Biogeosciences
Discussions

Interactive comment on "Greenhouse gas production in degrading ice-rich permafrost deposits in northeast Siberia" *by* Josefine Walz et al.

Anonymous Referee #1

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General comments

The article "Greenhouse gas production in degrading ice-rich permafrost deposits in northeast Siberia" by Josefine Walz et al. discusses the important issue of permafrost aggradation history and organic matter quality on greenhouse gas (CO_2 and CH_4) production from degrading yedoma deposits. The findings are based on short-term (134 days) and longer-term (785 days) incubation of samples collected at three locations, and the measured CO_2 and CH_4 production is linked to a wide array of measurements on geochemical characteristics and the stratigraphy of soil/sediment cores.

The potential future C release from thawing permafrost soils, especially yedoma, is

connected to large uncertainties. Only a limited number of studies address this topic and I particularly value the authors' efforts to asses the longer-term production potential. This topic clearly is of interest to the broader scientific community and I thus consider this manuscript highly relevant for the journal. The manuscript is carefully written, however, it would benefit from some streamlining, especially of the results and discussion section as outlined in my comments below, in order to further improve readability and scientific value of the manuscript.

Specific comments

1) First of all, the results section is rather detailed, partly repeating values presented as figures and reporting many numbers, making it difficult to follow. I would recommend providing part of the information as tables, e.g. an overview table with site names, site codes, ages, mean CO_2 and CH_4 production rates etc., helping the reader to get an overview of the differences between the three locations. Chapters 4.2, 4.3, 4.4 should be presented under a sub-heading, e.g. "greenhouse gas production". To improve readability, I would further recommend dropping the numbers in the site codes, e.g. just MUO, BK, and L instead of MUO12, BK8, L14.

2) the conclusions drawn in the discussions are partly based on results obtained in this study, but also quite heavily rely on detailed analyses reported in previously published literature (radiocarbon age, plant macrofossils and soil microbial analyses), e.g. L285-303. I suggest to emphasize results measured within this study throughout the discussion. Additionally, section 5.1 of the discussion is rather lengthy and would benefit from some streamlining to more clearly emphasize the main results from this study.

3) The CO_2 and CH_4 production potential was assessed using separately incubated soil samples, excluding effects of vegetation (e.g. input of fresh OM to the soil system, atmospheric CO_2 uptake), and processes among different layers in the soil profile (e.g. diffusion and leaching, as well as priming of old OM). How would the authors relate the gas production measured in these soil incubations to gas release to the atmosphere

under in situ conditions? I would appreciate some more discussion on this part.

Technical corrections / line edits

Abstract L31: if more than 80% were produced during the first 134 of the long-term incubation, shouldn't that rather highlight the importance of the labile C pool, rather than the slowly decomposing C pool?

Introduction L40: give depth range for C stocks, is it 0-3m? L44: "The changes" is slightly vague, please specify. L54: what about MIS 4 and 6, are they not preserved in this region? L60: Either separate sentence by colon ":" or add reference. L62-64: Are those C stocks representative of the whole yedoma deposits, or a certain depth range? L66: Consider replacing "thawed out", e.g. "exposed by degradation of ice-rich permafrost" L67: decomposed to the greenhouse gases carbon dioxide (CO_2) and methane (CH_4) L77: Do they authors mean "permafrost aggradation"?

Methods L97: Consider replacing "modern" with "current" L155: Might the low temperatures during storage (-18oC) have had an effect on soil microbial community functioning during the incubations? -11oC seems to be the minimum naturally occurring permafrost temperature in this region. L164/165: Some specifications about the gas sampling would be useful, e.g. how many mL of gas were sampled from the headspace for GC analysis? Did gas sampling cause underpressure in the headspace? L171-174: Was the temperature dependency of gas solubility taken into account? I would suggest to provide some more details on the solubility/temperature coefficients used for CO_2 and CH_4.

Results L236: "anaerobic CO_2 production"? L243: increased 30-fold over what time frame?

Discussion L282-284: This seems like an overall conclusion of the study and does not belong in the opening paragraph of the discussion L369-372: Using the term "long-term" for a period of ca. 2 years is slightly questionable, I advise some caution with the

use of this term throughout the manuscript.

Figures L675 (Fig. 3): adding both y-axes (height and depth) to each figure panel, as well as using the same x-axis scaling (e.g. 0-80?) would improve readability of the figure. Since CH_4 production is included as a third panel for the other cores, please mention in figure caption why it is not included here. L684 (Fig. 4 and Fig. 5): Please mention AL thickness in figure caption.