Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2020-317-AC1, 2020

Biogeosciences Discussions
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EGU

Interactive comment on "The water column of the Yamal tundra lakes as a microbial filter preventing methane emission" *by* Alexander Savvichev et al.

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Received and published: 1 December 2020

Review of: The water column of the Yamal tundra lakes as a microbial filter preventing methane emission General Comments: This manuscript contains information that appears to be of considerable value in understanding the role of methane production and consumption in both deep and shallow Yamal tundra lakes. It likely has valuable application to understanding these processes in thermokarst lakes across the arctic. However, there are some significant adjustments/edits needed. The manuscript needs a thorough proof read. There are many grammatic errors/issues, I've outlined a fair number in the technical corrections, but this is by no means comprehensive. Further, this manuscript needs to be more focused and organized. A more clearly outlined hypothesis/research statement at the end of the introduction would be helpful. There is

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a wealth of information presented here, but it is not immediately clear how some information relates to the stated goals. E.g. the information presented in section 3.1 seems to be fairly important to the processes involved in methane production, but there is minimal discussion of these results in section 4.

We thank the reviewer for carefully reviewing our manuscript.

Specific Comments: Line 42: Thermokarst lakes are also widespread in Northwestern Canada and the Hudson Bay Lowlands – eg. Marsh et al. (2009): Marsh, P., Russell, M., Pohl, S., Haywood, H. and Onclin, C.: Changes in thaw lake drainage in the Western Canadian Arctic from 1950 to 2000, Hydrol. Process., 23(1), 145–158, doi:10.1002/hyp.7179, 2009.

Introduced into the text on the advice of the reviewer

Table 1: This is a small sample size of lakes, and characteristics appear to be quite different depending on the lake, especially temperature. I think some discussion of possible reasons for these differences is merited. Also, I have a hard time believing the bottom temperatures for the deep lakes? How is it that LK-004 has a temperature of 14.2 ÌŁC at a depth of 11m while LK-002 is only 11.7 ÌŁC at the surface? This seems like a very weak temperature gradient for 11m of depth? Do you have temperatures (and other variables) available for all sample depths? It would be helpful if they were all presented here.

Explanation concerning the absence of stratification in the water column of deep lakes was added to the text.

Fig 2 & Lines 206-208: Define what is considered to be the photic layer. Is this the integral of the entire water column? In line 207, the term photic depth is used instead? Also, it is not apparent from Fig 2 that LK-003 has higher PP than LK-002 as claimed? This requires further explanation.

Fig. 2 was changed according to the Reviewer's recommendations. PP values for all

tested water horizons are provided. It may be seen that in shallow lakes photosynthetic production was detected at all depths, including the near-bottom horizon. The terms photic layer and photic depth were removed as hindering the understanding of the experimental procedure. Integral PP values are shown separately.

Line 209 & Fig 3a: LK-004 appears to contradict the claim of < ($\pm$ 0.5 mg L$-$1) variability in DOC within the water column?

Đąorrections made to figure 3A

Line 203 & Fig 4: Should this figure show the DCA values for the near-bottom layer of the lakes as well for better comparison?

Fig. 4 was changed according to the Reviewer's recommendations. DCA values for all tested water horizons, including the near-bottom ones, are provided.

Fig 2 & 4: The integrated values would be better shown in a separate subplot or with a secondary y-axis to make it more apparent they are in different units.

On Figs. 2 and 4 integral values of PP and DOC are shown separately, and their different units are noted.

Line 315: What are the other mechanisms of formation?

A brief description of other mechanisms of formation has been added to the manuscript.

Lines 384 – 397: I think this point needs further clarification? Why did you only measure hydrogenotrophic methanogenesis if it is likely to be only a small fraction of total methanogenesis? The methane production vs. oxidation figures presented in here make it seem like there should be no methane emissions because rates of oxidation are orders of magnitude higher than production?

We agree that this comment of the reviewer is very significant. Indeed, on the basis of our radioisotope studies, it is impossible to carry out a full-fledged balance calculation

of methane production. Therefore, we restrict ourselves to the following conclusion. ÂńBased on the above calculations, it can be concluded that the contribution of hydrogenotrophic methane to the total methane production in the upper sediment layer does not exceed 5%Âż.

Line 471-474: From the results presented here is it possible to get some sense of the relative magnitude methane emissions from the surfaces deep vs. shallow lakes? What are the implications of these findings in regards to climate change?

Indeed, the main superconclusion of our studies is that the microbial community of the water column of deep lakes is a fairly effective gas filter. The efficiency of methane utilization in the water column of thermokarst lakes is lower. It can be assumed that climate warming will lead to an increase in the total area of âĂŃâĂŃthermokarst lakes, which will enhance the effect of methane release into the atmosphere. To carry out quantitative calculations, it is required to use other methods than we use, namely the use of floating cameras. We believe this is the subject of another study.

