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Peak-summer CO_2 balance in a thawing permafrost peat mire in northern Norway

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Arctic and boreal soils store approximately twice the amount of carbon currently present in the atmosphere. These regions are currently warming twice as fast as the rest of the world, and models project that about 10% of their soil carbon is vulnerable for release to the atmosphere as CO_2 or methane (CH4) as the permafrost thaws this century. Methane has a global warming potential 25 times that of CO_2 over a 100-year time period, but due to overall greater efflux, CO_2 is expected to dominate the climate forcing from permafrost carbon emissions. However, these projections are still relatively uncertain with more observations needed in order to determine the quantity and timing of greenhouse gas emissions from remote permafrost regions.
In this study, we use the eddy covariance (EC) method to quantify peak-summertime (7 July to 6 August, 2017) CO_2 and surface energy balance on a peat mire with actively thawing permafrost. Our study site is located in Finnmark, northernmost Norway (69°N), and the area consists of large palsas, which are peat plateaus containing intact permafrost within their thick organic mounds. As the permafrost thaws, the palsas degrade, and they eventually collapse into inundated wetlands. The steep hydrological gradient going from dry palsa mounds and into inundated thaw-ponds drastically alters the local carbon cycle. Therefore, in addition to using an EC tower measuring the CO_2 balance on a catchment scale, we also quantify the small-scale greenhouse gas emissions using a series of well-replicated static chambers deployed along the hydrological permafrost thaw gradient. Together, the main goals of our study are i) to estimate the net peak-summertime CO_2 balance at a degrading palsa mire ecosystem under permafrost thaw, ii) to evaluate the EC method by considering the surface energy balance, and iii) to compare the EC method and the chamber method for carbon flux measurements by upscaling chamber measurements to the whole catchment. Our study adds to similar but scarce research on the permafrost-carbon climate feedback.
The palsa mires in Fennoscandia define the westernmost edge of the Eurasian permafrost zone, and ground temperatures here are generally higher than in other vast permafrost regions. This suggests that changes observed in Fennoscandia today might reveal what lies ahead for similar ecosystems in the much colder and larger areas in, for example, Russia.