**Atmospheric
Measurement
Techniques
Discussions**

Interactive comment on "Water vapor isotopologues retrievals from high resolution GOSAT short-wave infrared spectra" *by* C. Frankenberg et al.

Anonymous Referee #3

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Review of Frankenberg et al: *Water vapor isotopologues retrievals from high resolution GOSAT short-wave infrared spectra*

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This manuscript, along with a manuscript by Bösch et al (2012) published at almost the same time, describes the first attempt to retrieve water vapor isotopologues (specifically the ratio of heavy water "HDO" to "H_2O" (i.e. δD) from spectra acquired by the Greenhouse Gases Observing Satellite. The manuscript focuses largely on applying the same (or at least a very similar) method used by the same lead author on SCIAMACHY spectra, and its feasibility for GOSAT. The results are compared to one TCCON site, at Lamont, Oklahoma, and qualitatively compared, with respect to seasonality and spatial variability, to the previous SCIAMACHY results, which are from a different time period.

The viability of retrievals of HDO/H_2O ratios from GOSAT are indeed an interesting topic - one which should be addressed and is well suited to publication in AMT. This publication shows that these retrievals are indeed feasible, and as such I recommend its publication after addressing some issues, detailed below. It should also be cautioned, however, that as also noted by the other referees (Dr. Schneider and Anony-

mous Referee #2), further validation is required, as is the characterisation of the retrieval characteristics, sensitivities and uncertainties. It is my belief that this should be a priority for future work with GOSAT retrievals, as well as for the "validation" product from TCCON. The fact that this is required before scientific interpretation of the data is undertaken should be emphasised further in the revised manuscript. Nevertheless, demonstrating the agreement between GOSAT and TCCON retrievals is at the very least a good step from which to expand these studies.

General Comments

- When comparing seasonal averages between GOSAT and SCIAMACHY, it would be nice to have some estimate of the magnitude of the expected interannual variability. While I appreciate that the precision of the satellite retrievals lends itself to the need for averaging lots of data (e.g. to seasonal averages over multiple years), can the authors make any estimate of the IAV from their retrievals, which do indeed cover multiple years in each case?

- The differences between GOSAT and SCIAMACHY are tentatively attributed to the differences in vertical sensitivities. The averaging kernels for GOSAT and TCCON are presented in the paper, and that from SCIAMACHY is discussed, but not referenced, or even better, presented for comparison with GOSAT.

- ECMWF is used as "truth" south of $60°S$ in order to derive a bias correction for the GOSAT retrievals. Are there any references or information concerning the relative accuracy of the ECMWF product used for this purpose? These would also enable some level of uncertainty to be attached to the bias correction.

Technical and Specific Comments

- p6358, L2: demonstrate feasibility $\rightarrow$ demonstrate the feasibility

- p6358, L9: this is not necessarily a depletion, right?

- p6359, L3-5: is this really worthy of a separate paragraph?

- p6360, L13: At least H_2O and possibly HDO should be separated by either parentheses or surrounding commas.

- p6361, L17: chose $\rightarrow$ chosen

- p6361, L18: where 1500 % as 1σ ensures - this needs clarification. "Where a choice of 1500% as 1σ ensures" or similar.

- p6361, L22: viz??

- p6361, L24-25: allows to retrieve sounds funny. I suggest changing to either "allows retrieval of" or "allows us to retrieve"

- p6362, L21: with $\rightarrow$ to

- p6363, L1: how is the relative error in the retrieved column calculated?

- p6363, L5,L6: while this is somewhat clarified in the following sentence, it would be nice to have these ratios better defined (e.g. is it CO_2(weak)/CO_2(strong) used to define the CO_2 ratio? What are the spectral ranges used for these retrievals). One could also add the details of the retrieval windows used here to Table 1.

- p6365, L6: up-looking? Would this not be better expressed as upward-looking? In fact, better still would be to describe TCCON as ground-based direct solar

measurements, because up(ward)-looking could mean direct vertical measurements, e.g. emission measurements or measurements from scattered-radiance only.

- p6365, L10-12: on what is this empirically-derived HDO/H_2O profile shape based?

- p6365, L14-17: while the GOSAT measurements take place at close to local noon, H_2O variations occur relatively rapidly, so despite the assimilation of sonde measurements, the apriori profile could be significantly different from the true profile. It is also likely that the viewing geometry relative to the location of the sonde profiles could play a role. So the comment that the a priori profile is relatively close to the truth is perhaps misleading.

- p6365, L25-26: This sentence needs rephrasing. Perhaps something like "The columns are not bias-corrected, as the differences would not be visible at this scale." I also don't believe that the fact that one cannot see the differences is a reason to not bias correct here - you have introduced and derived the bias-correction, why not apply it rather than have to explain why it isn't applied?

- p6365, L27: Indeed this coincidence criterion is quite lax for H_2O. One obviously needs a relatively lax criterion to get good statistics for the comparison, but can you say anything about whether the distribution is more-or-less normal within the 6 by 6 degree colocation gridbox on the time scales examined (monthly-averages)?

- p6365-6366: It is interesting to see the IAV between all 3 years here. How does the δD correlate with this? Or to put it another way, is there any apparent link in a plot of δD vs H_2O?

- p6367, L15-17: some more details about to what extent the filter criteria are relaxed, and what "hardly affected" means, would be appreciated.

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- p6367, L19: why is Nadir capitalised?

- p6367, L23-24: presumably you are not surmising that the δD variability itself is lower in SCIAMACHY, but rather the retrieval variability is? As such, this would be nicer phrased as "variability is somewhat lower in the SCIAMACHY retrievals."

- p6368, L5-7: what exactly do you mean by "very reliable"? I assume that this is with respect to the filter criteria, but that future work would require assessment of potential biases between glint and other observation modes to confirm this reliability.

- p6368, L27-29: double use of impact is confusing.

- p6369, L3: not necessarily depletions, or at least δD is not defined as being a depletion.

- Acknowledgements: NASAs is missing an apostrophe.

- Table 2: I believe a number of the TCCON retrieval windows have the wrong widths presented, specifically that for all the HDO windows and for the 6401.15 H_2O window, the full width is presented as the width either side of the centre wavenumber. E.g., I don't believe the 6377.40 cm^{-1} HDO window is 100.40 cm^{-1} wide. I assume that H_2O should not be listed as an interfering species for the H_2O retrievals.

References

Bösch, H., Deutscher, N. M., Warneke, T., Byckling, K., Cogan, A. J., Griffith, D. W. T., Notholt, J., Parker, R. J., Wang, Z.: HDO/H_2O ratio retrievals from GOSAT, Atmospheric Measurement Techniques Discussions, 5, 6643–6677, doi:10.5194/amtd-5-6643-2012 http://www.atmos-meas-tech-discuss.net/5/6643/2012/, 2012.