

Anonymous Referee #2 Received and published: 21 August 2017

We would like to thank the anonymous referee for the review and comments on the manuscript, which was greatly improved after considering them. The point-by-point responses are provided below in blue.

We also made two additional changes:

1. During the discussion period, further analyses have demonstrated that the bias correction applied over sea should also be applied over land. This was shown by the negative biases observed over islands in the tropics. Applying this correction improves the obtained distributions. We therefore describe this in the manuscript by changing the paragraph (P6, L14-16 and P7, L1-2, numbering of updated manuscript) to “A final change introduced in v2 is a HRI bias correction over the seas, where the HRI was found to be slightly negative overall, and decreasing with increasing H₂O total column amount. As this was identified to be also the case over land, the same correction was applied over land in v2.1. A H₂O dependent bias was determined from a region assumed NH₃-free by calculating the median over sea for 30 days in 2015 over bins of $0.1 \cdot 10^{23}$ molec.cm⁻² of H₂O total column. These median values are then used to correct the HRIs before using them as an input in the neural network.”
All the figures have been adapted following this change and now present the ANNI-NH₃-v2.1 dataset. Additional textual changes to v2.1 have been done all over the manuscript.
2. A correction was made P9 L32-33 where the sentence “The inputs of this neural network consist of 105 IASI channels and the satellite zenith angle.” has been changed to “The inputs of this neural network consist of 105 IASI channels, the satellite zenith angle and the emissivity.”

Van Damme et al. present the version 2 of the IASI NH₃ neural network retrieval algorithm (ANNI-NH₃-v2). This version is an improved version of previous developed and published, version 1 (Whitburn et al., JGR, 2016). The main improvements concern: separated land and sea neural networks, extended training dataset (including more representative scenes for high thermal contrasts and low latitudes), and change in the NN output to avoid overtraining the low sensitivity scenes. Thanks to the expertise acquired with the previous NH₃ algorithms developed by the ULB group, improvements and simplifications of the input parameters have been made as well as for the post-filtering process. Performances of the new version are compared to the previous version and recommendations for use are made. Finally, the authors present another version of the ANNI-NH₃-v2, ANNI-NH₃-v2R-I. This version allows the correction of errors and biases introduced by changes in the EUMETSAT version of meteorological parameters needed for the NH₃ retrieval. These changes introduce discontinuities in the NH₃ timeseries. To avoid this, the authors based their retrievals on the ECMWF ERA-Interim reanalysis for temperature profiles and the development of a NN for surface temperature retrieval. They discuss the implication of the changes in the meteorological parameters on the NH₃ retrieval and recommend the use of ANNI-NH₃-v2R-I for long timeseries analyses, when the product will be available. The paper is well written and structured with detailed discussions of the major changes in the algorithm and their implications in terms of NH₃ retrieval for both the versions ANNI-NH₃-v2 and ANNI-NH₃-v2R-I. This work is suitable for AMT publication and the recommendations made for the use of the different products is very useful for the users, especially considering the warning and improvements for the long timeseries. I recommend this paper for publication in AMT after the following comments are addressed.

- The authors should consider introducing a table summarizing the changes between the 2 versions 1 and 2 and listing the different inputs parameters and their description used in the NN (page 5).

We agree with the referee and have added a table listing all the changes between v1 and v2.1 (Table 1, P6 and here below) which includes the 20 input parameters of v2.1.

Table 1. List of changes from ANNI-NH₃-v1 to ANNI-NH₃-v2.1.

	NN-v1	NN-v2.1
Output parameter	$\frac{[\text{NH}_3]}{\text{HRI}}$	$\frac{\text{HRI}}{[\text{NH}_3]}$
Input parameters*	31: T (12 levels), T_{surf} , P (11 levels), H ₂ O (7 levels), σ , z_0 , ϵ , angle	20: T (12 levels), T_{surf} , P_{surf} , H ₂ O total column, σ , z_0 , ϵ , angle, HRI
Training set	250000 simulations	450000 simulations
Land/sea treatment	One network	Separate networks
Angle treatment	Angle dependent HRIs	1 st order correction of the HRIs by the cosine of the zenith angle Angle as input parameter for 2 nd order corrections
Bias correction	No	Over sea (v2 dataset) / Over land and sea (v2.1 dataset)
Pre-filtering**	Cloud cover > 25 %	Cloud cover > 25 %
Post-filtering**	$[\text{NH}_3] < 0$ and $\text{HRI} > 1.5$ in absolute value $\frac{[\text{NH}_3]}{\text{HRI}} > 3 \cdot 10^{16} \text{ molec.cm}^{-2}$ in absolute value	$[\text{NH}_3] < 0$ and $\text{HRI} > 1.5$ in absolute value $\frac{[\text{NH}_3]}{\text{HRI}} > 1.75 \cdot 10^{16} \text{ molec.cm}^{-2}$ in absolute value

* σ and z_0 are parameters characterizing the shape of the NH₃ vertical profile; ϵ represents the emissivity.

