

## ***Interactive comment on “Validation of the CrIS Fast Physical NH<sub>3</sub> Retrieval with ground-based FTIR” by Enrico Dammers et al.***

### **Anonymous Referee #1**

Received and published: 14 April 2017

The manuscript presents comparisons between a retrieval product for NH<sub>3</sub> of the CrIS satellite instrument ('Fast Physical Retrieval') and ground-based FTIR observations. Both, total column amounts and vertical profiles are intercompared. As knowledge about the global distribution of ammonia is essential for model validation and emission assessments, this work is an important step towards the characterization of the global distributions from space-borne instruments. Unfortunately, there is no comparison with ground-based observations in the region of NH<sub>3</sub> 'hot-spots' (apart from the Bremen site) like northern India or China which would add important information. In general the applied methods and the results are well described and I support publication of the manuscript. Still there are open issues mainly regarding the total column comparisons as listed below. These should be clarified/implemented before publication.

General comments:

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Since the mean number of degrees of freedom of the NH<sub>3</sub> retrieval for both instruments seems to be near 1, comparison of the total NH<sub>3</sub>-column amounts is a central part of the paper. However, some major retrieval characteristics should additionally be provided. Especially a kind of total column operator, like the one shown by Rodgers and Conner, 2003, Fig. 11. E.g. Fig 5 of the actual draft could be modified such that the AK for absolute concentrations or partial column amounts is provided. Further, in Fig. 5 I wonder why the FTIR AK does not peak at the ground level: is there some problem with half-levels there? This should be explained in the paper. Also, while error estimations of the profile retrievals are presented, it would be helpful to have those numbers for the total column amounts as well.

Specific comments:

L27-35:

The abstract should be made more concise. These lines, which include mainly motivation could be skipped.

L39, L48-49: 'compare well'

These are qualitative terms which do not contain much (if any) information content. Please try to avoid those throughout the manuscript and concentrate on quantitative assessments.

LL95-96: 'However, the uncertainty of the satellite observations is still high due to a lack of validation.'

The reasoning is a bit strange: the uncertainty is not caused by lack of validation but rather the knowledge of the uncertainty.

LL245-246: 'Do note that on average the observations have a DOFS between 0.9 and 1.1.'

Could you please provide a Figure or numbers of the DOF distribution of all measure-

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ments entering the comparison.

L246: 'clouds will implicitly be accounted for by the quality control':

What is the effect of a partially cloudy field-of-view?

L301: 'total column comparison':

Has this comparison been performed with or without the application of the FTIR-AK as described in chapter 2.5? Since the FTIR is generally better suited for total column retrievals due to its better sensitivity nearer at the ground (where most of the NH<sub>3</sub> is present), I doubt that the transformation like in Eq(1), L278 is helpful. Here the better instrument (FTIR) should be transformed to the worse (CrIS) to compare with the CrIS total column amounts. I.e. there should be Figures like Figs. 2 and 3 with the raw data and after the transformation as just described.

L318: 'In Toronto, Bremen and Pasadena there is good agreement'

In case of Pasadena, I would not call the agreement good. Please also avoid this qualitative terms.

L319: 'and low bias in the CrIS total columns for intermediate values'

This seems not to be the case for Bremen.

L322, Fig. 3:

Could you also discuss in the text what the reason for the apparently systematic deviations at Wollongong may be.

L331, Fig. 4: 'show the standard deviation for each value'

Is this the standard deviation of the distribution of the differences or the standard error of the mean difference (i.e. the former divided by  $\sqrt{\text{number of values}}$ )? The latter should (also) be shown to detect any significant measurement bias.

LL379-380: 'along with the shorter atmospheric path lengths for observations from the  
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ground-based solar-pointing FTIR'

Could you explain, why the FTIR path length is shorter compared to the satellite? Is this always the case?

LL377-385:

As already mentioned, for this discussion the total column operator or the partial column (number density) AK would be interesting. As the FTIR is more sensitive down to the ground level than the satellite where there are highest concentrations of NH<sub>3</sub>, the satellite retrieval should be determined by the a-priori there. So the higher column amounts may be produced by higher a-priori values at the ground.

L550: 'improvements to the NH<sub>3</sub> line spectroscopy to reduce the uncertainty coming from this error source'

Could you give the information if the CrIS retrieval also uses Hitran2012, like the FTIR?

Technical comments:

L566, Fig. A1:

the arrangement of the panels in the figure is transposed with respect to the description in the caption

L571, Fig. A2:

same problem as in Fig. A1. Moreover, the top and the bottom row seem to show identical data.

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Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2017-38, 2017.