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Title: *Hydro-climatic change scenarios and their implications for permafrost formation and degradation dynamics and subsurface water residence times*

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Previous studies have demonstrated the importance of including coupled multiphase flow processes with heat transport in order to better understand the dynamics of permafrost formation and degradation and its interactions with subsurface flow. In particular, long-term simulation results show that warming trends reduce the temporal and seasonal variability of groundwater discharge into surface waters. A compelling question for waterborne transport of substances relevant for climate feedbacks, biogeochemical cycling and/or water pollution is how different scenarios of hydro-climatic change influence permafrost formation and degradation dynamics and through that also the residence times of subsurface water, from the land surface to nearest surface water.

In this presentation subsurface water residence times are evaluated and their changes analysed under permafrost formation and thaw dynamics due to changing hydro-climatic input scenarios. Residence times are also studied and compared for different scenarios of heterogeneous subsurface geological media at a hillslope scale. This is done by numerical simulations of flow and heat transport in partially frozen ground, incorporating infiltration and ambient temperature variations, and evaluating the subsurface water seepage and discharge into surface water. The dynamics of permafrost variation, as active layer freeze and thaw cycles, as well as longer-term change trends in permafrost formation/degradation, and how this impacts the hydrogeological flow system and its subsurface water residence times and outflow rates to surface water are evaluated. Residence times implications are evaluated and discussed in the context of solute transport and potential climate feedback mechanisms. Initial results indicate non-linear residence time responses to permafrost formation and degradation under changing hydro-climatic forcing, which impacts the distribution of subsurface flow-transport pathways and thereby also the associated residence time.