Technical Corrections: Fig 1, Table 1, & throughout text: Would it not be better to refer to LK-010 as LK-001?

The digital names of the lakes are taken from a large database used by Yamal cryogeologists. In this database, a lake named LK-001 already exists.

Line 22: (90−1000 μmol ĐąĐİ4 dm−3) – What timeframe is this over? One day? The whole summer? Clarify the temporal unit.

Changed. The data refer to the concentration of dissolved methane, not to its production.

Line 37: Consider rewording- e.g. These lakes have been classified as thermokarst lakes in continuous ice-rich permafrost (Dubikov, 1982) although other origins have also been proposed (Arctic and Antarctic Research Institute, 1977; Kritsuk, 2010).

Changed

Line 41: Change “in case if the topography of the area is flat” to “in flat areas”.

Changed

Line 47: Change “the increase of total lake area by 12% is observed” to “an increase in total lake are of 12% has been observed”

Changed

Line 70: Change “are usually revealed" to “usually occur”

Changed

Line 76: Define acronym OM

Definition has been provided above (line 55). Used this acronym several times more.

Line 78: Remove the word therefore

Removed

Line 80: Change “widely presented” to widespread

Changed to "common"

Table 1: Define or be clearer with use of acronyms (e.g. NL/WL – Lat/Lon). EC, this acronym isn’t used in the text, but you spell out electrical conductivity on line 134. Be consistent. What is secci depth? Also, LK-004 is missing a “)” after the depth in the left-most column.

Corrected

Line 260: This sentence as is reads like it might be more appropriate in section 2.2. You could reword to say something like “Bottom sediment samples from the bottom surface and to the depth of 14−15 cm are described in Table 3.”

Changed

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Line 273-274: Be consistent with acronym usage, you use methane oxidation in one sentence then MO in the next.

Corrected

Line 442: annual methane what? Production? Emission?

Corrected

The figures changed according to the Reviewer's recommendations (Figs. 2, 3A, 3B, and 4) are uploaded.

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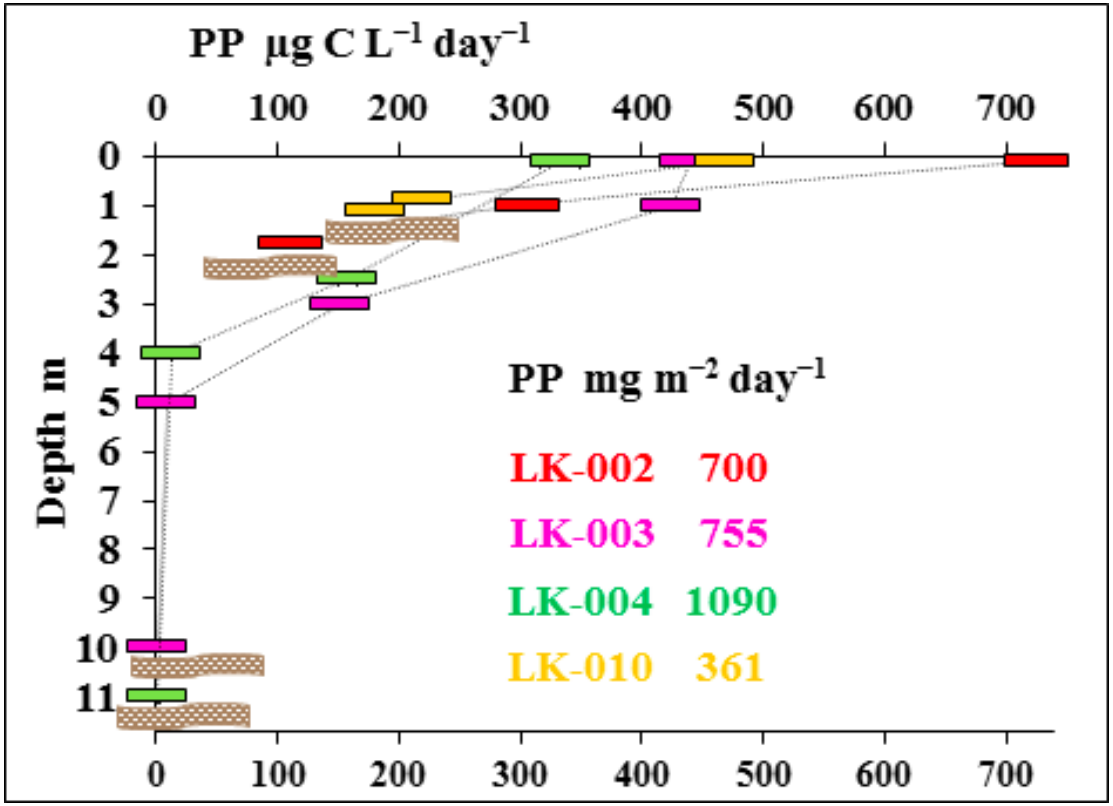

Fig. 1. Fig. 2. Primary production (PP) in four lakes of the Yamal Peninsula (August 2019) in the water horizons, μg C L−1 day−1; and integral PP for the entire water column, mg C m−2 day−1.

