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Comment

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

**Anonymous Referee #2**

Received and published: 18 September 2012

### **General Comments:**

The manuscript by Frankenberg et al. presents first results of a retrieval of HDO/H<sub>2</sub>O ratios from GOSAT data. This is an interesting topic and well suited for a publication in AMT. The GOSAT results are compared with TCCON data and corresponding SCIAMACHY measurements. The TCCON data are however not validated yet, and the SCIAMACHY data are from a different time period; therefore the comparisons are more qualitative and further validation is required. This is also stated in the manuscript.

The retrieval method is described quite briefly and needs some more explanation as

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detailed below. Especially, the retrieval makes some assumptions about the shape of the HDO profiles which is derived from ECMWF water vapour profiles. Since only the total column of H<sub>2</sub>O and HDO is retrieved I assume that the shape of the profile is unchanged. In addition, the performed bias correction is based on a linear fit to ECMWF H<sub>2</sub>O data (see Fig. 2). This assumes a proportionality between H<sub>2</sub>O and HDO, at least for a dry atmosphere. In this sense the HDO retrieval results are somehow coupled to the assumed a-priori H<sub>2</sub>O profiles. The sensitivity of the retrieval to these a-priori assumptions should be assessed in more detail to make sure that e.g. the observed HDO variability is not only a variation of the a-priori.

What is also missing is a more specific quantification of the errors of the used data sets (GOSAT, TCCON, SCIAMACHY).

The manuscript may be published after these issues and the more specific comments given below have been considered.

### Specific Comments:

#### 1. Section 2.1 Quality filtering:

- (a) Several statistical quantities are used which are somehow related:  $\chi^2$ , standard deviation of residuum, relative error in retrieved HDO column. Are the associated thresholds consistent with each other? Why is it necessary to have more than one criterium which is related to the quality of the fit?
- (b) The cloud filter is based on a retrieved O<sub>2</sub> column. This O<sub>2</sub> column retrieval has not been mentioned before, and the spectral regions listed in Table 2 do not contain O<sub>2</sub>. Please give some more explanation on this.
- (c) p. 6363, l. 7/8:  
'The CO<sub>2</sub> and H<sub>2</sub>O ratios are from IMAP-DOAS retrievals using the weak

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and strong CO<sub>2</sub> bands.' Please explain which spectral regions are used for these ratios.

2. p. 6364, l. 7/8:

As stated in the text, the multiplicative errors  $c_i$  are not quantified in the study. However, they occur in the formula for the bias correction. Please specify which values for  $c_i$  have been used. What is the impact of this choice on the results?

3. Section 3:

As stated in the manuscript the TCCON HDO data are so far not validated. Is there any information on the quality of the TCCON HDO data? Is there also a bias, and has this been corrected? For the TCCON retrieval the HDO a-priori profile is derived from a scaled H<sub>2</sub>O profile (but different to the one used for GOSAT retrievals). What is the impact of this difference on the results?

4. Fig. 4 and related text:

Could the similarity in the temporal variation of both TCCON and GOSAT data (Fig. 4) be related to the use of HDO a-priori profiles which are scaled H<sub>2</sub>O profiles, i.e. is the observed variability (at least on this scale) only the variability of the a-priori profiles?

5. p. 6367, l. 7:

Maybe one should mention here that the SCIAMACHY HDO retrievals are performed at 2.3  $\mu\text{m}$  as this is used in the discussion on p. 6368 l. 8. Would it be possible to use the GOSAT spectral range (1.56  $\mu\text{m}$ ) also for SCIAMACHY HDO/H<sub>2</sub>O retrievals?

6. p. 6367, l. 18–20:

'Over the oceans at higher latitudes, GOSAT takes regular Nadir observations and retrievals are so far only possible over low cloud layers having passed the simple filter...'

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How large is the impact of the remaining cloudiness on the retrieval results? Shouldn't this result in too low H<sub>2</sub>O and HDO columns?

7. p. 6368, 3rd paragraph:

Is there also a bias correction performed for the SCIAMACHY data? What are the estimated errors of the SCIAMACHY HDO product? Could these be also reasons for the observed differences? Have there been comparisons performed between TCCON and SCIAMACHY HDO data?

8. p. 6369, l. 5:

The precision of 20—40 per mill of the retrieved single HDO columns has never been mentioned before (except for the abstract). The quality of the HDO data product should be addressed already earlier in the paper in a more detailed way. Some error contributions are mentioned in the text (e.g. errors due to a bias in the retrieved H<sub>2</sub>O columns on p. 6366), but there is no real error estimate given for the GOSAT HDO product.

### Technical Corrections:

1. p. 6361, line 17:

'chose' → 'chosen'

2. p. 6362, l. 18:

'we use of an effective pressure' → 'we use an effective pressure'

3. p. 6369 (Appendix A):

Although this is quite clear from the context, the used variables ( $\gamma$ ,  $\gamma_{n_i}$ ,  $\gamma_{\text{air}}$ ,  $\gamma_{\text{H}_2\text{O}}$ ,  $n_i$ ) should be explicitly defined.

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4. p. 6370, l. 5:  
Add closing bracket:  $'(1+4\text{VMR}(\text{H}_2\text{O}))' \rightarrow '(1+4\text{VMR}(\text{H}_2\text{O}))'$
5. Table 2:  
Why is  $\text{H}_2\text{O}$  listed as interfering species in the  $\text{H}_2\text{O}$  retrieval?
6. Fig. 1:
  - (a) The variable  $F$  in the lowest panel is not defined (probably it is the radiance?).
  - (b) Please increase the size of the QQ plot; it is much too small. Please also add labels to the axes. Alternatively, remove the QQ plot as it is not explicitly addressed in the body of the manuscript.
7. Fig. 6:  
Please add some error bars to the data and/or give an estimation of the errors in the text.
8. Fig. 7:  
The colour for the 'raw' points should be the same as for the fitted line and the corresponding text.

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Interactive comment on Atmos. Meas. Tech. Discuss., 5, 6357, 2012.

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