Biogeosciences Discussions

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# Comment on bg-2022-26

Anonymous Referee #1

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Referee comment on "The dominant role of sunlight in degrading winter dissolved organic matter from a thermokarst lake in a subarctic peatland" by Flora Mazoyer et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2022-26-RC1, 2022

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Mazoyer et al. evaluated whether sunlight or bacteria drive DOM mineralization to $CO_2$ in a thermokarst lake following spring ice-off. The authors measure the combined effects of sunlight exposure and bacterial activity on $CO_2$ production from DOM, while measuring changes in DOM composition, bacterial abundance, and bacterial production throughout the 18-day experiments. They found that bacteria mineralized similar amounts of DOM to $CO_2$ before and after sunlight exposure of DOM, but that more DOM was mineralized to $CO_2$ when bacteria were inoculated in the water exposed to sunlight.

Overall, this study aims to address an important gap in the literature on $CO_2$ emissions from thermokarst lakes because few studies to date have tested the reactivity of DOM immediately following ice-off. However, I think there are two shortcomings need to be addressed in the manuscript:

1) The authors aimed to test the reactivity of DOM after ice-off in a lake, but had an altered DOM composition and possibly different bacterial community composition during their experiments compared to the water originally present in the lake. It is likely that the changes in DOM composition (shown by the substantially lower $SUVA_{254}$ value and higher Fmax value) measured between the initial water sampled (Table S1) and water at the start of the experiments (Table 1) were due to bacterial mineralization of DOM during the 4-month storage period of the unfiltered lake water. The authors found that fluorescent DOM increased with bacterial production during their experiment. Then, previous work from these authors showed that bacteria in similar lakes degrade aromatic DOM (Laurion et al, 2021).

Many papers have shown how bacterial community composition and activities change to adapt to new DOM compositions (Crump et al, 2003, Dinasquet et al, 2013, Logue et al, 2016). If bacterial community composition did change to adapt to the altered DOM composition, then the bacterial production and mineralization measured during the experiment does not reflect what is taking place in the lake water. I think that the authors should include these limitations in their discussion because they impact the authors'

conclusions on how much sunlight and bacteria can mineralize DOM to $CO_2$ following ice-off in thermokarst lakes.

2) The authors did not compare their findings to Laurion et a (2021), which studied DOM mineralization in other lakes in the region with a similar experimental design. Because Laurion et al (2021) conducted the sunlight exposure and bacterial incubation experiments sooner after water sample collection, the authors could benefit from discussing how their results compare and how they might be due to differences in the experimental design alone (not due to different study sites).

Other comments:

- Lines 18-21: It is incorrect to report that 18% of DOC was directly lost over 18 days of sunlight exposure when the higher abundances of bacteria later in the experiment could have contributed to that mineralization. The authors do a good job discussing how much DOM mineralization could have come from sunlight and bacteria, so this should be clarified in the abstract too.
- Lines 106-108: The sentence "Indeed, DOM variables … and aromaticity)" needs to be revised to accurately report the results. Tables S1 and 1 show substantial changes in DOC, $SUVA_{254}$, and the fluorescent DOM components during the 4-month storage period. Statistical tests should be used to report the statistical significance of those differences.
- Table 1: Define all of the abbreviations in the caption.
- Lines 144-145: Can you cite a paper where this is reported?
- Line 483: It is not accurate to report that the DOM in the lake prior to ice-off is refractory to biodegradation when there were 4 months before the experiment when bacteria could have been mineralizing the most labile DOM to $CO_2$.
- In general, I think the manuscript would read better if each treatment were spelled out rather than abbreviated.

Crump et al (2003). Bacterioplankton community shifts in an arctic lake correlate with seasonal changes in organic matter source. Applied and Environmental Microbiology 69(4), 2253–2268; doi:10.1128/AEM.69.4.2253–2268.2003

Dinasquet et al (2013). Functional and compositional succession of bacterioplankton in response to a gradient in bioavailable dissolved organic carbon. Environmental Microbiology 15(9), 2616–2628; doi:10.1111/1462-2920.12178

Logue et al (2016). Experimental insights into the importance of aquatic bacterial community composition to the degradation of dissolved organic matter. The ISME Journal 10, 533–545; doi:10.1038/ismej.2015.131

Laurion et al (2021). Weak mineralization despite strong processing of dissolved organic matter in Eastern Arctic tundra ponds. Limnol. Oceangr. 66, S47–S63; doi: 10.1002/lno.11634