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Individual rain events decrease long-term boreal peatland net CO_2 uptake through reduced light availability

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Northern peatlands sequester enormous quantities of carbon, suggesting these wetland ecosystems are of fundamental importance for the global carbon cycle. The long-term carbon storage of these wetland ecosystems depends on wet surface conditions, and is prone to drought. Future climate predictions indicate that most of the northern hemisphere is projected to become wetter, but that precipitation will fall in less frequent but more intense events. How such fine-scale climatic changes will affect long-term future net ecosystem exchange (NEE) of northern peatlands remains unknown.
In this study we explored the short-term peatland NEE response to day time rain events during the growing season, how timing and characteristics of individual events and environmental conditions modify this response, and the impact of NEE responses to individual rain events for the longer-term (annual) carbon uptake. We used an 11-year time series of half-hourly eddy covariance and meteorological measurements from Degerö Stormyr, a peatland in northern Sweden.
Our study shows daytime precipitation events systematically decreased the sink strength for atmospheric CO_2. An individual daytime precipitation event reduced net ecosystem CO_2 uptake by 0.23–0.54 gC m-2 on average. This reduction was best explained by the reduction in light associated with precipitation events, rather than by precipitation characteristics, timing of events, or drought length. On an annual basis, this reduction of net CO_2 uptake corresponds to 24% of the annual net CO_2 uptake (NEE) of the study site, equivalent to a 4.4% reduction of gross primary production (GPP) during the growing season.

We conclude that accounting for the short-term response of NEE to individual rain events is crucial in determining climate change impacts on long-term sink strength of peatlands to atmospheric CO_2. Moreover, reduced light availability associated with rain events is more important in explaining the NEE response to rain events than rain characteristics and changes in water availability. This suggests that the long-term peatland CO_2 uptake is highly sensitive to changes in cloud cover formation and to altered rainfall regimes, a process hitherto largely ignored.