**An observation is removed as soon as one of the criteria is met.

- Page 7, lines27-33: it would be interesting to show series for one or more regions to illustrate the discontinuities and to show how the ANNI-NH3-v2R-I reduces these discontinuities.

We agree with the referee and have added a figure (Figure 3, P10 and here below) to illustrate the discontinuities. It presents ANNI-NH3-v2.1 (red) and ANNI-NH3-v2.1R-I (blue) timeseries over the Northern Hemisphere and clearly shows the added value of the reanalysis. While an increase of NH₃ columns is observed in 2015 with the introduction of the meteorological L2 in ANNI-NH₃-v2.1 dataset, the ANNI-NH3-v2.1R-I dataset present a more consistent NH3 column record over time.

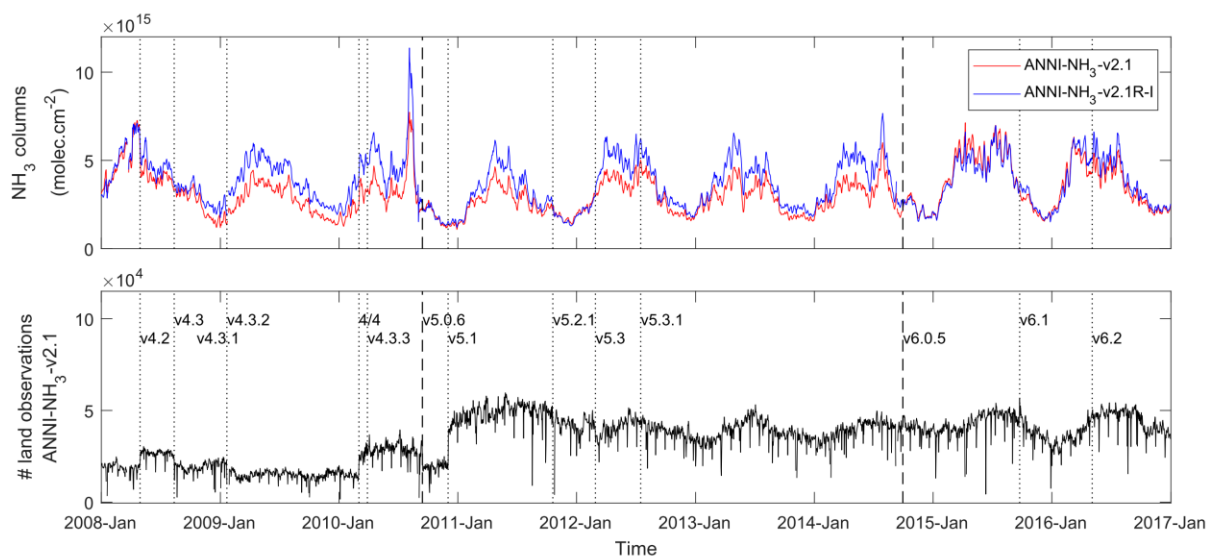


Figure 3. (Top) 5-day moving average timeseries of the morning NH_3 columns (molec.cm^{-2}) over the Northern Hemisphere for the near-real time retrieval (ANNI- NH_3 -v2.1, red) and the reanalysed retrieval (ANNI- NH_3 -v2.1R-I, blue). (Bottom) Number of land observations available for the Northern Hemisphere using the Eumetsat L2 data. The corresponding version number is indicated as a function of time.

The first paragraph of P9 (updated manuscript) now reads:

“Top panel of Figure 3 presents daily timeseries (5-day moving average) of the NH_3 columns for the reanalysed retrieval (ANNI- NH_3 -v2.1R-I, blue), and the near-real time retrieval (ANNI- NH_3 -v2.1, red) over the Northern Hemisphere. Figure 4 shows morning distributions over South Asia for 3 days corresponding to v5.3.1, v6.0.5 and v6.2 of the IASI Eumetsat L2 (see Table 2 and bottom panel of Figure 3). Taking the ANNI- NH_3 -v2.1R-I as reference, it can be seen that prior to v6, retrieved columns are much lower. With v6.0.5, the retrieved columns are slightly higher in magnitude. Finally, with v6.2, the retrieved columns are again a bit lower than the reanalysis, but still higher than with v5.3.1. From this, it can be deduced that the use of v6.0.5 resulted in a rather large increase of the NH_3 columns, while v6.2 resulted in a slight drop of the columns. Several different regions were studied, and these statements appear equally applicable elsewhere.”

A new sentence was also added P9 L2-3: “This is illustrated for land observations over the Northern Hemisphere in the bottom panel of Figure 3.”

- In the data availability statement, it would be useful for the readers/users to have the information about the period from when the authors expect that the new data will be publicly available.

The data availability statement has been changed to: “The near-real time ANNI- NH_3 -v2.1 data used in this work are freely available for all users through the AERIS database <http://iasi.aeris-data.fr/NH3/>. The ANNI- NH_3 -v2.1R- dataset will also be made available at the same place and its delivery is planned for the beginning of 2018.”

Technical comments: - Page 2, line 20-21: “detailed” and “introduced” should be inverted.

This has been corrected accordingly.