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CH_4 and CO_2 fluxes at sites with different hydrological patterns in the polygonal tundra of Samoylov Island, Northeastern Siberia

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In the last two decades, there were registered record high permafrost temperatures promoting permafrost thawing and leading to additional CO_2 and CH_4 emissions. It is crucial to assess the amount of C that is mineralized to CH_4, due to its higher global warming potential (GWP) compared to CO_2. The role of CH_4 in the total C emissions is mainly governed by the hydrological patterns of ecosystems. CH_4 oxidation is another critical process and is largely controlled by vegetation. The soil CO_2:CH_4 production ratio shows the contribution of CH_4 to the C emission budget of a determined area. Few studies evaluated *in situ* CO_2:CH_4 production ratios. Our objective was to assess CH_4 emissions and the heterotrophic CO_2:CH_4 production ratios in the Siberian tundra during the growing season. To accomplish these goals, we measured CH_4 and CO_2 fluxes using the chamber technique in the polygonal tundra of Samoylov Island in the Lena River Delta, Northeastern Siberia. The plant-mediated CH_4 transport and the heterotrophic respiration (R_h) were determined by comparing plots with and without vegetation through a trenching experiment. To account for the differences between wet and dry tundra, one representative polygon was selected, measurements were made at its water-saturated center and at its drained rim. We also estimated the C budget of the polygonal tundra of Samoylov Island during the measurement period. This is the first study measuring and calculating *in situ* CO_2:CH_4 ratios from the R_h of the soil. The CH_4 emissions at the polygon center were much higher than the rim and showed evident seasonality. The polygon center median CH_4 flux of 26 $mg.m^{-2}.d^{-1}$ decreased by 80% when the vegetation was removed, indicating the relevance of plant-mediated CH_4 transport in these emissions. This was not detected at the polygon rim that had much lower emissions (1.8 $mg.m^{-2}.d^{-1}$). The heterotrophic CO_2:CH_4 ratios varied from 1 to 100 at the polygon center, and from 100 to 1000 at the polygon rim, showing the greater importance of CH_4 production to the heterotrophic C release at the polygon center. The polygonal tundra on Samoylov Island was a C sink during the measurement period. The wet tundra had a CO_2-C sequestration rate (-23 kg CO_2-$C.ha^{-1}.d^{-1}$) more than 3 times higher than the dry tundra (-7 kg CO_2-$C.ha^{-1}.d^{-1}$). Overall, the CH_4 emissions represent a decrease of just 5% in the total CO_2-e offset of the tundra in Samoylov during the growing season. The CH_4 emissions measured in this study were low. However, it is important to point out that only the growing season is considered, and the off-season and winter C emissions might be significant. Our results stress the high microscale variability of emissions of CO_2 and CH_4, specially related to hydrology, topography, and vegetation.