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Atmospheric Measurement Techniques Discussions

Interactive comment on "Characterization and Evaluation of AIRS-Based Estimates of the Deuterium Content of Water Vapor" *by* John R. Worden et al.

Anonymous Referee #1

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This study presents the application of an existing retrieval methodology of HDO/H2O vertical profiles originally applied on TES, on AIRS thermal infrared measurements. The authors briefly remind the retrieval methodology, describe the error and sensitivity, and show a comparison with co-located TES retrievals. In my view, this is a welcome study as the capabilities of AIRS sensors for HDO/H2O ratio retrievals were unknown/not tested, and the sampling characteristics of AIRS offer great potential for isotopes related studies. The manuscript is short and generally convincing but the presentation is too minimalist and should be improved. Some discussions on previous improvements in characterizing HDO/H2O-H2O pairs retrieval is missing. I list a few comments which should be easily resolved by the authors.

Specific comments

- Introduction: A short introduction on water isotopes, their usefulness and a description on what are the remote sensing capabilities to observe HDO/H2O ratios in the free troposphere would be useful to strengthen the importance of this work and to smooth the feeling of reading a purely technical report.
- P2, Line 19: estimates of HDO/H2O ratios and not HDO
- P2, Line 20: Why only summertime TES global survey's? Do you mean boreal summertime?
- P2, Line 23: "We then compare the AIRS and TES data to evaluate and quantify the calculated uncertainties of the AIRS data" - To evaluate and quantify the calculated uncertainties sound a little odd. This needs to be rephrased.
- This paper is relatively short and yet there is a lot of statements about futures publications (P2, L17-18;P2, L23-24;P5, L29 – P6,L8). Some of them could be removed.
- P3, L8: There is a redundancy here of the statement that TES is part of the A-Train, it was just said in the previous sentence.
- P5, L9: "This retrieval algorithm can use radiances (..) to quantify and characterize geophysical observables appropriate for the corresponding radiance." – What is an appropriate geophysical observable? To retrieve different geophysical parameters?
- P5, L16-17: "in order to ensure that [the retrieval of] the ratio is optimized, as opposed (..)" [missing]

- P5, L29 – P6,L8: All this part describes the importance of including the 12 microns radiances for the methane retrieval. That is not interesting in the frame of this paper.
- P6, L17-19: Jacobians have not be defined. What does the -50 treshold represent? How is it calculated?
- P6, L22: "(..) partial derivative of the estimate relative to [partial derivative] of the true state". Or maybe in a language more accessible to potential users not familiar with optimal estimation: "the response of the retrieved state to perturbations of the true state"
- P6, L23: It is confusing to translate the example in terms of HDO/H2O ratios since the averaging kernels are for HDO.
- P6, L28-29: Schneider et al., 2012 proposed an a posteriori methodology to characterize the joint retrieval of H2O and HDO. The method allows to transform the products obtained in the log(H2O),log(HDO) space into a proxy state log(H2O),δD which is very useful for characterization. Moreover, the HDO/H2O ratio product is often used in pair with H2O it is therefore important to discuss the differences of sensitivity of H2O and HDO/H2O ratios. This is missing here.
- P7, L13-L15: There are a lot of measurements within the tropics with DOFS between 0.5 and 1 so I wouldn't generalize this situation to the whole tropics. This might be valid only for the averaging kernels shown.
- P8, L6->L11: All this part would better fit in the error characterization part
- Comparisons of AIRS and TES retrievals - In order to be really convincing, this part needs to be completed.
  - Would it be possible to show a scatter plot of AIRS versus TES?

  - What is the correlation between AIRS and TES retrievals?
  - Because this kind of product is used in pairs with humidity retrievals it is also interesting to show that both sounders show the same humidity-δD information and not only δD.
  - I didn't understand the error assessment reasoning. The mean bias across latitude is -2.6 permil, later on the authors assess the RMS to be 7.8 permil then the authors say the accuracy is 7.8 permil. Is this a mistake or do I miss something? The language between accuracy and precision should be clarified.
  - What about the latitudinal variations of the bias which are greater (-15 to 15 permil) than the mean standard error? It looks like there is a latitudinal bias, could it be caused by some dependence on temperature or humidity content?
  - Could you plot the data in Figure 5 until 40°S as in the previous figure?
- The conclusions could be more developed. One of the interest of this paper lies in the development of a HDO retrieval methodology from AIRS data which was unknown and opens great perspectives for users interested in such measurements. In this context, a word on the future plans of the authors on processing more AIRS data, or not, would be interesting.
- P9, L8: Please reference the natural variability of δD

Technical corrections

- Abstract, L17: Northern instead of N;
- P1, L28: a verb is missing

- L29, degrees
- P4 , L30 : Description of Retrieval Approach -> Description of the retrieval approach
- P5, L29 : (e.g. Figures 1-4).
- P7, L4: add degrees to latitude
- P7, L8: use the delta Greek notation δ
- Figure 4: A legend is missing, what is TES and what is AIRS?

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