

Reviewer #1

We wish to thank the referee for his/her helpful comments. The full reviews are copied hereafter and our responses are inserted. The comments of the reviewer are in normal black and our answers in bold.

GENERAL COMMENTS

The manuscript compares 3 inventories of NH₃ over France for the year 2011. The inventories are referred to as the "TNO" dataset (from a European inventory, based on reported national totals), the "NH₃SAT" dataset (based on IASI inventories), and the "CADASTRE" dataset (based on a highly detailed model). The emission inventories are compared to each other, and used in simulations with a regional transport model from which simulated concentrations are compared too. Since NH₃ is an important pre-cursor for aerosols and nitrogen deposition in agriculture intensive regions, this study provides a useful contribution to air quality modelling. I would therefore recommend to publish the manuscript after some minor clarifications.

The results show that to a large extent the three inventories are in agreement with each other, with exception of northern France during the spring period. An important conclusion is that application of mineral fertilizer in combination with certain soil properties could be very relevant when compiling NH₃ emission database. When this is taken into account, as is done in the "CADASTRE" set, then simulated NH₃ concentration columns are in better agreement with IASI observations than simulations driven by the "TNO" emissions, which uses a more simple approach for spatial distribution of emissions. It would be useful if the authors could provide an outlook on how their results should be used in future.

Thank you for this suggestion, which allows highlighting the implications of our study. We added a couple of sentences at the end of the Conclusion section:

“Yet, current results of our study have important implications for air quality modelling over Europe. The important changes in the spatial distribution of NH₃ emissions as a function of soil properties are of general concern not only for France, but for whole Europe. Soils are alkaline or neutral (pH>6) not only over North-Eastern France, but also over large parts of Italy, eastern Spain, or eastern Germany [Reuter, 2008]. Over these regions, our study suggests potentially larger NH₃ emissions than with a constant emission factor treatment, with impacts then on fine particle formation. These features should be included in “operational” emission inventories used for air quality modelling.”

Reuter, H.I., Lado, L.R., Hengl, T. and Montanarella, L.: Continental-scale digital soil mapping using European soil profile data: soil pH, *Hamburger Beiträge zur Physischen Geographie und Landschaftsökologie* – 92 Heft 19/2008, pp. 91-102, 2008.

It is clear that a more detailed emission model as used in "CADASTRE" could provide better emission inventories, but from the provided information it seems not possible to apply this over, for example, the rest of Europe.

Indeed, Skjøth et al., [2011] already showed that agricultural practices of a specific country cannot be extrapolated to another country, right now. Specific adaptations to national databases (especially agricultural practices) should be performed beforehand. Also, soil properties need to be updated for each country. However, we think it is worthwhile to undertake such an effort in future work.

In addition, it seems that in spite of its high detail also "CADASTRE" is not able predict the timing of emission right. But could the information that is used in "CADASTRE" find it's way into the "official" inventories such as that from "TNO" ? For example, would it be sufficient to just have maps of fertilizer use and soil properties for a better spatial redistribution, which is now primary based on livestock densities? Or is modelling of emissions too uncertain anyway, and should we rely most on (satellite) observations?

Yes indeed, while predicting day to day timing of NH₃ emissions is still in research area, modulation of emission factor (per fertilizer use) taking into account soil properties is a realistic perspective for official emission inventories. This is what we put into the perspectives added to the manuscript (just above).

SPECIFIC COMMENTS

Table 1. Some clarifications on the temporal resolutions would be useful. Emission inventories like "TNO-GEN" are usually accompanied with profiles for month-of-the-year (as used here), but also "day-of-the-week" and "hour-of-the-day". That would change the resolution to "hourly", although the uncertainty is high of course. For "NH₃SAT" there is no full daily resolutions, since data coverage in time is not 100% as shown in Figure 1 lower panel. For "CADASTRE" line 525-526 mentions two-weekly data on agricultural practices; what does this do with the "daily" temporal resolution of the emission model?

Indeed, we agree. The legend of Table 1 has been changed in « Main characteristics of the different compared inventories before their aggregation/disaggregation for the inter-comparison.» Clarifications on the temporal resolutions about TNO have also been added in Table 1 and in Section 2.1: “The emissions remain constant between days in each month and between hours in each day.”

