December 29, 2014

Response to **S. Zimov**

We are grateful for this reviewer's comments on our manuscript. Based on these comments and suggestions, we have revised our manuscript in an effort to improve it and address the concerns. Below is our response to the reviewer's comments (reproduced in bold).

I like the manuscript. It is rather bare (without emotions) with minimum of discussions. The work is very useful. I know how it is difficult to manage the work - to measure CH_4 and CO_2 fluxes from the number of lakes both in summer and in winter. Many years ago, I tried to do this work on Kolyma lowland from Arctic cost to taiga area. The authors have done the work much better than we had done. The received results looks very probable. Unfortunately, yedoma on Alaska exists fragmentary. The authors were not able to show dependency of methane flow on temperature (latitude). According my experience I can note that the dependency is more strong for diffusive flow than for bubbling.

We thank the reviewer for sharing results of his previous experience measuring CH_4 and CO_2 fluxes from lakes along a latitudinal transect in Northeast Siberia, where the landscape is predominately covered by yedoma permafrost. The reviewer is correct that we were unable to determine a temperature dependence of lake CH_4 emission along our North-South Alaska lakes transect, most likely due to geographic variability and the highly dissected distribution of yedoma permafrost in Alaska - Our transect crossed yedoma only in Interior Alaska, but not in the North or South. We agree with the reviewer that diffusive flux is more likely controlled by temperature than ebullition, since at low temperatures CH_4 oxidation is more temperature sensitive than CH_4 production (Whalen et al., 1990, Schulz et al., 1997) and seep ebullition, which we studied, seems to bypass aerobic oxidation. Tan et al. (2014) recently showed this as well through process-based climate-sensitive lake biogeochemical modeling of lake CH_4 production and emissions for Alaskan lakes as well. We were not able to demonstrate temperature relationships to any emission modes in our field measurements, likely due to the confounding factor of geographic variability of substrates (e.g. yedoma vs. non-yedoma soils) and the fact that organic matter supply from thawing yedoma in the yedoma lakes seemed to overwhelm CH_4 production and emissions among lakes. We have added these points of discussion to the manuscript as well as references suggesting such temperature (latitude) dependency of diffusive emissions should exist based on studies that found these results in other non-yedoma regions (Marotta et al., 2014; Rasilo et al. 2014; Yvon-Durocher et al., 2014) [See Sec. 4.2].

The authors experimentally have confirmed that fact that yedoma is an important factor of the methane global budget. That is the main result of the work. Their data support that the permafrost (yedoma) thawing could be a main factor of atmospheric methane rising during Pleistocene-Holocene transition and can be important methane source in nearest future. Data of gas rate dynamic in lakes is also important for understanding hydrobiota distribution. For example, to the northward fish in lakes are more sensitive to low concentration of oxygen and high concentration of methane.

We agree with the reviewer that CH_4 and CO_2 dynamics in lakes have important implications for lake biota. We have added a paragraph to Sec. 4.3 explaining that understanding the dynamics of dissolved CH_4 and O_2 in northern lakes has also relevance to hydrobiota distribution. Ohman et al. (2006) showed that CH_4 concentration in the water column is correlated with fish community composition in lakes, which is easily understood since CH_4 can be used as an indicator of anoxia and therefore, correlated with the fish O_2 requirements.

We thank the reviewer for the time and thought they put into reading our manuscript and for their helpful suggestions for improvement. We hope that our revised manuscript will be considered suitable for publication in *Biogeosciences*.

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