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Lateral carbon export from polygonal tundra catchments on Samoylov Island, Lena River Delta

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Permafrost-affected soils contain a large quantity of soil organic carbon (SOC). Two processes control the amount of carbon stored in soils. The photosynthetic activity of plants produces biomass that may accumulate in the soil, while microorganism's respiration leads to a depletion of the soil carbon stocks through decomposition. The carbon balance defines whether a soil acts as a source or sink of carbon. In recent decades, many researchers observed and analyzed the carbon balance of permafrost soils. In most cases, the focus lays on observations of the vertical carbon flux (CO_2 and CH_4) to estimate the carbon balance. However, there is lack of information regarding the lateral losses of carbon via dissolved organic carbon (DOC) or dissolved inorganic carbon (DIC) in ground- or rainwater.

In this study, we estimate the lateral carbon fluxes from a permafrost-affected site in north-eastern Siberia, Russia. Long-term measurements of vertical carbon fluxes have been conducted at this study site. By considering both, the vertical and the lateral carbon fluxes, we estimate the complete carbon balance for one growing season in 2014 and discuss the contribution of the lateral carbon flux to the overall carbon balance.

The results show that the vertical CO_2 fluxes dominate the carbon balance during the growing season from June 8th – September 8th (-19 ± 1.2 kg-C m^{-2}). The lateral fluxes of DOC and DIC reached values of +0.1 ± 0.01 and +1.4 ± 0.09 kg-C m^{-2}, respectively, whereas the vertical fluxes of CH_4 had values of +0.7 ± 0.02 kg-C m^{-2} integrated over this time. By considering the lateral carbon export, the net ecosystem carbon balance of the study area was reduced by 8%. On shorter time scales of days, the relationship between lateral and vertical flux changes within the growing season. Early in the growing season, the lateral carbon flux outpaces the weak vertical CO_2 uptake for a few days and converts the estimated carbon balance from a sink to a source.

We conclude that lateral carbon fluxes have a larger influence on the carbon balance of our study site on time scales of days (early and late growing season) and that this influence decreases with

annual time scales. Therefore, the vertical carbon flux can be seen as a good approximation for the carbon balance of this study site on annual time scales.