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Can frequent precipitation moderate drought impact on peatmoss carbon uptake in northern peatlands?

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Northern peatlands represent one of the largest global carbon stores that can potentially be released by water table drawdown during extreme summer droughts. Small precipitation events may moderate negative impacts of deep water levels on carbon uptake by sustaining photosynthesis of peatmoss (*Sphagnum spp.*), the key species in these ecosystems.

We experimentally assessed the importance of the temporal distribution of precipitation for *Sphagnum* water supply and carbon uptake during a stepwise decrease in water levels in a growth chamber. CO_2 exchange and the water balance were measured for intact cores of three peatmoss species representative of three contrasting habitats in northern peatlands (*Sphagnum fuscum*, *S. balticum* and *S. majus*).

For shallow water levels, capillary rise was the most important source of water for peatmoss photosynthesis and precipitation did not promote carbon uptake irrespective of peatmoss species. For deep water levels, however, precipitation dominated over capillary rise and moderated adverse effects of drought on carbon uptake by peat mosses. The ability to use the transient water supply by precipitation was species-specific: carbon uptake of *S. fuscum* increased linearly with precipitation frequency for deep water levels, whereas *S. balticum* and *S. majus* showed depressed carbon uptake at intermediate precipitation frequencies.

Our results highlight the importance of precipitation for carbon uptake by peatmosses. The potential of precipitation to moderate drought impact, however, is species specific and depends on the temporal distribution of precipitation and water level. These results also suggest that modelling approaches in which water level depth is used as the only state variable determining water availability in the living moss layer and (in)directly linked to *Sphagnum* carbon uptake may have serious drawbacks. The predictive power of peatland ecosystem models may be reduced when deep water levels prevail, as precipitation frequency and quantity are likely the main variables controlling carbon uptake.