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Predicting current and future peatmoss drought stress: Impact of hydrological complexity

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Northern peatlands sequester enormous amounts of carbon and therefore represent a carbon store of global importance. The vegetation in northern peatlands is dominated by peat-forming bryophytes of the genus Sphagnum. The growth of this carbon fixer, and hence its carbon uptake, strongly depends on the moisture availability in the living moss layer, which is a function of both water table and rewetting by rain. Peatland hydrology models are used to predict how changes in climate may modify the future water balance of peatmoss carpets and influence associated carbon and energy balances. These models, however, differ considerably in the number and type of processes included, which will have yet unknown consequences for peatland drought predictions in a future climate.
Here, we assessed the importance of rainwater storage and peat volume change for predicting peatmoss drought projections in northern peatlands using an ensemble of downscaled, bias-corrected climate scenarios for current (1991 – 2020) and future (2061 – 2090) climate. Peatmoss drought projections were compared among four model variants with or without rainwater storage in the peatmoss carpet and peat volume change, which are considered as two important hydrological feedbacks controlling moss moisture availability. The performance of the four model variants was assessed using field data from a site in northern Sweden (Degerö Stormyr, 64°N 19°E).
Our results show that adding rainwater storage in the moss layer as well as peat volume change significantly improved model performance; the most complex model had best model performance. Compared to the reference model, including both model extensions reduced the predicted drought frequency experienced by peatmoss with around 50%. Moreover, projected climate change is expected to reduce predicted peatmoss drought stress with about 20% for the studied site.

In conclusion, this study shows that including rainwater storage in the peatmoss layer and/or peat volume change will reduce the predicted number of peatmoss droughts. Peatland hydrology models that include these processes will more adequately assess climate change impact on moisture availability in northern peatlands and on associated cycling of carbon, energy, and water.