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3D thermohydraulic modeling of the coupling of surface water bodies to the subsurface below the major urban center of Berlin

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This study aims at a better understanding of the present-day thermal and hydraulic configuration below the major urban center of Berlin, capital city of Germany. The study area is located in the Northeast German Basin, showing an infill of several kilometers of sediments. Herein, the shallow sedimentary succession is made up of a sequence of alternating aquifers and aquitards, most importantly the local aquitard of the Rupelian clay. This geological unit represents a natural barrier between the deeper saline aquifers and the shallow fresh water aquifers from whom Berlin produces 100% of its drinking water. Additionally, the shallow thermal and hydraulic configuration has been anthropogenically overprinted which may also influence deeper domains to some extent.

In this study we make use of 3D thermohydraulic models of the subsurface, focusing on the coupling of surface water bodies to the underground, based on newly available hydraulic data integrated into a 3D hydrogeological model.

The results of the study show, that the coupling of surface water bodies and groundwater might lead to significant modifications of predicted subsurface temperatures and fluid flow field. These modifications are most prominent, where differences in hydraulic head between surface water bodies and the adjacent aquifers are highest. Consequently, the predicted surface to groundwater flow field differs most in these areas and it also results in differences in predicted temperatures as a consequence of advective heat transport. Quantitatively, the presence of major lakes may account for temperature differences up to 5°C, while considering rivers only accounts for modifications up to 1°C.

Additionally, the models created in this study set up a basis for future thermohaline simulations as saline groundwater may represent a threat to drinking water supply. First results from the models run in this study already indicate, that uprising heated water from deeper domains may rise to shallow levels in locations where increased concentrations of contaminants have been previously measured, thus emphasizing the degree of vulnerability of shallow groundwater utilization beneath the city.