

Responses to Review of Anonymous Referee #1

We would like to thank the anonymous referee for his/her useful remarks and comments which helped to improve the manuscript. All comments have been addressed as detailed hereafter in blue.

Review of “Towards validation of ammonia (NH₃) measurements from the IASI satellite” by Martin Van Damme

Anonymous Referee #1

Received and published: 31 December 2014

This paper describes several comparisons of IASI NH₃ measurements with surface and aircraft measurements in various regions and periods. It presents a good evaluation of the difficulties inherent in these comparisons: spatial and temporal sampling differences, sparseness of in situ data, lack of sensitivity of the satellite instrument to smaller NH₃ concentrations, the lack of knowledge of the NH₃ profile structure. The comparison results are not very robust, and the author at times overstates the agreement between the in situ measurements and the IASI data, but the results do provide a valuable snapshot of the state of the satellite NH₃ validation efforts. This is an important and active area of research in the study of reactive nitrogen, and fits well within the scope of Atmospheric Measurement Techniques: some related work for the TES instrument has been described by Sun et al. (JGR, submitted) and briefly for the CrIS instrument in Shephard and Cady-Pereira (AMTD, 2014). I recommend that the paper be published after the minor revisions listed below.

Technical issues:

Page 12132:

Please define the coefficient of variation: is it the standard deviation divided by the mean times 100?

The coefficient of variation is defined as the ratio of the standard deviation to the mean that we have chosen to express in %.

Pages 12137-12138:

Estimating the surface concentration from the IASI total column is fraught with issues, as the author himself states. Any conclusions on the biases seen in Figure 3 are extremely tentative, and should be more qualified. The biases basically just serve as an illustration of the issues. I suggest that the author also show the scatter plots of the IASI total columns vs the surface measurements; these would demonstrate that at least the correlations are somewhat meaningful.

We agree with the referee on this. In fact, the conversion factor between total columns and surface concentrations being close to constant, the scattering does not change so much.

The Pearson's r obtained is close to 0.28 in both cases (see Figure R1).

To clarify it, we had a sentence L438-442 (line numbering of the revised manuscript): “As an example, the Pearson's r calculated when comparing IASI total columns and NEU ground-based concentrations is equal to 0.284 while it is equal to 0.275 when comparing satellite and ground-based surface concentrations”.

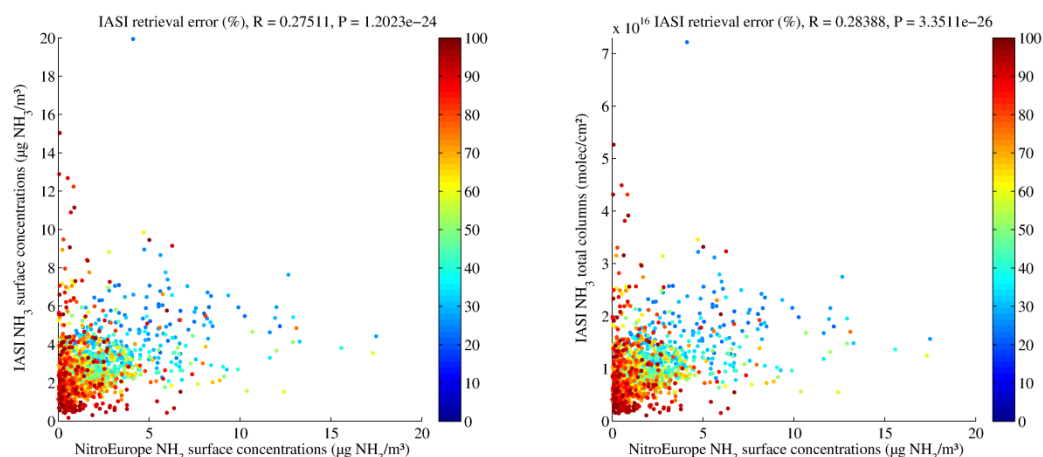


Figure R1: IASI surface concentrations (µg/m³) versus NEU surface concentrations (µg/m³) (left, Pearson's $r=0.28$) and IASI columns (molec/cm²) versus NEU surface concentrations (µg/m³) (right, Pearson's $r=0.28$) for Europe.

Page 12138:

Please clarify which statistical test was used to determine the p value of the correlation coefficient.

The p-value is computed by transforming the correlation to create a t statistic having N-2 degrees of freedom, where N is the number of obs. The confidence bounds are based on an asymptotic normal distribution of $0.5 \cdot \log((1+R)/(1-R))$, with an approximate variance equal to $1/(N-3)$. These bounds are accurate for large samples when X has a multivariate normal distribution.

