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The outgassing of carbon dioxide from aquatic ecosystems of Western Siberia (ZOTTO area) and implications for the regional carbon budget

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The lateral migration of dissolved carbon dioxide (CO_2) with soil solutions to fresh water aquatic systems and in situ mineralization of soil-derived organic carbon (OC) often causes supersaturation of the inland waters with CO_2. An evasion of excess CO_2 from lake and stream surfaces to the atmosphere is important, but underestimated, pathway of carbon flux in the coupled terrestrial-aquatic carbon cycle. As a result, the loss of terrestrial OC as CO_2 through the drainage networks remains poorly accounted in regional carbon budgets estimated on the basis of eddy covariance measurements. In this study we have made an attempt to quantify fluxes of dissolved CO_2 (pCO_2) and CO_2 emissions (fCO_2) in fluvial and lacustrine waterbodies located within the peat-bog dominated landscape of Western Siberia (ZOTTO area, 60°N, 89°E). For two consecutive years (2018-2019) we studied the seasonal and diurnal dynamics of pCO_2 and fCO_2 in several different order streams (1-4) and ponds within a peatbog. Dissolved pCO_2 was measured by portable IRGA Vaisala GMP222 placed in PTFE membrane. Carbon dioxide emissions were analyzed using floating chamber equipped with same portable IRGA (Vaisala GMP222). Despite, the pCO_2 values were highest in winter season (350-820 umol/l) we did not detect sizeable emissions from water surface in that period. The peaks of pCO_2 in summer-fall season (up to 360 umol/l) occurred at stormflow regimes. The frost-free season emission of CO_2 from stream surfaces ranged from 0.2 to 7.5 umol/m^2/s and decreased with the order of stream. An averaged for the season CO_2 evasion from the Razvilki stream (2nd order stream) was 4.9±1.3 umol/m^2/s, which is comparable to the seasonal mean of soil CO_2 emissions in the study area. However, in opposite to soil respiration, which maxima often corresponds to highest soil temperatures, peaks of CO_2 outgassing occur at high flow regimes. The fCO_2 values were correlated with discharge ($r = 0.60$, $p<0.05$) and DOC concentrations ($r = 0.69$, $p<0.05$). Aquatic C losses are still under analysis in terms of surface water area estimation.