Indeed, for CADASTRE_NH₃, available information on agricultural practices is resolved at a two weeks scale. It is linked to the data source and treatment. In fact, the dates of fertilization are extracted from a national survey on the basis of a relatively small number of farms per region and per crop: they are then exploited through statistical analyses. In order for the extracted results to be meaningful, we have chosen this fortnightly basis, which is also consistent with the surveys of previous years (fortnightly basis). The dates for which simulations are carried out are randomly selected from the fortnightly surveys in proportion to their representation: this method does not lead to an exhaustive choice of dates. A sensitivity analysis of the dynamics and extent of volatilization is currently being carried out to evaluate the possibility of changing the number of draws in relation to the quality of the outputs in view of the dynamics and extent of volatilization. Results of these tests and potential evolution of the Cadastre_NH₃ framework would be published at a later date.

Line 154. CHIMERE has not been mentioned before, maybe point forward to section 2.2.1.

Indeed, the reference to CHIMERE in this sentence has been removed.

Paragraph 192-196. It is not clear to me how many IASI pixels are typically used for a single "super-observation".

1, 2 or 3 IASI pixels are typically used for a single « super-observation ». We have completed the definition of the « super-observation »: « average of all IASI data within the 0.5°×0.25° resolution and for the given CHIMERE physical time-step of about 5/10 minutes)»

The "robustness" of the data is mentioned, does that mean the variability between nearby pixels is low? Figure 1 shows some strong gradients however. Or thus "robustness" more refer to the temporal and regional differences?

Indeed, the robustness here refers to the temporal and regional differences. We have completed the sentence: « the results about the temporal and spatial variability of the NH₃ French emissions presented in Section 3».

Line 219-221. When no IASI super-obs is available, the "NH3SAT" inventory uses the "TNO-GEN" data. Given Figure 1 that would mean that for at least half of the days in a month the "TNO" emissions are used. Given the regional differences between the "TNO" and "NH3SAT" inventories, wouldn't it be logical to assume some kind of persistency here? Thus, use the latest "NH3SAT" value if for some day there is no super-obs available? Also temporal interpolation would be an option. How would that change the emission totals? And the conclusions on temporal variability, e.g. at line 433?

We indeed could assume some persistency. As a test, we calculate a mean daily corrective factor for each region A, B, C, D and we applied this corrective factor at the grid-cell scale when IASI super-observations are not available. This results in the daily variability shown in light orange below, showing for example higher emissions in the northeastern part of France the second week of March. Nevertheless, the small number of IASI pixels taken into account for this corrective factor may be partially contaminated and may not be sufficiently robust. We prefer not to integrate this test in our study. In future work, variational inversion might be a better option to better take into account transport, chemistry on the one hand and adjust the window to reduce the impact of days with few data on the other hand.

