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Discussions

Interactive comment on "Seasonal methane dynamics in three different Siberian water bodies" *by* Ingeborg Bussmann et al.

Anonymous Referee #1

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The manuscript "Seasonal methane dynamics in three different Siberian water bodies" by Bussmann et al. presents measurements of methane concentrations and oxidation rates (MOX) from different samplings in an Arctic river delta, in the adjacent coastal waters and in a nearby small Arctic lake from sampling campaigns carried out during ice-free summer conditions and under ice cover in late winter. The presented data close knowledge gaps on winter time methane dynamics in Arctic waters. The authors find that CH4 accumulation under ice is governed by the exchange of waters under the ice, with insignificant accumulation in the river and strong accumulation in the stagnant lake waters. Additional measuremements from ice cores did not show large CH4 accumulation and no CH4 gradients, and confirmed that the ice cover is an effective barrier for the CH4 flux to the atmosphere.

The manuscript is generally well written, and the presentation of the CH4 concentration and ice core data is clear and comprehensive.

I have some issues with the part on the MOX rates, however, which need to be resolved by the authors: in addition to the methane concentrations from the different water bodies, MOX rates were determined in winter time in the Lena river. The authors use these MOX rates to determine the potential of MOX for reducing the CH4 accumulation under ice. Based on their assumptions, they conclude that the measured low MOX would lead to a rather small reduction of the CH4 inventory, and strong CH4 accumulation under ice is likely. However, this estimate is based on a number of assumptions the authors make, and I am missing a detailed chain of arguments that justifies these assumptions:

- the authors transfer the fractional MOX rate determined from the Lena river sampling to the coastal and lake waters (lines 318-320), but they miss a convincing argumentation if this isjustified. In lines 460 to 470, they discuss the influence of different environmental factors such as oxygen and phosphate concentration and temperature (lines 460-470), but these factors are not taken into account or even discussed when the MOX rates from the coastal and lake waters are calculated. Instead, the authors present the MOX rates from these two water bodies as if these were independently determined (lines 320-325, Fig.5), and not calculated from the CH4 concentrations.

- the authors conclude that the accumulation of CH4 under ice will lead to a pulse release of CH4 when the ice melts, and the low MOX in winter compared to summer conditions induce larger overall emissions from winter than from summer conditions. I think this argumentation is a bit too superficial – summer and winter conditions not only differ in the effectiveness of CH4 oxidation, but also in the fact that during summer, gas exchange is an additional sink for CH4, and that CH4 emissions are determined by the effectiveness of CH4 oxidation vs. gas exchange. To fully assess the potential of CH4 emissions from pulse release during ice-off or from continuous emissions under ice-free conditions, all sink terms would need to be carefully taken into account.

Specific comments:

Line 20: "Arctic regions and their water bodies are affected...“

Line 134: "the Bykovskaya Bay“

Line 467: "But temperature is also. . .“: remove "but“

Lines 504-505: A 60% reduction of the methane inventory by MOX does not seem like an insignificant reduction of the CH4 inventory to me.

Lines 508-509: "we assume, that after ice-on, both parameters increase/decrease in a linear way“ Could you explain this assumption? Why would this be justified?

Lines 546-550: I think this statement is somewhat speculative- I doubt that the increased MOX rates in summer than in winter is the only factor that determines CH4 emissions from the Arctic water bodies. The authors should at least mention which additional factors could influence CH4 emissions.

Line 554: The data should be submitted to PANGAEA and the data availability statement updated.

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