

Interactive comment on “Daytime SABER/TIMED observations of water vapor in the mesosphere: retrieval approach and first results” by A. G. Feofilov et al.

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We are very grateful to Reviewer#2 for his/her detailed analysis and comments on the paper that have helped us to improve it. The responses to both major and minor comments are given below. We marked the reviewer's and the author's comments by “**RC:**” and “**AC:**”, respectively.

Major comments:

1) **RC:** “Section 5.2. There is a discussion here on sensitivity of the retrieval to local

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temperature, which appears to be an important effect. The authors introduce two artificial adjustments to a temperature profile to assess the impact. The reviewer suggests a figure showing the temperature profile for one case and the two test profiles over-plotted. . . . This figure is just conceptual, but the reviewer strongly suggests a figure of temperature profiles added to support the temperature sensitivity discussion.”

AC: The sensitivity to local temperature is, indeed, very important as is clear from the right-hand side panels of Fig. 4–6. The reason we did not plot the temperatures on a separate plot is the magnitude of the temperature adjustment. To our experience, the 4 K temperature shift will be hardly noticeable if plotted on top of the atmospheric temperature profile that changes by 100–150 K in the altitude range of 45–105 km selected for the presentation. The absolute value of the temperature shift (4 K) used for the sensitivity studies shown on Fig. 4–6 is of the same order as the temperature correction given on p. 13962, line 14. Thus, the information from the recommended plot is partially embedded to the existing Fig. 4–6 and the effects of the temperature correction used in the paper can also be estimated from the same figures.

2) **RC:** “Table 5. It is difficult for the reviewer to study this table and decide on the quality of the agreement between datasets. The vertical resolution of the ground-based H₂O retrievals is much larger than that of SABER, so a direct comparison between the columns in this table may be misleading.”

AC: We agree with this suggestion so we convolved the SABER data with WVMS and microwave spectrometer averaging kernels for the comparisons in the first and second part of Table 5, respectively. The corresponding phrase has been added to the text. The right-hand side panel of Table 5 has been updated including the uncertainty values that also have changed for some of the points. In general, there is no disagreement between the new and old values. H₂O VMRs at 50 km and 60 km altitudes are about the same in “non-convolved” and “convolved” versions. The values at 70 km altitude have moved closer to the ground based measurements. The 80 km H₂O VMRs have increased due to the shape and centering of the averaging kernels. Overall, these

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changes are within error limits and they do not change the conclusions made in Section 6.2.1.

3) **RC:** “Figure 8. This is an important figure and very hard to read. It must be larger. It also might only be necessary to show every ppmv interval (or 0.5 ppmv) rather than every 0.25 ppmv. In addition, the contours need to be thicker for clarity.”

AC: The figure has been modified in accordance with the reviewer’s suggestions. Only 1 ppmv contour lines remained and the contour lines thickness has been changed. The size of the figure is defined by the ACPD page width while the electronic version of the manuscript is scalable and the reader can blow the figure up for details. The hard copy options will be discussed with the ACP publishing department.

4) **RC:** “Section 7, p. 13971, Fig. 9. Rather than show a ratio of radiances in Fig. 9c, the reader would like to know the change in H₂O mixing ratio. Can the authors include a panel which shows this? Similarly, it would be far more instructive in Section 8, line 21 to indicate the variation in mixing ratio rather than the difference in simulated radiance.”

AC: The right-hand side panel of Fig. 9 has been replaced with the H₂O VMR difference plot suggested by the reviewer. The radiance ratio has been described in the text.

5) **RC:** “Section 7. At the end of this section there is a statement indicating that the “new” SABER retrievals will be better in the “next release” of SABER data. . . . It would be very useful at the end of this section to 1) identify the version of SABER H₂O released or to be released, 2) state the non-LTE code used in the retrieval (presumably SOPC) and how well it agrees with other non-LTE models, 3) indicate explicitly what reaction rates were fixed in the SABER H₂O retrievals, 4) indicate whether SABER temperatures were adjusted in this version of the H₂O retrievals and whether these adjusted temperatures will or will not be in the database and 5) indicate to the reader what improvements will be made in future releases of the SABER H₂O data. Any other relevant information that the authors can add for the interested researcher would be much appreciated. All this in a summary paragraph at the end of this section would

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improve the traceability of the results. Thank you.”

AC: Section 7 deals only with the comparisons between the operational and research codes and the phrase at the end of this section says that the retrievals obtained with the help of the SABER operational code will be consistent with the results of this work. The comparisons made in this section validate the operational code and give estimate of the retrieval error arising from simplifications used in it. The main purpose of Section 7 is to ensure the reader that the operational code describes the same physics as the research codes do and that its accuracy is sufficient for the sound retrievals. Below we give the numbered list of answers to the questions of this subsection: 1) The SABER H₂O was not included to any of the previous SABER data releases including the latest one, V1.07 that is available online. The current work is aimed at paving the way for the SABER H₂O dataset to be released. 2) The main results of this work were obtained with the help of the ALI-ARMS research code (p. 13591, line 13, Section 4, p. 13962, line 24, p. 13966, line 20). The agreement of the SOPC with ALI-ARMS and GRANADA research codes is discussed in Section 7. 3) The reaction rates for the H₂O retrievals are given in Section 6.1, p. 13966, lines 20–22. The reaction rates for the comparison are described in Section 7, p. 13970, line 20. The implementation of new rates to the operational code implies the verification similar to that described in Section 7. Usually, it is performed for a number of typical atmospheric scenarios. 4) The temperature adjustments for these retrievals are discussed in Section 6.1, p. 13966, lines 15,16. The new version of SABER temperatures is being discussed by the SABER Team. 5) Due to complexity of the analysis the improvements in one SABER channel are almost always linked with the improvements of the other channels. Of primary importance is the quality of pressure/temperature retrievals that depends on several parameters like, for example, $k_{V-T}(CO_2 - O)$, the quenching rate for the ν_2 -vibrationally excited CO₂ molecules colliding with oxygen atoms. At the moment we cannot speculate on the properties of the next release of SABER H₂O since the first release has not been published yet (see the first answer in this row). In general, the approach described in this paper is applicable to the analysis and improvements of the future H₂O datasets using

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an extended set of coincidental measurements with other satellite and ground based instruments.