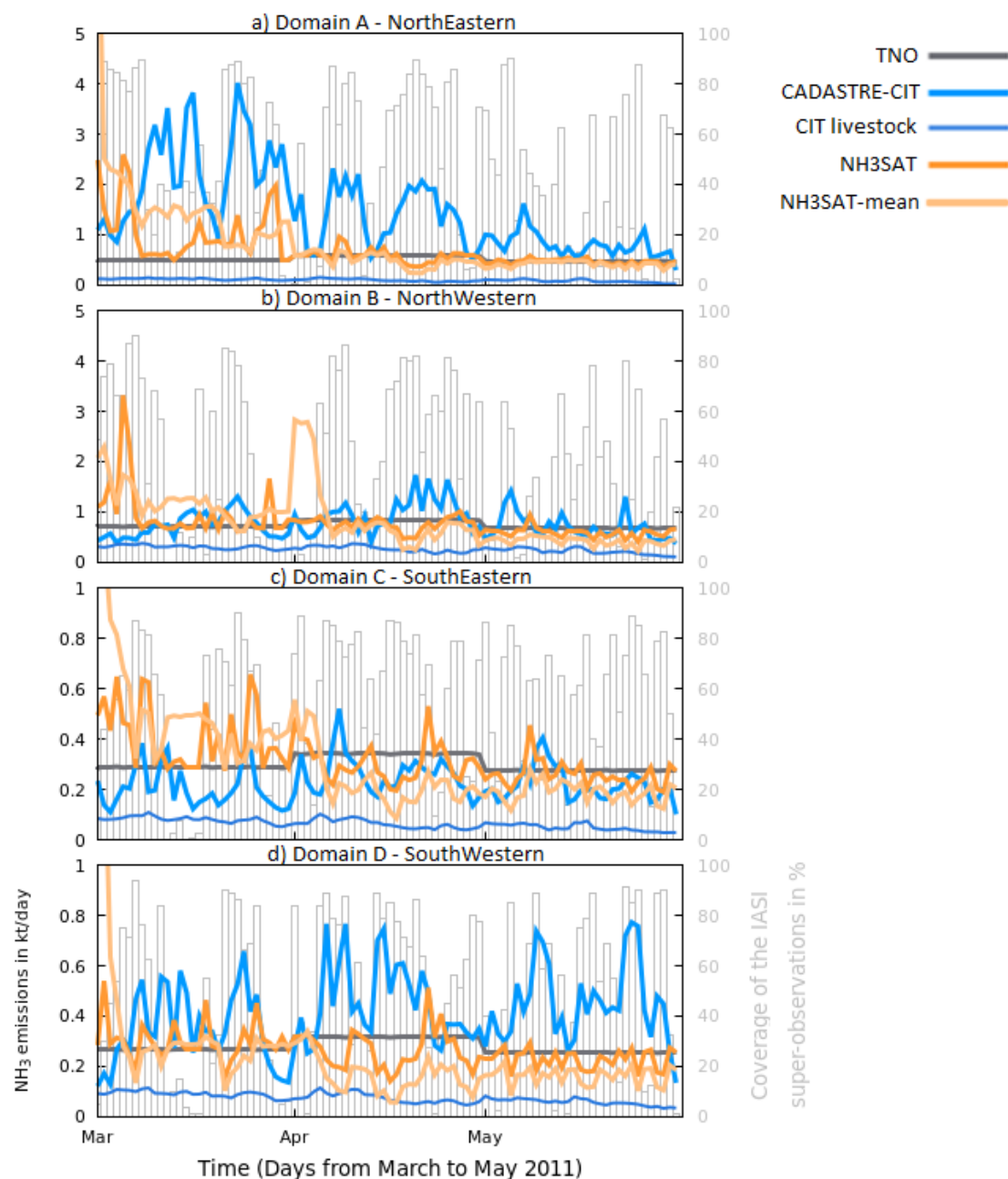


Figure 4. This figure would be better interpreted if also maps with absolute emissions for "NH₃SAT" and "CADASTRE" are added, and not only the differences.

We agree, absolute emissions are now shown in Figure 4.

In general, the comparisons are now often "against" the "TNO" set, while I would think that it should not serve as a "truth" but just as one of the 3 inventories, each with their advantages and disadvantages.

Indeed, we choose to make the analysis of CADASTRE-CIT and NH₃SAT against TNO-GEN. It is relevant as TNO is one of the European reference, widely used by the community. Also, it could be considered as a baseline starting from which refinements and potential improvements can be documented.

In order to better explain this status of TNO-GEN as reference and not as truth, we have added elements in this sense in the text of the introduction:

“(i) the reference, in the sense that this is the method currently used. the hereafter called TNO-GEN, is the European inventory based on the annual budgets provided by the TNO-MACCH inventory [Kuenen et al., 2014] and seasonal profiles from GENEMIS [Ebel et al., 1997]...”

TECHNICAL CORRECTIONS

45. "encourage" instead of "encouraging"

It has been corrected.

72. "may not be well"

It has been corrected.

85. "... its temporal and spatial ..."

It has been corrected.

129. just "crops", not "N crops"

It has been corrected.

219. "When IASI is not available ..."

It has been corrected.

240. "There is no evaluation available ..."

It has been corrected.

246. "excluding" instead of "except"

It has been corrected.

296. "Weather condition effects"

It has been corrected.

325. "that can"

It has been corrected.

379. "Regions are marked in bold ..."

It has been corrected.

440. "after spreading, reducing"

It has been corrected.

448. "inventory"

It has been corrected.

Figure 5 and 6: I would call this color "black" rather than "gray"...

It has been corrected.

At many places it seems that white-space is missing (or is this something in the pdf?)

We apologized for the inconvenience. It has been corrected.