Stem CH_4 and N_2O fluxes from Downy Birch during the spring sap-run period and dependence on dissolved gas concentrations in xylem sap

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Tree stems are known to emit greenhouse gases CH_4 and N_2O to the atmosphere but the processes and drivers behind these fluxes are still contested. Soil water is taken up by tree roots and moves up the xylem due to a negative pressure gradient caused by transpiration through the leaves. Consequently, dissolved gases in the soil water move up the stem and are potentially diffused to the atmosphere through the bark. Periods of soil freeze-thaw in the spring are crucial hot-moments of GHG release from the soil, as well as stems. As birch trees go through a sap running period between the thawing of the soil and bud break, they provide an opportunity to study GHG fluxes during the peak time of emissions, together with the concentrations of dissolved gases in the birch sap.

Accordingly, we quantified the fluxes of CH_4 and N_2O from Downy birch (*Betula pubescens*), as well as Norway spruce (*Picea abies*) for comparison, in a temperate nutrient-rich drained peatland forest in April and May 2023. In addition, we studied the relationship between birch stem CH_4 fluxes and dissolved CH_4 concentrations inside the xylem sap. Stem fluxes were determined using static chambers attached to the tree stems and automatic LI-COR gas analysers. In addition, we analysed dissolved gas concentrations in birch sap and soil water, and the chemical and microbiological composition of the soil.

Birch stems CH_4 and N_2O fluxes ranged from 1.48 to 7.24 μg CH_4 m^{-2} h^{-1} and −0.47 and 2.98 μg N_2O m^{-2} h^{-1}, respectively. Meanwhile, spruce stem fluxes ranged between −0.12 and 2.19 μg CH_4 m^{-2} h^{-1} and −2.76 and 0.77 μg N_2O m^{-2} h^{-1}. Stem fluxes followed the temporal trend of soil and air temperature, with higher fluxes during warmer days, likely related to increased microbial activity in the soil. Dissolved CH_4 concentrations in the birch sap increased during the study period, from 2893 ppb to 9158 ppb. Average CH_4 concentrations were higher in sap collected from higher parts of the tree. A more detailed analysis together with examination of the underlying soil chemistry and microbiology will be presented to further explain the processes behind soil and tree stem GHG flux dynamics.