6) **RC:** “Section 8, p. 13972, lines 5–6. Did the authors only have to vary the rate coefficients to achieve good agreement with other instruments and models (see comment #1)? Section 6.1, p. 13966, lines 15–16 indicate that the temperature profiles were modified as well. Please be explicit. Thank you.”

AC: The study performed in Section 5 provides the rate constants that are necessary to match SABER and ACE-FTS datasets. The ACE-FTS H₂O profiles have been validated elsewhere and they were found to be in agreement with other instruments. The phrase the reviewer refers to states the fact that SABER H₂O VMR retrieved with new set of rate constants is consistent with other measurements and models without any further adjustments. Temperature profile mentioned by the reviewer was modified at the altitudes where LTE effects are pronounced and its influence on the non-LTE area is small.

Minor comments:

1) **RC:** “Abstract, p. 13945, line 9. “We analyze” and “suggest” (line 11) is more accurate than “The paper analyzes” and “suggests”.”

AC: We modified the text in accordance with the suggestion.

2) **RC:** “Introduction, p. 13946, line 7. The Zasetsky et al. reference addresses homogeneous nucleation, which is controversial and only potentially relevant for extremely cold conditions in the polar summer. Perhaps a more general reference discussing possible nucleation processes in the polar summer mesosphere may be more appropriate [e.g. Rapp and Thomas, JASTP, 68, 715, 2006]? ”

AC: The reference has been changed.

3) **RC:** “Introduction, p. 13946, line 12. The idea that NLC are indicators of climate change is interesting but is not shared by all [e.g. von Zahn, EOS, 84, 261, 2003].

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There is furthermore no direct evidence making this climate change connection. The reviewer suggests the word “possible” before “indicators”. ”

AC: The word “possible” has been added.

4) **RC:** “Introduction, p. 13946, line 15. The first study to make the connection between space shuttle exhaust and NLCs was Stevens et al. [GRL, 30, doi:10.1029/2003GL017249, 2003]. ”

AC: The reference has been added.

5) **RC:** “Introduction, p. 13947, line 6. Missing the word “the” after “providing”. ”

AC: The word “the” has been added.

6) **RC:** “Section 3, p. 13949, line 2. Comma missing after “gas phase”. ”

AC: Missing comma has been added.

7) **RC:** “Section 3, p. 13949, lines 8–11 and Fig. 1. It would be useful to the reader to somehow highlight the 6.6 micron transition in Fig. 1.”

AC: The figure has been modified. The 6.6 micron transitions are now marked by thick solid lines. The figure caption has been correspondingly modified.

8) **RC:** “Section 3.2, p. 13950, lines 20–21. This sentence is not clear to the reviewer, if the daytime model includes the nighttime model, why do the authors not present nighttime data? Please reword for clarity.”

AC: The answer to this question is partially given on the same page, lines 17–21. One of purposes of this work was to update the non-LTE model used for the H₂O retrieval at 75–85 km altitude. Lower nighttime signal does not allow one to go to these altitudes with this type of measurements. The second reason for using the daytime profiles in the work is the stability of the retrieval. The presence of the solar radiance makes the retrieval less susceptible to the radiance coming from below that is defined

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by stratospheric temperatures and H₂O VMR with their own uncertainties. Thus, the retrieval becomes more stable and reliable. Processing the nighttime data is scheduled as the next step in SABER data processing.

9) **RC:** "Table 1 is difficult to read. Please enlarge. Thank you."

AC: The electronic version of the manuscript is scalable. The hard copy options will be discussed with the ACP publishing department.

10) **RC:** "Section 5.6, p. 13966, line 2. Missing the word "the" before H₂O. "

AC: Missing word has been added.

11) **RC:** "Section 6.1, p. 13967, lines 23–27. The reviewer is confused. The authors advertise better agreement with a better SABER temperature retrieval, but weren't the profiles already modified assuming a SABER temperature bias (p. 13966, lines 15–16)? Please clarify. Thank you. "

AC: That is true. The SABER V1.07 temperature profiles were really modified assuming the bias. Now the work is being done by SABER Team to find the reasons of these biases and to produce a dataset that is not simply corrected by the average bias but where each individual profile is correct. See also the answers to the major comment #5 of this review.

12) **RC:** "Section 7, p. 13970, line 23. Based on the approach outlined by the authors in this manuscript, the reviewer believes that "inferred from" is more accurate than "found in". "

AC: The reviewer's suggestion has been accepted.

13) **RC:** "Section 8, p. 13971, line 17. Missing "the" before "H₂O". "

AC: Missing word has been added.

14) **RC:** "Section 8, p. 13971, line 23. The reviewer suggests "inferred" instead of

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"identified" (see comment #12). Interactive comment on Atmos. Chem. Phys. Discuss., 9, 13943, 2009."

AC: The reviewer's suggestion has been accepted.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 13943, 2009.

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