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Year-round measurements of CH4 exchange in a forested drained peatland using automated chambers

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Pristine peatlands are usually carbon accumulating ecosystems and sources of methane (CH4). Draining peatlands for forestry increases the thickness of the oxic layer, thus enhancing CH4 oxidation which leads to decreased CH4 emissions. Closed chambers are commonly used in estimating the greenhouse gas exchange between the soil and the atmosphere. However, the closed chamber technique alters the gas concentration gradient making the concentration development against time non-linear. Selecting the correct fitting method is important as it can be the largest source of uncertainty in flux calculation.

We measured CH4 exchange rates and their diurnal and seasonal variations in a nutrient-rich drained peatland located in southern Finland. The original fen was drained for forestry in 1970s and now the tree stand is a mixture of Scots pine, Norway spruce and Downy birch. Our system consisted of six transparent polycarbonate chambers and stainless steel frames, positioned on different types of field and moss layer. During winter, the frame was raised above the snowpack with extension collars and the height of the snowpack inside the chamber was measured regularly. The chambers were closed hourly and the sample gas was sucked into a cavity ring-down spectrometer and analysed for CH4, CO_2 and H_2O concentration with 5 second time resolution. The concentration change in time in the beginning of a closure was determined with linear and exponential fits.

The results show that linear regression systematically underestimated the CH4 flux when compared to exponential regression by 20-50 %. On the other hand, the exponential regression seemed not to work reliably with small fluxes (< 3.5 μg CH4 m-2 h-1): using exponential regression in such cases typically resulted in anomalously large fluxes and high deviation. Due to these facts, we recommend first calculating the flux with the linear regression and, if the flux is high enough, calculate the flux again using the exponential regression and use this value in later analysis.

The forest floor at the site (including the ground vegetation) acted as a CH4 sink most of the time. CH4 emission peaks were occasionally observed, particularly in spring during the snow melt, and during rainfall events in summer. Diurnal variation was observed mainly in summer. The net CH4 exchange for the two year measurement period in the six chambers varied from -31 to -155 mg CH4 m-2 yr-1, the average being -67 mg CH4 m-2 yr-1. However, this does not include the ditches which typically act as a significant source for CH4.