bg-2017-424-RC1: answer to referee 1 comments.

We would like to thank referee 1 for his helpful comments which we have answered below.

General Comments

This study carried out are providing answers to the much discussed question about the effect of having many plots in the field on measured ammonia emission from manure applied on the plots. Exploring the effect of measuring average ammonia concentration for increasing time intervals, the numbers of measuring heights and the best heights for measuring the emission. The answers to these questions are most important and the issue is discussed by scientist in Europe especially after the publications of Sinterman et al. questioned the existing design of measuring ammonia emission

The authors have developed a model for calculating emission of ammonia from as it varies over the day and year as affected by surface soil temperature, wind and atmospheric stability. Then, as I understand the paper, they calculate how much the emitted ammonia will contribute to atmospheric ammonia concentration at different heights above the soil surface as it is affected by climate and plot size i.e. the loss pattern over time after volatilization start is assessed using decay curves of source strength.

The atmospheric NH3 concentration data, climate data are then used as input to model calculation of the emission from a plot and plots in a field as affected a range of different management of measuring ammonia concentration, height of the ammonia concentration measurements, number of plots affecting ammonia concentration in plots downwind a plot, plot size, etc.

This reviewer is not a specialist in micrometeorology so I cannot evaluate the quality of the model calculations. In the following is my impression of the presentation and interpretation of the data.

Abstract

Line 9 NH3 is presented but later the authors write ammonia – should be NH3

This is a sound remark; we agree that we can use NH_3 throughout the manuscript once it has been defined as “tropospheric ammonia” except when it is the first word of a sentence.

Line 10: the abbreviation N for nitrogen should be given and N used in the text.

We thank the referee for the suggestion; we however think we could stick with “nitrogen” to avoid too many abbreviations in the abstract.

I am not familiar with the term inference method, the term inferring, inferred in this context? May be because my native language is not English.

We agree with the referee that “to infer” may not be a very commonly used term. It is a synonym of “to deduce”. We hence speak about a “source inference method” in the sense that the method is used to “deduce” the ammonia source.

L68: What is an intensive source?

We thank the reviewer to spot this term which we might have miss-used. We rather wanted to mean an intense or strong source. We propose to change term the “intensive” to “strong” in the manuscript.

L69-70: require hourly concentrations of what????

Of NH_3. We propose to add this precision in the text.

L87 Multiple-source inversion problem?

We thank the reviewer for spotting this incoherency. Actually, we defined what we meant in lines 76-77, as “the multiple source problem, which consists of inferring multiple sources based on measured concentrations at multiple points in space and time,…”. We hence propose to use the term “multiple-source inference problem” throughout the manuscript to keep it coherent.

L121-124: Units are missing

Thanks for spotting, that units for concentration and emissions were missing. The concentration and source are in µg N-NH_3 m^{-3} and µg N-NH_3 m^{-2} s^{-1}, respectively. We propose to add these precision in the manuscript.

L324-327: Has the data from this experiment been used in previous articles, reports, proceedings?

Results from this experiment have been used jointly with other experimental trials in a poster proceeding, but not for testing the multiple-source inference methodology presented here. The poster was presented is a French meeting on fertilisation. The objective was to compare the emissions potential from several treatments based on the use of a “gradient” method applied to badges. This objective of the poster presentation was to show the potential of using alpha badges to discriminate between nitrogen application methods in terms of potential ammonia losses. The link to the poster abstract in French is here:

http://www.comifer.asso.fr/images/pdf/11emes_rencontres/Interventions/Session%201/5%20-%20Jean-Pierre%20COHAN/Article%20Jean-Pierre%20COHAN.pdf.

L355-356: Rewrite

We propose to change for the following simplified sentence: “The friction velocity u* varied between 0.024 and 1.181 m s-1, and the stability parameter z/L varied between -49 and 21 m-1 (Figure 3).”

