technical comments:

p1222,l21: these data p1228,l25: Figure 2 shows ... p1229,l9: apriori statistics
p1230,l21: the the p1231,l3: it increases p1233,l19: reanalyzes p1234,l22: Particularly

Interactive comment on Atmos. Meas. Tech. Discuss., 2, 1221, 2009.

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