Page 12139:

Why is the range is surface measurements (0-10) over China not matched by the range in the IASI data (0-3)? The surface range is much higher in this region than in Europe or Africa, but the IASI range is the same.

The IASI range is indeed larger in China than in Europe. It is not straightforward from the scatterplots presented in the paper but still can be observed looking at the point associated with lower retrieval errors. In Figure R2 (below) we highlight this by providing same axis limit for Europe (left column) and China (right column). Also, it is even more obvious that the IASI Chinese range (~1.5-13, excluding outliers) is substantially higher than the IASI European range (~2-9) when looking at the point excluding the ones associated with a relative error above 35%.

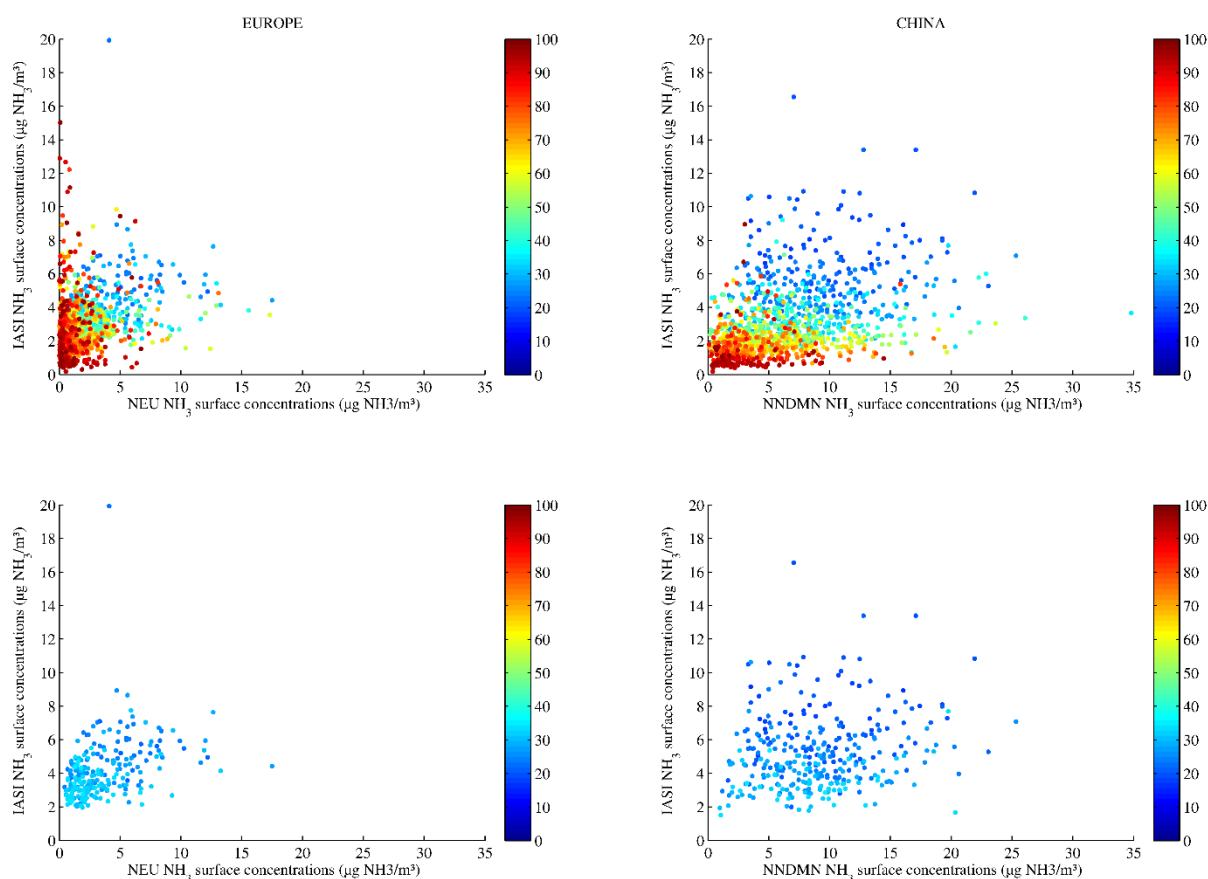


Figure R2: IASI versus ground-based surface concentrations ($\mu\text{g NH}_3/\text{m}^3$) for Europe (left panels) and China (right panels) using observations associated with a retrieval relative error below 100% (top panels) and below 50% (bottom panels).

The time series comparison is very interesting, but the peak listed by the author for October is not at all evident. Could these peaks be highlighted with special symbols? Similarly for the January 2013 peak.

These peaks have been highlighted by an asterisk in Figure 4 of the paper. We have added to the legend of Figure 4: "Asterisks highlight the fertilization peaks of March, July and October 2013 (Shen et al., 2011)."