383: Condition number – what is this – referring to an equation S1 in annex, it is a number often used so a presentation of how it is calculated should be given in the article

The condition number is indeed an important indicator of the geometry of the multiple sources inference problem. We feel that it was well defined and discussed in the supplementary material section S2. The way it is calculated in practice is mentioned at line 46 of the supplementary material. We propose to slightly modify this sentence to make it even clearer: “In practice, the calculation of CN was performed using the kappa function in R (version 3.2.3).” We also propose to add the mention (see supplementary material section S2) in lines 384 and 684 of the manuscript were this indicator is mostly mentioned.

P519: When discussing the effect of height for measuring the horizontal then the authors should relate the outcome of their study to that of Wilson et al. who showed on basis of micro-met. Calculations that there is a best height for measuring the horizontal flux at one height (This Zinst height is higher that the height recommended here)

Although the ZINST method has no link with our approach, it is an interesting remark that brought back to our attention that the heights at which should be placed the alpha badges would depend on roughness length and displacement height. Indeed, the ZINST method is a method that uses the finding of Wilson et al. (1982) that the ratio of the source strength to the horizontal flux at height ZINST is somewhat constant whatever the stability conditions. Interestingly, Wilson et al. showed that ZINST was an exponential function of z_0 for a given source diameter. We hence propose to add the following text after Line 519: “It is interesting to notice that the heights which were found to found to provide an optimal inference of NH_3 sources (below 0.5 m) are smaller than ZINST reported by Wilson et al. (1982) (which were 0.9 m for 40 m diameter circular sources, and which we estimate as 0.65 m based on a power law extrapolation as in Laubach et al. (2012)). It is also important to notice that this height should vary with both the roughness length z0 and displacement height as was showed by Wilson et al. (1982) for ZINST.”

L555: What is the highest source?

We actually meant the largest source. We propose to change the text in L555 and L540 and also Figure 12 accordingly.

Figures:

The font size of the Y and X axis and some of the legends are too small on most figures. On some figures there are too many lines (7 lines on fig 4) making it very difficult to see the individual lines.

We thank the reviewer for his suggestion. We have looked at the figures thoroughly again and we agree indeed that some figures may be difficult to read, but most figures look good to us. We propose to improve some figures are explained below but we would like to have the editor point of view for the other figures.

- Figure 4: we propose to reduce the number of integration periods and to keep only 0.5h, 24h and 168h which are sufficient to show the variability that is lost by integrating concentration measurements.

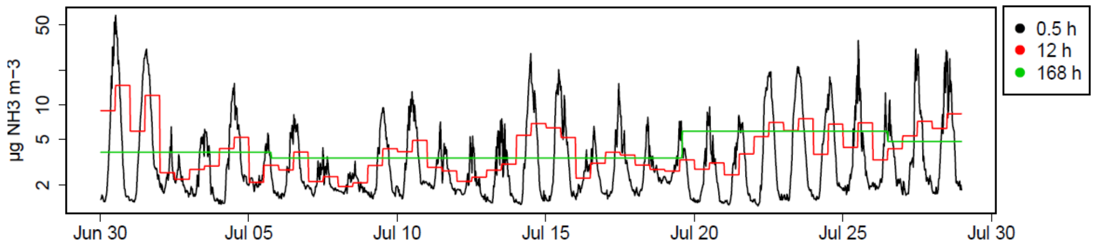

Figure 4. Example modelled concentration pattern at 1 m above a single 50 m width source for several averaging periods (0.5h, 12h and 168h) for the month of July 2008. The source Γ was set to 10^5. The y-axis is log scaled.

- Figures 5: there were some legends that we left in the right corner but these are not useful as the main legend was written at the top of the graph. We propose to erase these legends:

