

Reply on RC1

A brief introduction to the revision of the manuscript (MS) as follows:

In the revised MS, the reviewers' comments were fully incorporated into the text accordingly. The text of the MS was revised by us: i) providing more details of the original model and the modifications; ii) reorganizing and rewriting the Abstract, Results and Discussion sections; iii) the sensitivity analysis for the parameters of the improved model was added. Furthermore, we recompiled the Supplementary materials by adding Table S1 and S2 to present the equations and symbols of the regulatory factors affecting NH₃ volatilization from uplands in the original and modified CNMM-DNDC.

Referee #1:

1. Does the paper address relevant scientific questions within the scope of BG?

The paper present results of a modified version of DNDC-CMMM to better represent the NH₃ volatilization of paddy rice field and upland crop. Considering the importance of N cycles in soil biogeochemistry and of NH₃ emissions in global change the paper seems within the scope of BG.

>> Thanks.

2. Does the paper present novel concepts, ideas, tools, or data?

The paper improve existing model of N emissions for two types of cultivation and performed sensitivity analysis to several environmental factors. In this way, tools and findings are novel.

>> Thanks.

3. Are substantial conclusions reached?

Yes, however it is a bit difficult to follow which simulations are considered as valid and which one are considered as non relevant. Maybe a table or few clear sentences to sum up might be helpful.

>> Fully agreed. In the revised MS, we summed up the performance of the original and modified models in a newly-added separate subsection. Please see changes in the 3.4 subsection.

4. Are the scientific methods and assumptions valid and clearly outlined?

The methods are well detailed, however the authors combined 3 different models (DNDC, CNMM and Jayaweera-Mikkelsen) while only Jayaweera-Mikkelsen model is accompanied by a schema. In my opinion, taking into account the numerous processes involved in each model and the successive optimizations performed by the authors, a complete scheme of the full model including the parameters used by default or optimized could be helpful.

>> Fully agreed. Our MS was based on the application of CNMM-DNDC model regarding the prediction of NH₃ emission from soils. The original model has a

NH₃ algorithm. The attempt in this MS was to incorporate the J-M algorithm into the CNMM-DNDC to improve its performance for the NH₃ prediction. As the result, we revised the statements regarding the descriptions of the original model and the modifications. Please see changes in Lines 143-146.

5. Are the results sufficient to support the interpretations and conclusions?

The results are well detailed but the difference in the Fig 3 to 5 is not very clear for me. Also, a comparison of the NH₃ volatilization sensitivity to environmental factor between rice paddy field and upland crops might be interesting. I found that the 4.1 title does not precisely correspond to the paragraph and that the 4.3 is a bit long and difficult to follow.

>> Fully agreed and revised the MS accordingly.

- i) we added the detailed description regarding the difference of Figs. 3-5. And the cases with the same observed variables were associated in a figure for unified formatting. Please see changes in Lines 444-446.
- ii) we rewrote the title of the 4.1 subsection and reorganized the Discussion section. Please see changes in the Discussion section.
- iii) we are sorry for missing out the title of 4.3 and jumping the titles from 4.2 to 4.4. We renumbered the titles and reorganized the Discussion section to make it more readable in the revised MS. Please see changes in the Discussion section.

6. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)?

I think all the data and results are provided, however, as noticed above the numerous processes and step involved in modification make it difficult to evaluate without a complete scheme (especially because several parameters were took from other model).

Also, it is not very clear if the data of re-calibration was the same than used in the last version of DNDC of Li et al., 2019 (l.117). Several parameters have been recalibrated (l. 168 to l.176) without mentioning how they were recalibrated (algorithms and data). Also, I don't understand why the time conversion factor is 0.75 (so not a ratio of the two initial models time step) while one model is based on 3 hours and the other on 24 hours.

>> Agreed and revised the MS accordingly.

The two new Table S1 and S2 were added to present the equations and symbols of the regulatory factors affecting NH₃ volatilization from uplands in the original and modified CNMM-DNDC. Please see changes in the Supplementary materials.

The sensitivity analysis of the improved parameters was added. Please see changes in Fig. 8 and the 2.4 subsection.

The calibration and parameterization of the regulating factors except f_{depth} and f_{Tstep} were adopted from Dubache et al. (2019) and Li et al. (2019). Please see changes in Lines 189-190.

In this revised MS, the zero-intercept linear regression was applied for the calibration of f_{depth} and f_{Tstep} . Please see changes in Lines 200-210. In Fig. S2, we provided the calibration process of f_{Tstep} as an instance.

The ratio of time steps of the two models (T_{layer} , with the value of 8) was involved in the modified model. But T_{layer} was missed out in Eq. (1) in the original MS due to our negligence. We are sorry for that. In the revised MS, we added the ratio of time steps (T_{layer}) of the two models into Eq. (1). Nevertheless, the deviation derived from the different time steps existed, as shown in Table S3. To solve the above deviation, a time-step parameter (f_{Tstep}) was introduced into Eq. (1) and the calibration process of f_{Tstep} was provided. Please see the new added Fig. S2.

7. Do the authors give proper credit to related work and clearly indicate their own new/original contribution?

For the major parts of the manuscript there is enough references, however the 4.4 lack of some references

>> Fully agreed. We added several references and sentences to support the subsection 4.3. Please see changes in the subsection 4.3.

8. Does the title clearly reflect the contents of the paper?

Yes

>> Thanks.

9. Does the abstract provide a concise and complete summary?

Yes but maybe the description of the sensitivity analysis could have been a bit more longer. Also, the validation part is presented after the sensitivity analysis in the abstract while in the results it came afterwards.

>> Agreed and revised the abstract accordingly. Please see changes in Lines 27-42.

10. Is the overall presentation well structured and clear?

The results are relatively clear except that in my opinion the fig 6 should be cited earlier in the text while comparing the model performance. Also, large part of the results focused on ABC treatment which is only 2 sites, in my opinion the results for others amendment are more robusts. The material and methods part is long and, as mentioned above the model and model parameter fitting is complicated to follow. The material and methods sections on data analysis are much clearer.

>> Fully agreed and revised accordingly. As a result, we summed up the performance of the modified model in a newly-added separate subsection 3.4 and especially focused on the performance of the model in simulating NH_3 volatilization from urea application. Please see changes in the 3.4 subsection.

In addition, Table S1 and S2 were provided to present the equations and symbols for the simulation of NH_3 volatilization from uplands in the original and modified CNMM-DNDC. Please see changes in the Supplementary materials.

Is the language fluent and precise?

Yes

>> **Thanks.**

11. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used?

Yes

>> **Thanks.**

12. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated?

As mentioned above the fig 3 and 5 are similar and a conjugated presentation of these two figures would be easier. Also, I there is several subplot in each of them but the whole figures seems somehow similar. Also, the text police is not the same in the whole manuscript, please adjust.

>> **Fully agreed and revised accordingly. Please see changes in Lines 444-446.**

We also double-checked the whole MS carefully and adjusted the inconsistent expressions throughout the revised MS.

13. Are the number and quality of references appropriate?

Yes

>> **Thanks.**

14. Is the amount and quality of supplementary material appropriate?

I would have appreciated if the model the authors build was available for re-use.

>> **Agreed. The code and executive program of the modified model can be obtained from <http://doi.org/10.6084/m9.figshare.19388756>. Please see the additional descriptions in Lines 757-758.**