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Permafrost landscapes in transition - towards modeling interactions, thresholds and feedbacks related to ice-rich ground

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Thawing of permafrost is governed by a complex interplay of different processes, of which only conductive heat transfer is taken into account in most model studies. However, heat conduction alone can not account for the dynamical evolution of many permafrost landscapes, e.g. in areas rich in ground ice shaped by thermokarst ponds and lakes. Novel process parameterizations are required to include such phenomena in future projections of permafrost thaw and hereby triggered climatic feedbacks.
Recently, we have demonstrated a physically-based parameterization for thaw process in ice-rich ground in the permafrost model CryoGrid 3, which can reproduce the formation of thermokarst ponds and subsidence of the ground following thawing of ice-rich subsurface layers. Long-term simulations for different subsurface stratigraphies in the Lena River Delta, Siberia, demonstrate that the hydrological regime can both accelerate and delay permafrost thawing. If meltwater from thawed ice-rich layers can drain, the ground subsides while at the same time the formation of a talik is delayed. If the meltwater pools at the surface, a pond is formed which enhances heat transfer in the ground and leads to the formation of a talik.
The PERMANOR project funded by the Norwegian Research Council until 2019 will extend this work by integrating such small-scale processes in larger-scale Earth System Models (ESMs). For this purpose, the project will explore and develop statistical approaches, in particular tiling, to represent permafrost landscape dynamics on subgrid scale. Ultimately, PERMANOR will conceptualize process understanding from in-situ studies to develop new model algorithms and pursue their implementation in a coupled ESM framework.