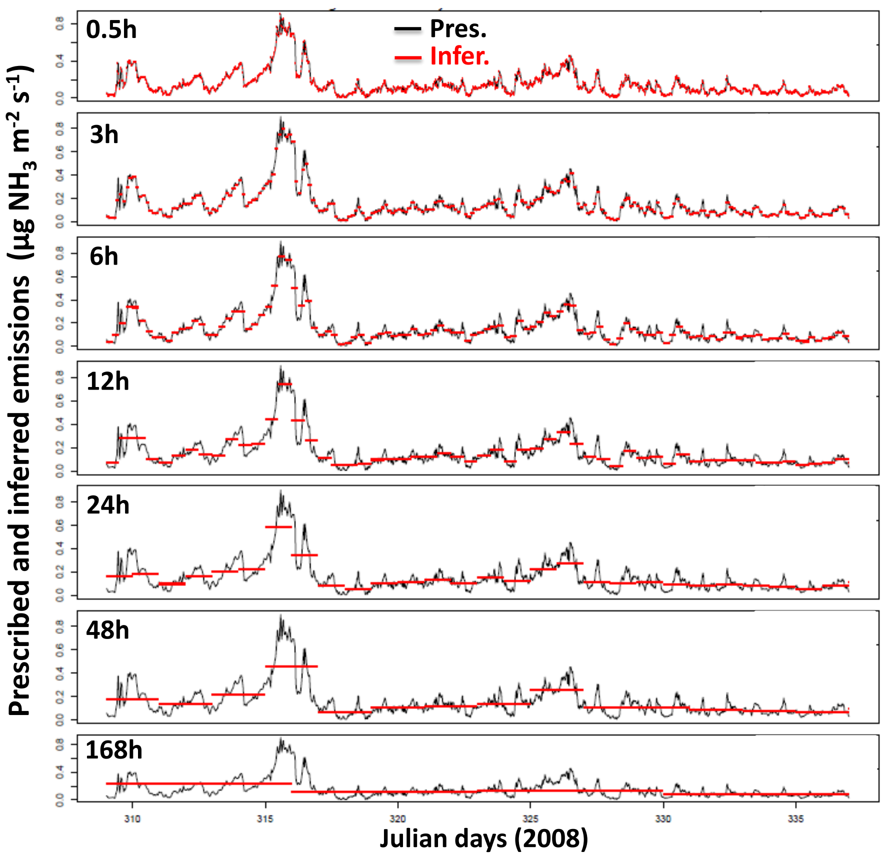

Figure 5. Example source inference for a 25 m width square field and a concentration sensor placed at 0.5 m above ground. Here Γ = 10000 and is set to constant (pattern 1). The 7 integration periods are shown: 0.5h to 168h. The x-axis shows the day of year and corresponds to a span over November. The prescribed source is in black (Obs.) and the inferred one in red (Pred.)

- Figure 7: we propose to change the font size and the Y axis label. We also change the caption for u_* and $1/L$ classes:

