

Reply on RC2

Brian Scott et al.

Author comment on "Quantification of potential methane emissions associated with organic matter amendments following oxic-soil inundation" by Brian Scott et al.,
Biogeosciences Discuss., <https://doi.org/10.5194/bg-2021-182-AC2>, 2021

Commenter #2

The manuscript is focused on wetland soils affected by organic matter amendment and its effect on gases (carbon dioxide and methane) production and on iron reduction. The topic of the manuscript is important and actual. Carbon balance in wetland ecosystems, organic matter accumulation and greenhouse gases production are often studied within last ten years. In the study, two soils from newly constructed wetlands differing in soil texture and organic matter content were used and amended by four types of organic matter: hay, manure, compost, biosolid. Then gases production and iron reduction were studied under anaerobic conditions in the laboratory microcosm system.

In the result section I would expect to find the data which would show, what was the percentage of methane production from the total gas produced or the ratio of methane to CO₂ production. Some data are shown in the supplemental table S2, but this table is not too helpful, as it is complicated to read it and to find the numbers, which I need. Some smaller clear summarizing table or graph of these data would be much better and it should be included in the manuscript.

Table S2 is intended to be complete - we agree that results in less readability. We will add an additional table with CH₄: CO₂ ratios.

The authors did a conclusion that organic matter amendment to soil is dangerous as it increases methane emission from soil. However, methane emissions in the field were not measured but only potential methane production under laboratory conditions. It is therefore very difficult to make any conclusion about methane emissions from the soil in the field based only on data measured under controlled laboratory conditions. The problem is, that in the field many other factors affect methane emissions from the soil, which were not measured. These factors include especially water level, presence of vegetation and its composition, presence and activity of methane oxidizing bacteria (methanotrophs) in the aerobic layer on the soil surface and in the rhizosphere, presence and activity of anaerobic methane oxidizing bacteria in the soil, soil physico-chemical conditions like concentration of other electron acceptors in the soil profile (oxygen, nitrates, sulphates etc.).

We agree with both points: that methane emissions from field sites and consideration of other factors (e.g. methanotrophs) are important factors. This lab study is part of a much larger body of work that includes a field study, which we will publish separately. With

*respect to our choice to do a lab study in a jar, without plants and under nitrogen headspace to remove the activity of methanogens and plants - this was intentional. Our reported values represent methane production **potential**, not actual expected emissions. Our intention is to compare various OM amendments, and it is often the case in science that we do that by removing potentially confounding factors. We will add the reference Yang et al, Evaluating the Classical Versus an Emerging Conceptual Model of Peatland Methane Dynamics: Peatland Methane Dynamics, Global Biogeochemical cycles, 2016. This paper discusses the limitations of various approaches to estimating methane production and oxidation rates. As Yang points out, there is the potential for methanotrophy (including anaerobic methane oxidation), so methane generation in soils may be underestimated. This work is a truer measure of potential methane production and has intentionally removed important factors such as methanotrophy and transport by plants. In that way it is a small but important part of a larger puzzle.*

Methane production increased after addition of organic matter to soil, which is not surprising and it is known phenomenon. The data are then interpreted in sense that it is dangerous to add organic matter to soil due to increased methane production. But I miss any calculation, estimation or extrapolation of measured gases production rates to the field conditions. What happens in the field after organic matter amendment? How much would be methane emission from soil increased? And are then these values really much higher as compared to other sites, e.g. to natural wetlands? Is it possible to do such calculation/estimation based on the data measured under laboratory conditions? If we assume that constructed wetlands should function as natural wetlands, then there will be some methane emitted from flooded soil – this is nothing wrong, methanogenesis is natural process occurring in wetlands generally and it will never disappear.

With respect, we disagree with the commenter on several points. We did not state OM amendments were dangerous. However, if we can learn a means to reduce methane emissions, we would consider that beneficial. Wetlands do emit methane naturally, but rather than accept this we are confident knowledgeable human action can limit emissions. We do agree that this is just one small piece of a larger picture and companion field studies are needed. We have performed a field study and will be reporting that the general patterns we observed in this lab study were evident in the field.

Also it is known, that wetlands are source of methane but it must be also taken into account that they accumulate carbon in soil organic matter. If these two processes are calculated and assumed in long-term (hundreds and thousands of years) the wetlands have generally cooling effect on both local and global climate because the effect of fixation of C to the soil is stronger than emission of methane to the atmosphere. This is also due to shorter retention time of methane in the atmosphere (so higher turnover rate) as compared to carbon dioxide. Moreover, there are other effects of organic matter amendment on soil characteristics and they may be even more important for soil and whole ecosystem functioning: effect on soil physico-chemical conditions like soil structure (soil aggregates, porosity, aeration), effect on humic substances, on sorption capacity (fixation of ions on humic substances), support of microbial activity and support of plant germination and growth etc. Generally, addition of organic matter to the soil and increase of its content in soil have positive effect on soil and it is desirable.

It is the lead author's opinion that scientific studies do not support the assertion that OM amendments are particularly beneficial for wetland restoration. See Scott et al., The role of organic amendments in wetland restorations, Restoration Ecology, 2020. While we would invite debate on that issue, we specifically did not mention the broader impacts of OM amendments because this study targets methane generation potential. As an example, we will include reference to Souza et al., Optimal drainage timing for mitigating methane emissions from rice paddy fields, Geoderma, 2021. They recommend discontinuing the use of rice straw amendments, or altering hydrology, to reduce excess methane emissions.

Therefore the conclusion.

We assume more was intended here. Since the comment period is closed, we appreciate your input and would welcome an email about this final comment and attempt to revise the manuscript accordingly.

The units used for gases production: "cc" – for me unusual, I guess, these are cubic centimeters? You should use either "mL" or "cm³" as SI units instead of "cc".

We will make this make this modification subject to the journal's editorial requirements.