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Upscaling methane emission hotspots in boreal peatlands

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Small-scale surface heterogeneities can influence land-atmosphere fluxes and therefore carbon, water and energy budgets on a larger scale. This effect is of particular relevance for high-latitude ecosystems, because of the great amount of carbon stored in their soils.

Upscaling such small-scale surface heterogeneities and their effects to larger scales is a challenging issue in land surface modeling. We developed a novel approach to upscale local methane emissions in a boreal peatland from the micro-topographic scale to the landscape-scale.
We based this parameterization on the analysis of the water table pattern generated by the Hummock–Hollow model (Cresto Aleina et al., 2015), a micro-topography resolving model for peatland hydrology and methane emissions. By computing the water table at the micro-topographic scale, the Hummock-Hollow model is able to describe the effects of micro-topography on hydrology and methane emissions in a typical boreal peatland. We introduce the new parameterization of methane hotspots in a global model-like version of the Hummock–Hollow model. This latter version underestimates methane emissions because of the lack of representation of micro-topographic controls on peatland hydrology.
We tested the robustness of the parameterization by simulating methane emissions for the present day and for the next century, forcing the model with three different RCP scenarios.

The Hotspot parameterization, despite being calibrated for the 1976–2005 climatology, mimics the output of the micro-topography resolving model for all the simulated scenarios. The new approach bridges the scale gap of methane emissions between this version of the model and the configuration explicitly resolving micro-topography.