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# Experimental and numerical simulations of heat transfers between flowing water and a frozen porous medium

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In permafrost-affected regions, hydrological changes due to global warming are still under investigation. But yet, we can already foresee from recent studies that for example, the variability and intensity of surface/subsurface flow are likely to be affected by permafrost degradation. The feedback induced by such changes on permafrost degradation is still not clearly assessed.

Of particular interest are lake and river's taliks. A talik is a permanently unfrozen zone that lies below rivers or lakes. They are likely to play a key role in the formerly presented interactions, given that they are the only paths for groundwater flow in permafrost regions. Thus heat transfers on a regional scale are influenced by groundwater circulation. The aim of our study is therefore to investigate the evolution of river's taliks. In addition, they are the only perennial liquid water resources in continuous permafrost environments. The issue associated is to what extent can taliks develop into the future because of climate change and how likely are they to become open taliks, connecting sub-permafrost water with surface water with potentially strong geochemical changes?

We developed a multidisciplinary approach coupling field investigation, experimental studies in a cold room and numerical modeling. The field investigation concerns Central Yakutia, Siberia, where we have installed instruments to monitor ground temperatures and water pressure in a small river's talik between two thermokarst lakes. We present here the results corresponding to the cold room experimental work, associating numerical modeling and laboratory experiments in order to look after the main parameters controlling river's talik installation and validate our numerical simulation approach.

In a cold room at GEOPS, where a metric scale channel is filled with a porous medium (sand or silty-clay), we are able to control air, water and permafrost initial temperature, but also water flow. At initial time, the "river" water flow is started. The progression of the thawing front is monitored by an array of thermal sensors. A sensitivity study involving water flow rates and temperatures is carried on, so that we can test various parameter sets for a miniaturized river. Main thaw propagation controlling parameters are identified. These results are then confronted with a numerical model developed at the LSCE with Cast3m (www-cast3m.cea.fr). Various expressions for river-talik heat exchange terms are tested and the simulations are confronted with the experimental data.

Main results are presented as well as the baseline to deal with the field conditions in Siberia based on the present study.

Keywords: Talik, River, Numerical Modeling, Cold Room, Permafrost.