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Effect of global warming on vegetation dynamics and carbon storage in peatlands

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The effects of global warming on water table height and carbon storage in boreal peatlands and the interaction with vegetation dynamics have been investigated using a numerical model. Two types of vegetation have been considered in the model: a so-called "hummock community" dominated by vascular plants and a "hollow community" dominated by Sphagnum mosses. The hummock community is adapted to dryer conditions, whereas the hollow community is better adapted to wetter conditions. We simulated the long-term carbon balance for hummock and hollow communities for multiple temperature scenarios (0, +2, +4, +6 ºC). We first analyzed a model in which the interaction with vegetation dynamics was absent. Subsequently, we included this to examine its effect on the model results.

Results showed that in absence of vegetation dynamics, the effect of increased temperature on water table depth and carbon storage was small. Inclusion vegetation dynamics, however, led to different results. In this case, increased temperature led to decreased biomass production, especially for vascular plants. Interestingly, the modeled response of the water table to increased temperature depended on the dominant vegetation type. In vascular plant-dominated areas, decreased biomass outweighed the effect of increased evapotranspiration, causing a rise of the water table. The opposite trend was observed for Sphagnum dominated area, causing a lowering of the water table. The net effect of the change in biomass and water table height was a lowering of the carbon storage capacity. Although this was the case for both vegetation types, the reduction was stronger for vascular plants. The magnitude of the change in carbon fluxes, however, depends on the developmental stage of the peatland. More specifically, shallower (younger) peatlands generally have a higher accumulation rate than thicker (older) peatlands, consistent with current theory on peatland development. We conclude that on the long term, increased temperature may lead to peatlands switching from being a sink to becoming a source of carbon. This effect may be exacerbated by decreases in precipitation.