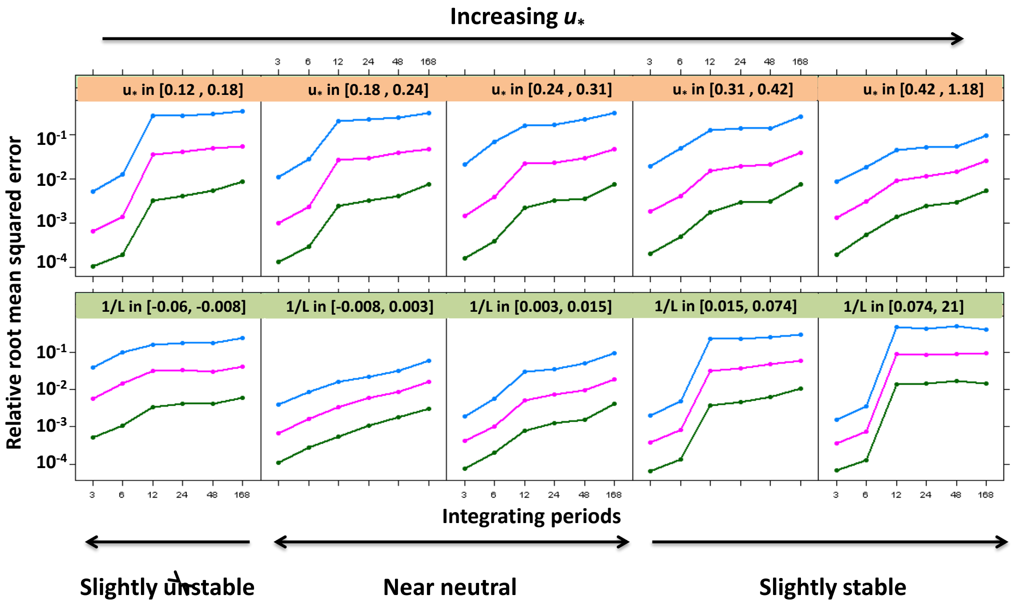

Figure 7. Relative root mean squared error as a function of integration period for stability factor and friction velocity classes for a single 25 m side field. Medians and quartiles are given for equally sized bins of u_* and $1/L$ and for the lowest sensor height (0.25 m). The blue, pink and green curves are the 3rd, 2nd and 1st quartiles, respectively.

Figure 5 & 8: I assume that prescribed is the emission data provided by calculation and inferred is emission calculated by knowing NH_3 concentration at 0.5 m and weather conditions.

Indeed prescribed emissions are calculated using equations (9) and (10) with a constant Gamma, and inferred are those based on measured concentration at 0.5 m height and transfer coefficient using equation (7).

Fig. 7: Need improvement

We agree. See previous section for our proposition.

Fig 9; Why not mention the emission strength of the source instead of Treatment 1-3 (what is the units?)

This is indeed a sound remark. We propose indeed to use the emission potential Γ, which actually has no units. Figure 9 would look like this (Figures 10-12 would be changed accordingly):

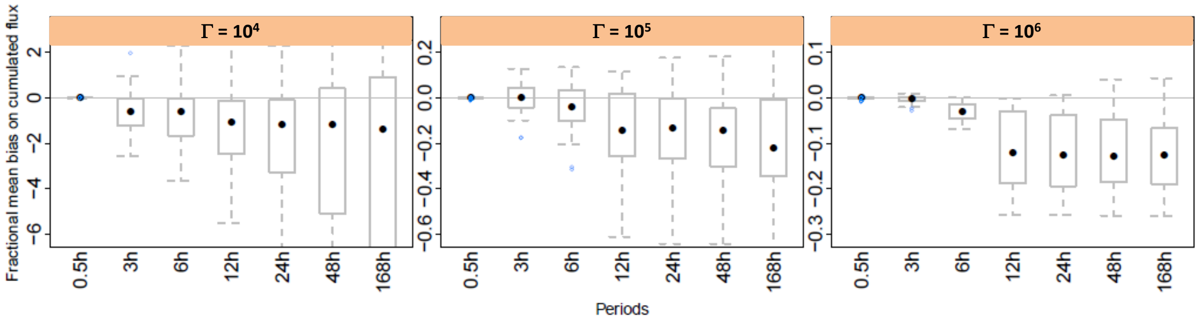

Figure 9. Effect of integration period on source inference in the multiple-plot setup. The fractional mean bias of the source is shown for each treatment. Inference strategy C1 was used (single sensor, independent blocks, and background concentration known). Statistics for runs with target heights 0.25 and 0.5 m and source side = 25 m are calculated. All application periods are considered. Filled points show medians, boxes show interquartiles and bars show minimums and maximums. Outliers are points to 1.5 times away from boxes limits.

Fig 16: Is it correct that measured emissions are not included – if so then the measured results should be included?

There might be a misunderstanding on that figure; indeed Figure 16 report inferred emissions using the multiple-source inference method that was presented and discussed in this manuscript. But in that experiment no other method than this one was used to "measure" emissions. This is actually our point to show that this inference method is coherent in estimating the emissions under real situation. In a way our inference method gives a measurement of the ammonia emissions.

References quoted in the answer to reviewer 1

Laubach, J., Taghizadeh-Toosi, A., Sherlock, R.R. and Kelliher, F.M., 2012. Measuring and modelling ammonia emissions from a regular pattern of cattle urine patches. Agric. For. Meteorol., 156: 1-17.

Wilson, J.D., Thurtell, G.W., Kidd, G.E. and Beauchamp, E.G., 1982. Estimation of the rate of gaseous mass transfer from a surface source plot to the atmosphere. Atmospheric Environment (1967), 16(8): 1861-1867.