Interactive comment on "Global distributions and trends of atmospheric ammonia (NH_3) from IASI satellite observations" by M. Van Damme et al.

Anonymous Referee #1

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We would like to thank the anonymous referee for his/her positive comments and useful remarks. He/She highlights the difficulty of dealing with a product with a variable uncertainty. We have addressed all the comments as detailed hereafter in blue.

This is valuable contribution to the growing area of remote sensing of ammonia. I recommend that this manuscript be published in Atmospheric Chemistry and Physics after addressing these minor points.

1. It is important and challenging to assess quantitatively the error in satellite measurements. The authors are to be commended for their work in this area. However, the scheme described in Section 4.2 has some shortcomings that should either be addressed or discussed in the text. On lines 10-15, page 24315, the authors point out that be excluding data with high error, the resulting averages will be biased high, because high values have lower relative error. While the weighting scheme presented may mitigate this some, on page 24316, line 7 states "the weighted averaging approach using Eq. 3 gives a high contribution to measurements with low relative error and this explains the large impact of fire plumes..." It seems the resulting calculated averages are still overly impacted by high values and are not good estimates of the actual mean. I think this approach could be significantly improved if the absolute, rather than the relative error was used to define sigma in Eq. 3 and Eq. 4. This would reduce the impact of large values with high absolute error, while increasing the contribution from low values.

Presenting averaged data with a large variability in the error is very challenging. Clearly a weighted approach makes a lot of sense, even though this can introduce biases. Weighting with the absolute or relative error both has its advantages and disadvantages.

In our opinion, the relative error gives the best indication of the accuracy of the measurement. Large NH_3 columns with low relative errors can still have large errors in absolute terms, exactly because of their large column. In this way the weighting of the average with the relative error makes best use of the good measurements. The disadvantage is, as we have pointed out that the mean automatically becomes biased towards the higher columns as larger columns are easier to measure.

Weighting with the absolute error does not have this high bias, but might suffer from a low bias for the same reasons. Large NH_3 columns typically have large uncertainties in absolute terms. Therefore, the weight of exceptional large concentrations is reduced on the mean, which for these areas will be low biased.

In view of this, we now present the five-year global mean ammonia distribution both using the absolute (Figure 10 in the publication) and relative weighting (Figure 11). We believe this is the most balanced way of presenting the data. It also allows us to discuss in more depth the issues related to averaging data with large variability in the error. However, we have chosen to mainly consider the distribution weighted by relative errors as it allows us to focus on the more reliable observations and to highlight all the events where high columns are observed over the course of the five years. We have added the Figure 11 at the beginning of section 4.2.

2. It is not clear to me how Equation 4 gives you the actual error in the resulting

average. It would be useful to explain more. Or empirically show that it works by dividing the dataset into two time periods, calculate the average and relative error for the first dataset, and then see how often the average of the second dataset falls within the relative error bounds calculated using the first dataset.

In equation 4, we use the same weighting factor ($\frac{1}{\sigma^2}$) on the relative error of each measurement as the one used on the NH_3 column in eq. 3. The resulting averaged weighted error is representative of the mean error of the weighted mean NH_3 column and not an assessment of the error of the mean.

3. Are their other errors are not included in the error assessment? Could these be described at the end of Section 3?

The main error which is not included in the error assessment presented here is the one made on the NH_3 vertical profile. We have chosen to use only two profiles of NH_3 (scaled at various NH_3 concentrations): one for land and one for sea. We believe this is a sensible approach in view of the unavailability of real profile data and the fact that such information cannot be extracted from nadir viewing IR measurements.

We have included in section 3.2.2 a paragraph dealing with the sensitivity of our retrievals on the NH_3 vertical profiles used in the look-up-tables.

4. The relative error shown in Figure 6 and 10 is the average relative error, not an assessment of the error in the mean. Is this correct? Please clarify.

Yes, it's correct. It is in fact a weighted average relative error, made using equation 4. The same weighting factor ($\frac{1}{\sigma^2}$) is used on the relative error of each measurement in eq. 4 as the one used on the NH_3 column in eq. 3.

Editorial comments:
* Consider replacing "trends" in the title with "error characterization". While seasonal differences are discussed, a quantitative trends assessment is not performed. However, the error characterization is very useful. Also, consider changing "distributions" to "distribution".

We personally find 'distributions' to be more adequate than distribution, so that we decided to keep this the way it was. The word 'trends' was indeed badly chosen and we have now replaced this with 'time series', as these are presented in the paper. Following your suggestion we have also added the words 'error characterization' in the title. The full title now reads: "Global distributions, time series and error characterization of atmospheric ammonia (NH_3) from IASI satellite observations".

* Page 24318, line 11, remove period after Nr

Done

* Page 24304, line 21, replace "instrumentations" with "instruments"

Done

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 24301, 2013.