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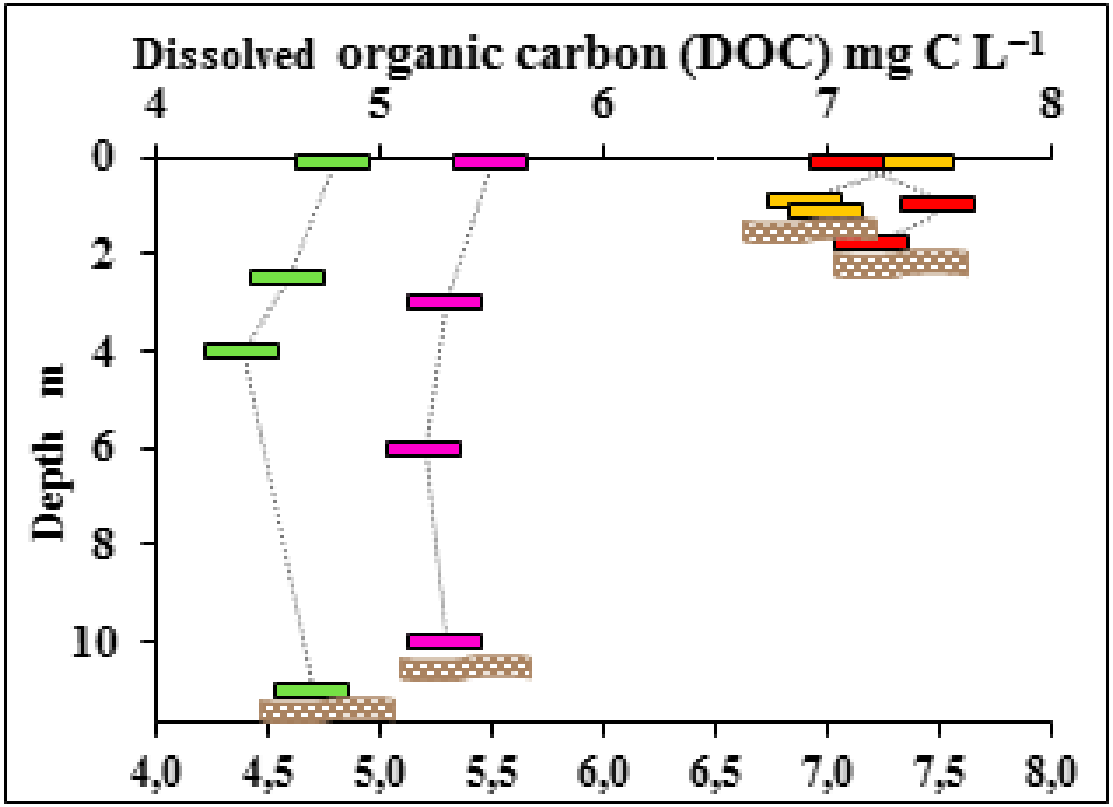

Fig. 2. Fig. 3. DOC concentration in the water column (a) and bottom sediments (b) of four lakes.

