General comments

The preprint numbered egusphere-2024-3979 investigated methane emissions from sediments from both eutrophic and oligotrophic lakes and the effect of additional algal organic carbon inputs, and examined the corresponding microbial community, which falls right into the scientific scope of BG. However, the similar studies have been published in recent years, and no substantial new finding was reported in the preprint. In addition, the manuscript was not organized in a good state. Specifically, the results were not supported by statistical analyses, the units of parameters are not standard, and the figures are not as meaningful as they should have, many sentences are not supported by literatures, and some sentences and paragraphs are redundant.

We thank the reviewer for the throughout reviewing of our manuscript and the very helpful comments. We have added specific replies to the individual points raised below.

Specific comments

ABSTRACT

It is argued that 3-week pulse of oxygen lowered the emitted methane for several weeks after anoxic conditions were re-established. However, this is because the 3-week pulse of oxygen decreased methane emission, which cause the total amount of methane in the headspace is lower than the control, not because oxygen pulse decreased methanogenesis rater after oxygen removal. It is suggested to re-evaluate the methanogenesis rate in different stages of the incubation based on the oxygen conditions.

We tried to convey the point that the measured methane emission rate per day in anoxic sediments is lower when those same sediments were previously exposed to oxygen. We however understand that this point is not conveyed well, and we will change the manuscript to bring this across more clearly, in both the text and the figures.

INTRODUCTION

It is well known that there are little algae in the oligotrophic lakes, so the influence of algal organic matter on methanogenesis in oligotrophic lake is seldom concerned. Why did you concern the influence of algal organic matter input on methanogenesis in oligotrophic lake? No sufficient reason was explained.

The mentioned lake has experienced nutrient-rich phases in the past (published elsewhere). We will make sure to refer to this in future versions of the introduction. Another reason is that eutrophication is an ongoing problem in many lakes worldwide.

The introduction is not well supported by references, many references should by supplemented in L41-49,L56-60, L66-75, 86-92, 100-106, 108-119.

The main hypothesis of the study should be explained and highlighted.

We thank the reviewer for raising these points and will adjust future versions of the manuscript to include this.

METHODS

More information about the two lakes should be supplemented, such as water depth, Chl a in water, hypoxia situations, etc.

Basic physical and chemical sediment properties should be supplemented.

We have not provided these here to keep the manuscript concise, but we understand now that it is good to mention more background on the lakes, both reviewers have suggested this. We will report them and also refer to publications where information on these lakes has been published previously.

L150, why 10 ℃?

We choose this temperature because it was close to the temperature in the lake itself, and we were able to use a temperature room at this temperature.

Table1, why there was no N2 flushed after 1 week treatment in Lake Baldegg?

We choose to not persue to 1 week treatment in Lake Baldegg because our results of Lake Lucerne had shown little difference between the 1 week and 3 week treatments.

L193, how to examine oxygen by Pyroscience? How to avoid the influence of slurry?

We used oxygen sensor spots that are glued inside the bottle, but that can be read out from the outside of the bottle. We will clarify this in the next version of the manuscript.

L215, why whole core experiment was not performed in the eutrophic lake?

We used our results from the Lake Lucerne study to decide on experiments in Lake Baldegg. Our results showed that whole core experiments showed large variations

and therefore were not the best way to perform experiments, therefore we choose to go for the bottle setup for the eutrophic lake.

L224, why Chlorella and Spirulina were chosen in the study? Are they the predominant in the studied two lakes?

This was mainly a practical choice, as these could be obtained. We will add more information on the used algal mass in the next version of this manuscript, as we have data available on the N and C content and isotopic values of both algae.

L227-230, how did you deposit algal biomass on the sediment surface, as freeze-dried algal cells usually are lighter than water. In addition, will the flushing of N2 influence the distribution of algal biomass?

