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Interactive comment on "Effects of anomalous high temperatures on carbon dioxide, methane, dissolved organic carbon and trace element concentrations in thaw lakes in Western Siberia in 2012" *by* O. S. Pokrovsky et al.

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Reply to Referee # 2 The first general comment of this reviewer is that more information on daily temperatures during anomalously hot summer 2012 and normal summer 2010 together with sampling periods should be provided. We agree with this constructive comment and added a new figure in the revised manuscript showing the seasonal variations of air temperature at the nearest meteo station in 2010 and 2012. Following the recommendation of this reviewer, we also showed the period of sampling on this plot. We added the sampling period in July 2013 to the Table 1 as requested.

The reviewer correctly required whether the same sites were sampled in 2010 and 2012. The epicenter of ground heating in June 2012 was almost at the territory chosen for this study (Fig. 1 A) and previously monitored in 2010 during a normal summer shown by white rectangular. The majority of samples collected in 2012 are from the Khanymey region located on the watershed divide tundra zone with large amount of thermokarst lakes (Fig. 1 C). Exactly the same region was sampled in July 2010 (Shirokova et al., 2013). We added the necessary explanation in the revised manuscript.

The reviewer suggested providing more integrated discussion on the processes operating in studied lakes. Following this recommendation, we added a big deal of discussion on three main processes mentioned by the reviewer – evaporative concentration, microbial activity and enhanced C leaching – in lines 506-522 of the revised manuscript.

We took into account all the specific comments of this reviewer as recommended.

p. 7258: TE, abbreviation is defined

Section 2.2. We added some sentences (L 132-141) on soil depressions and referred to previous papers and to photos on the ESM of this manuscript

Section 2.1. As requested, we added a new figure to the revised manuscript with daily temperatures for the summers of 2012 and 2010 and the sampling period.

p. 7267 ln 8-10: The reviewer correctly pointed out that the strong relationship between DOC and conductivity is an important mechanism for the increase in DOC between 2010 and 2012 and suggested to refer to this specifically in section 4.1. We did so in the revised version (Lines 347-351).

p. 7268 (L 19-21), we corrected as following: "To assess the size fractionation of elements in thermokarst lakes, we calculated the percentage of colloidal OC, major and trace elements."

p. 7270, L 24: The reviewer correctly pointed out that a 50% decrease is not the same as a two-fold decrease and we corrected the text as necessary.

p. 7272, L21-24: The reviewer requested to support the claim that trace elements are limiting in this region arguing that typically P and N are limiting for primary production in freshwater systems. Unfortunately, we do not have a straightforward answer to this question. First, the systems investigated in this study cannot be considered similar to other freshwater systems: these are dystrophic, acidic waters, with high DOC and very low total dissolved solid concentration. A km-size permanently existing lakes have specific conductance of 10 to 15 μS cm-1, which is an order of magnitude lower than that in other known pristine freshwater systems. At these conditions, not only N and P but also trace metals such as Fe, Mn, Zn, Co may become limiting. Second, there is virtually no phytoplankton and primary productivity in studied water bodies including large thermokarst lakes (Shirokova et al., 2009, 2013). The limitation of heterotrophic bacterioplankton by trace metals is at present unknown. And third, similar to oligotrophic coastal waters, it is not excluded that metal micronutrients such as Fe become limiting at certain conditions of thermokarst lakes. In the lack of direct field and laboratory measurements of aquatic biota limitation factors, we cannot be more precise in answering this comment and we added some explicatory sentences in the revised text (Lines 528-540).

p. 7274, L25-26 The reviewer correctly noted that if the DOC increase is a result of evaporative concentration, then the total stock of DOC in the lakes is not changing. Therefore, the overall flux of DOC from lake to river will depend on how the hydrology of the larger system changes. We agree and corrected the sentence as following: "...the short-term heating of thaw lakes and ponds may bring about almost 50% increase in CO2 flux and a five-fold increase in methane fluxes from the lake surface to the atmosphere."

p. 7276, L5-14. The reviewer added a big deal of insightful comments on multiple processes controlling element concentration in the lake water due to different mechanisms changing under temperature rise. In response to this comment and his/her third general comment, we revised the discussion on the mechanisms via adding lines 506-522

to the revised version. Yes, it is possible that the increased DOC release from peat is at most equivalent to the change in heterotrophic respiration. However, without direct in-field measurements of the latter, we are reluctant to discuss it explicitly in the paper.

p. 7278, L 5-6. The reviewer is confused, why the factor of 5 to 10 for CO2 and CH4 increase appeared which is different from the values given in the abstract and in previous section. The context of this sentence is different from the effect of water temperature rise. Here, we talk about the increase of CO2 and CH4 concentration with the decrease of the water body area, regardless of the climate conditions. We rewrote lines 583-586 of revised manuscript as following: "Given that elevated air and water temperatures during summertime will thaw the permafrost in Western Siberia, this will bring about the drainage of large thermokarst lakes and the appearance of small (< 0.01 ha) thaw ponds and permafrost subsidences. Regardless of the water temperatures, this small water bodies exhibit CO2 and CH4 concentrations and fluxes from lake surfaces to the atmosphere a factor of 5 to 10 higher than those of the large thermokarst lakes, which is not included in current climate and hydrological models."

Table 1: The reviewer requested to add the sampling date and explain whether these data are for 2010, 2012 or both. We added the sampling dates as requested. Only the data of 2012 are shown in Table 1. The data of 2010 are published in another paper (Shirokova et al., 2013) as referenced.

Figure 2 and others. The reviewer requested to provide a more complete description of samples labeled by "2010" and 2010 Khanymey". Here and below the pink squares represent the adjacent sites of thermokarst lake development within the white rectangular of Fig. 1A sampled in 2010 (Shirokova et al., 2013). The detailed maps for other sites of 2010 are given in our previous publication and thus we do not think it's worth including them here. We corrected the text accordingly.

Interactive comment on Biogeosciences Discuss., 10, 7257, 2013.