Biogeosciences Discussions

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Comment on bg-2021-182

Anonymous Referee #1

Referee comment on "Adding organic matter to restore wetland soils may increase methane generation and is not needed for hydric soil development" by Brian Scott et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-182-RC1, 2021

In this manuscript, the authors conduct microcosm experiments with two wetland soils, a sandy loam and a sandy clay loam, to explore how different organic amendments (from fresh to cured organic matter) affect CH4 emissions and Fe reduction. The paper addresses a topic of great interest to the biogeochemistry community, especially to those interested in mitigation efforts in wetlands. Amending soils with organic matter to increase soil carbon stocks is generally considered a key mitigation practice, so exploring systematically how different amendments affect emissions is important. The paper is also easy to follow, especially as it adopts a very simple structure. Overall, I believe the paper can be an important contribution, and I recommend publication after addressing some points of concerns described below. Generally, I think these points can be addressed by expanding the discussion and/or elaborating more on the methodology.

- There needs to be more connection between the experiments being done and the type of wetland (and location within the wetland), for which the results are relevant. For instance, the experiments are conducted under anaerobic conditions, but this is not always the case in wetland soils, as some soils are affected by tidal fluctuations or are not necessarily inundated (e.g., peatlands). In non-inundated wetlands or seasonal wetlands, there might be an interplay between methanogens/methanotrophs and between different metabolic pathways to decompose carbon. So, it seems that the experiments are more relevant to saturated/inundated wetlands (e.g., marshes or small lakes). I think that it would be important to read the authors' perspective on this.
- Another important point is related to the overall conclusion of the study. That CH4 and CO2 emissions generally increase upon organic matter addition is expected, I would say. But how much do emissions increase relative to the amount of C provided? The authors should consider studying the emissions normalized by the amount of C added. This normalized measure could also be more relevant in the context of wetland management and restoration. Overall, if we add organic matter to wetland soils, we should expect an increase in emissions. But the questions are: how much of this organic matter ends up being emitted as CH4? How much as CO2? And how much will it

be converted into stable organic carbon? Isn't it this partitioning that ultimately helps us decide whether adding a specific organic matter (and how much) is an effective mitigation/restoration or not?

- There is a lot of material in the supplementary information, which could be included in the manuscript. Right now, as soon as one starts reading the results, one needs to stop and look for the supplementary Figures and Tables to be able to follow. If they are important for understanding the analysis and findings, they should be included in the main manuscript.
- The observation that sandy loam has higher emissions than a sandy clay loam might seem trivial, if it is not discussed in more depth. Because of the higher clay content, I would assume that this is due to the higher specific surface area that tends to retain more carbon. If this is the reason, then this is well known. If there is more, then why do you suggest that they sandy loams are more vulnerable here? For example, in lines 235-239.
- The implications of the study seem important, but the authors could elaborate more on them. I suggest the authors discuss more the implications, perhaps with some rough numbers estimated from their analysis. For example, the authors mention the design of systems that regulate flooding depending on the breakthrough time. I am surprised the authors are not mentioning/citing work on rice cultivations, where this technique of managing inundation to reduce emissions is widespread. In this regard, it seems that using organic amendment with long breakthrough times can be very important in rice fields. However, in rice fields, farmers tend to use rice straw as amendment, because of course it is readily available. What would be the implications for other wetland systems? Going back to point 1, linking the analysis to wetland type can be an important point of improvement.

Minor comments

In the introduction, the different paragraphs are not well connected with each other. There is background material without explicit link to the overarching question. I suggest reframing a bit the introduction so that the research question is clear and so is the link to the background material in the various paragraphs.

The title mentions that adding organic material is not needed for hydric soil development, but this question is poorly discussed throughout the manuscript, so there seems to be a mismatch between title and manuscript. In my view, either the authors address this more explicitly in the manuscript, or they remove it from the title.

Line 44: what do the authors mean by "couple it"?

Fe reduction also depends on the amount of readily available Fe oxides and is not necessarily limited by available C. Did the authors consider this? Also, Fe reduction can be important in systems that experience oxic/anoxic fluctuations (or saturated/unsaturated conditions), because Fe reduction is very fast and if there is not an oxidation step where Fe2 is oxidized back to Fe3, then Fe reduction quickly stops. So, in what wetlands or

wetland position do the authors think that this part of their analysis is important?