Our algae-solution remained on the sediments, after careful deposition with a pipette. The N2 fliushing did indeed stir up the algal biomass, but after the flushing was ended, the material sunk down (the color of the overlying water was monitored to check whether the algal biomass was indeed on the sediment or present in the water). No algal biomass was observed at the water-headspace interface, showing that the algal biomass did not float.

L241-242, 10ml gas was sampled, why 10-15 ml gas was added?

Enough gas was added for a slight overpressure, to prevent the intrusion of oxygen.

RESULTS

Methane concentration in the headspace is the direct result from the examination, it is not suitable use the change of methane concentration to reflect the methanogenesis rate, such as Fig.1. The rate of methane emission in slurry incubation should be attributed to unit time and unit mass (or volume) of sediment, and methane emission from core should attributed to unit time and unit area of sediment, thus readers are able to compare your results with previous results.

Thank you for this suggestion, we will change the graphs and results accordingly.

Many units are not standard, such as 9 μmol per week in L299, μM in L305, μmol per L in L317, etc. Week is seldom used in the calculation of methanogens rate, and day is suggested in this study. μM should be replaced by μmol L^{-1}.

μM stands for μmol L^{-1}, but we will make sure to change this to make it more clear. We had chosen the per week rate because we could in that way report the differences between the phases of the experiment and between the different experiments. We do however see now that this makes it difficult to compare our

study to other literature, and will therefore change the units throughout the manuscript to make it easier to interpret the results.

Data of Fig1 are from Fig2, so their order should be changed in the manuscript.

Thank you for noticing, we will change this in the next version of the manuscript.

It is argued that 3-week pulse of oxygen lowered the emitted methane from both types of sediments by 50%. However, this is because the 3-week pulse of oxygen decreased methane emission, not because oxygen pulse decreased methanogenesis rater after oxygen removal. In figure 2, the similar methanogenesis rates are expected in different treatments after oxygen removal. It is more suitable to analyze rates of methanogenesis (Fig 2) based on the oxygen conditions in incubation (Table 1).

We purposely do not claim that methanogenesis is decreased, as we can indeed only draw conclusions on the net methane emission, not on the separate processes of methane production and methane consumption. We analyzed the microbial community, the reaction intermediates, and the isotopic values to be able to make an assessment of the processes occuring in the sediments.

Statistical analyses are needed in the results analyses, such as Fig 1, 6, 7, etc.

We will add error bars in Fig. 1. We are not sure what the reviewer is referring to in Fig 6 and 7, as these include error bars. Is this about significant differences between treatments? We will look into methods to analyse this.

The community structure of methanogens is quite important in the study, they should be put in the text and with special concerns.

Thank you, we will give this more emphasis and give it a clearer place in the text.

DISCUSSION

L529-541 are more suitable for the next section.

Thank you for noticing, we will change this in the next version of the manuscript.

L593-594, ?

We do not understand this comment.

L612-614, why, how did you know?

We make the assumption that methanogens are present predominantly in the sediments deeper than 5 cm, which are not exposed to oxygen at all in our

experimental setups. However, we will note more clearly in the next version of this manuscript that we make this assumption.

L633, the F□GS9, S10should appeared in the results firstly.

Thank you for noticing, we will change this in the next version of the manuscript.

On the base of the above suggestion, refine the main findings and polish the figures.

Thank you, we will do so.

Technical corrections

Reference styles in the text must be uniformed according to the requirement of BG.

L51, sedimentary methane production→methane production in sediment

L80, H2？

L108, Artificial aeration is not only applied in Switzerland.

L130, showing and shown are repeated.

L144-147, sampling in the two lakes were carried out in different months, how about the environmental parameters in the water and sediment surface? How many cores were sampled?

L240, N2O?

Fig1, the symbols are too similar between 1 and 3 week oxic.

Fig4, which one is figure A?

L537, what does OM mean?

Some parts of the manuscript are redundant, not limited to the following sections, L302-303, 365-366, 473-475, 493-498, 668-669, etc. So, refine the language in the revision

Thank you for these detailed suggestions, they strongly help us to improve the next verion of the manuscript.