Page 1240:

The use of the P value on line 8 is very confusing: I believe the author would like to state: "the r values are all significant at the 0.01 confidence level" or "the p value for these sites is less than 0.01".

We agree with the referee, it is definitely not clear. The second option is the one we have implemented in the text L532: "where the p values for these sites are all less than 0.01".

How much time does the aircraft spend in each IASI pixel? How is the mistime computed?

The mistime is calculated as the difference between the IASI overpass time and the airborne measurement time. As the airborne campaign has not been designed directly to validate the IASI satellite measurements, the number of observation by pixel as well as the time spent in each one of them is varying from one IASI pixel to another. This has been clarified in the manuscript by adding between brackets after mistime (L722) "being the time difference between the IASI overpass and the airborne measurement".

Page 12144:

Line 17: The high values in Colorado are not at all apparent in the airborne data.

We agree with the referee that it is not clear in this version of the manuscript. However, we can see it when increasing the figure size, which will be the case in the published version of

this AMT paper (full width (double column) figure); this will hopefully make the change to the Figure unnecessary

Lines 25-27: Is the IASI data shown in this footprint an average over the CalNex period? Please clarify.

Figure 7 of the paper present one single IASI footprint/observation. The IASI value is equal to the average of the vmr calculated from the same total column at the different altitudes of the aircraft observations. We have clarified this correcting “Figure 6 presents the NH3 distribution for...” by “Figure 6 presents the NH3 distributions for...” (L702).

Suggested wording changes:

Page 12127:

Line 15: allows investigations of

Agreed and change done.

Line 25: “agricultural activities” instead of “food production”

Food production is an important and well-identified source of reactive nitrogen. It is more specific than agricultural activities and we prefer not to be too general.

Page 12128:

Line 2: on ecosystems

Agreed and change done.

Page 12129:

Line 5: Even as the NH3 cycle becomes more integrated in ...

Agreed and change done.

Page 12131:

Line 11: ...and compared to previous algorithms

Line 22: ... an error estimate

Agreed. Both changes have been made.

Page 12132:

Line 8: The IASI instrument is on board....

Agreed and change done.

Page 12135:

Line 1: ... of providing

Agreed and change done.

Line 24: ... reaching as high as xxx

Agreed and change done.

Page 12136:

Line 21: Except for ...

Agreed and change done.

Line 24: The surface measurements are too sparse to state that “ we find the same general pattern in the surface measurements....”.

We agree and have changed that sentence to: “Nevertheless, we find a broadly similar pattern in the surface measurements...”

Page 12138:

Line 10: Saying that overall IASI observes a similar pattern to the surface instruments is an overstatement. There are low surface values near both the Ebro and Po valleys, where IASI sees high concentrations.

We have checked and confirm (this can also be seen zooming in the figure) that the low values reported in these regions are from stations outside from the source areas of both valleys. So IASI and the surface measurement indeed see similar patterns.

Line 15: analysis

Agreed and change done.

Page 12140:

Line 20: The sentence starting with “The high density...” is not clearly written and confusing.

We have clarified this sentence by cutting to obtain (L550-555): “The high density of livestock concentrated on the fresh pasture at that time implies high surface emissions.

However, this time period is typically also associated with a high deposition and/or cloud coverage, preventing IASI to capture these events, while they are monitored from the ground (Adon et al., 2010).”

Line 26: ... during the wet season (June-July); conversely,

Agreed and change done.

Line 29: ... are grouped. This ...

Agreed and change done.

Page 12142:

Line 18: Six of the sites

Agreed and change done.

Page 12144:

Line 12: ... is consistent... (not highly though)

Line 23: ... pairs of observations

Agreed and change done.

Page 12145:

Line 8: ... considering pairs of

Agreed and change done.

Page 12146:

Line 26: ... obtained, as they were with ...

Agreed and change done.

Page 12147:

Line 8: acquire

Agreed and change done.

Line 13: ... which are becoming available

Agreed and change done.

Table 2: ... and the mean of the satellite observations ...

Agreed and change done.

Table 3: n corresponds to the number of pairs

Agreed and change done.

Table A1: ... for each station. ... Only values with relative IASI ...

Table A2: ... for each station. ... Only monthly values with relative IASI ...

Table A3: ... for each station. ... Only monthly values with relative IASI ...

This was a mistake and we have corrected it by adding “monthly” in the caption of Table A1.

Figure 3: What does “Stations with less than two third of the monthly concentrations available have been excluded.” mean? This is not clear.

We agree that this sentence was not clear and changed it to: “Stations with less than two third of measurement availability for the period considered have been excluded.”

Figure 6: Only column means...

Agreed and change done.