Biogeosciences Discussions

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Reply on CC1

Jie Zhang et al.

Author comment on "Modeling nitrous oxide emissions from agricultural soil incubation experiments using CoupModel" by Jie Zhang et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2022-56-AC3, 2022

Great thanks to Lorenzo Brilli from the discussion community for the interest in the study and the time that you took to provide useful feedback for our manuscript. The comments are valuable and very helpful for revising and improving the paper. Please find the response to each comment below marked in red and italicized.

Community 1 (CC1):

Manuscript "Modeling nitrous oxide emissions from agricultural soil incubation experiments using CoupModel" by Jie Zhang et al.

CC comment: The manuscript provide results from a short-term (43-day) factorial incubation experiment to investigate the ability of a process-oriented model (CoupModel) to estimate N_2O and carbon fluxes, and soil mineral nitrogen (N) dynamics. The manuscript is well written, it fluently flows and the whole structure is coherent with the adopted approach. To my opinion, all three objectives indicated by authors at the end of the introduction were satisfying investigated. This would make the paper suitable to be published.

Response: Thank you for appreciating our effort in conducting the modeling study. It was a lot of work and we did our best to diagnose model behavior and test the performance.

CC comment: However, many similar works were developed and published through years, reporting similar issues and conclusions. This make the novelty of the paper very poor, despite the large work done. To overcome this huge limitation, I suggest authors to be more proactive at presenting solutions on how to solve the detected issues under current modelling limitations. Within the text, in fact, only general suggestions to cope

with these issues are reported (i.e., revisit basic model assumptions and equations, increasing high-quality measurement data, etc.), but none proper solution (new equations to implement and their description, description of further steps in soil incubation experiments, previous chemical analysis to do, etc.) and related changes in final results were reported. I understand that this is not the primarily objective declared within the paper, but since an exponential number of modelling works were published in the last 30 years, a step forward to indicate how to overcome these limitations would be done.

Response: In the responses to RC1 and RC2 we have tried to argue what makes this study unique. The incubation experiment providing the data used for modeling may be considered to zoom in a common field operation with residue recycling that may result in a period with high N_2O emissions in the field depending on residue quality. We have challenged the model to simulate results from short-term incubations to learn about sensitivities and limitations. The simulation showed predominantly aerobic conditions, but still N_2O emissions were substantial, which supports experimental studies demonstrating the importance of mm-scale hotspots for N_2O emissions. Both the high O_2 availability predicted by the model and the observed N_2O emissions are consistent with the measured O_2 distribution and coupled nitrification-denitrification around manure hotspots (e.g., Petersen et al., 1996) and red clover hotspots (Kong et al., 2017). Also, weak responses of estimated N_2O fluxes to soil moisture could be related to heterogeneous moisture distribution in the real soil-residue mixture and the implicit role of soil moisture response function in denitrification module as discussed in section 4.2 and 4.3. As discussed earlier, the gap between model simulations and the most intense N_2O emissions could be partly due to experimental design, and partly due to constraints on parameters associated with denitrification. We agree with the Lorenzo Brilli that further statements on how to overcome limitations could be done. **We plan to include a new section in the Discussion about these modeling challenges and better experimental design.**

References:

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Petersen, S. O., Nielsen, T. H., Frostegård, Å. and Olesen, T.: O_2 uptake, C metabolism and denitrification associated with manure hot-spots, Soil Biol. Biochem., 28, 341–349, doi:10.1016/0038-0717(95)00150-6, 1996.