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Continuous measurements of CO_2 emission from a large boreal river using the eddy covariance technique

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Recent global studies suggest that the total emission of CO_2 from streams and rivers is highly significant and correspond to as much as 85% of the total oceanic CO_2 uptake. To address this issue, a large boreal river in Northern Sweden (Indalsälven) was instrumented in April 2018 with water-side measurements combined with an atmospheric eddy-covariance system measuring the vertical fluxes of CO_2. This is one of the first known studies of its kind where long term eddy covariance measurements are conducted in a river setting

The river Indalsälven was found to be almost constantly oversaturated with respect to CO_2 and with high water-side pCO_2 dynamics varying in the range of 400-4500 ppm. During the spring, the pCO_2 in the water was in the range of 500-700 ppm and at the same time, large emissions of CO_2 from the river were measured. The rapid snowmelt resulting in high water flow in combination with occasionally high winds resulted in high gas transfer velocities, k600. By the beginning of July, the pCO_2 in water had increased to over 4000 ppm, likely due to high aquatic degradation of organic material. During the period of July to September, a diel cycle of pCO_2 in water was observed with amplitudes of up to several thousand ppm. Simultaneously CO_2 emissions in the range of 13-17 μmol m-2s-1 were measured. Wind speed showed a positive correlation with the measured CO_2 emissions and k600, with the highest emissions associated to data from the wind sector where the upwind distance to land was greatest.

Our data show that a boreal river act as a strong source of atmospheric CO_2. The dynamic behaviour in pCO_2 and emission clearly highlight the importance of continuous high-frequency CO_2 measurements in order to correctly incorporate rivers in landscape carbon balances.