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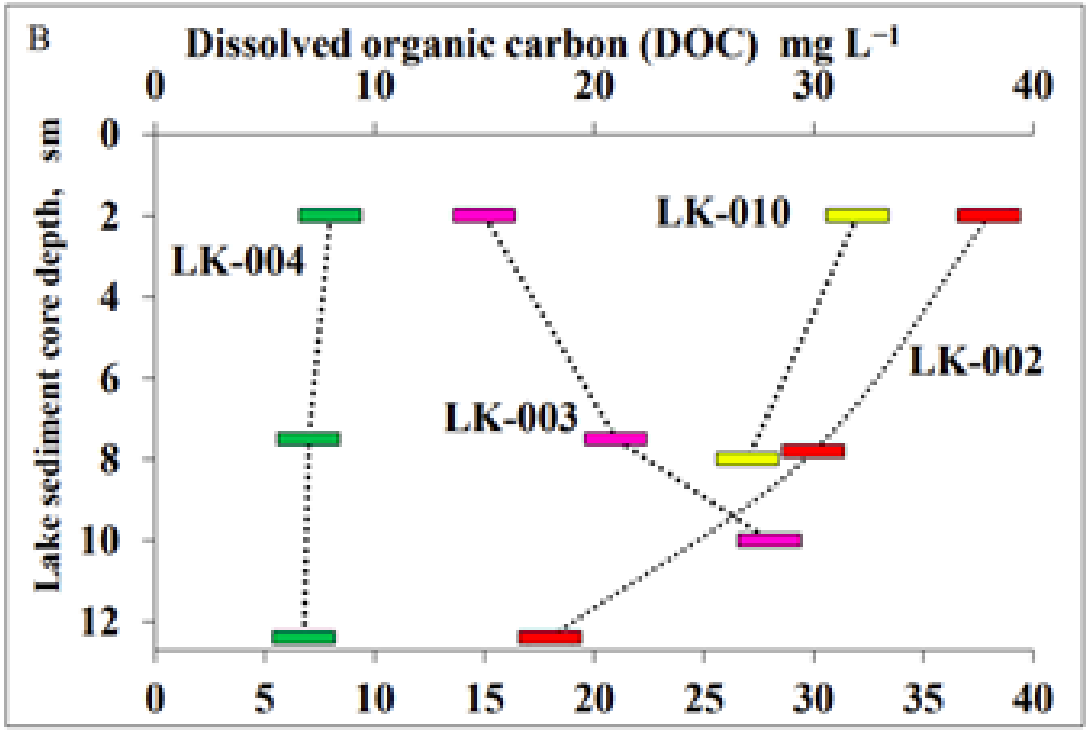

Fig. 3.

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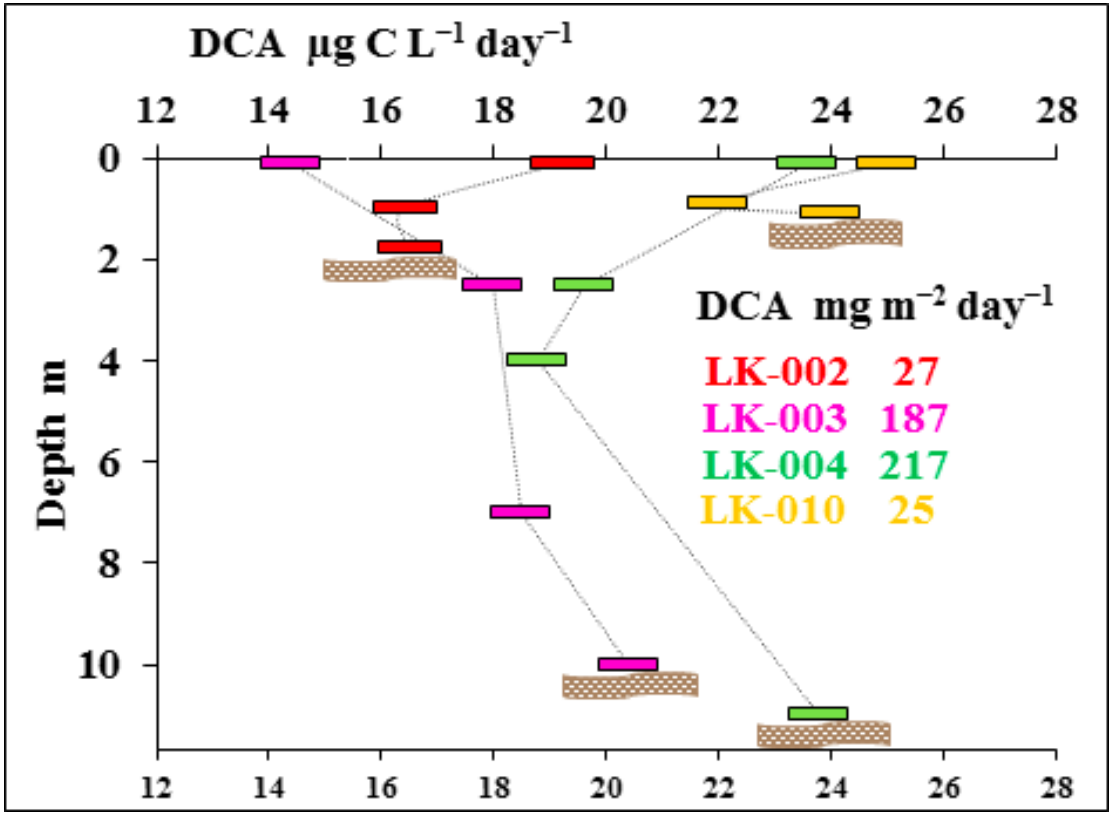

Fig. 4. Fig. 4. Dark CO2 assimilation (DCA) in four lakes of the Yamal Peninsula (August 2019) in the water horizons, μg C L−1 day−1; and integral PP for the entire water column, mg C m−2 day−1.

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