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The geothermal field below the city of Berlin, Germany: Results from structurally and parametrically improved 3D Models

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The goal of this study was to quantify the influence of the geological structure and geophysical parametrization of model units on the geothermal field as calculated by 3D numerical simulations of coupled fluid and heat transport for the subsurface of Berlin, Germany. The study area is located in the Northeast German Basin which is filled with several kilometers of sediments. This sedimentary infill includes the clastic sedimentary units Middle Buntsandstein and Sedimentary Rotliegend which are of particular interest for geothermal exploration.

Previous studies conducted in the Northeast German Basin have already shown the geometries and properties of the geological units majorly control the distribution of subsurface temperatures. In this study we followed a two-step approach, where we first improved an existing structural model by integrating newly available 57 geological cross-sections, well data and deep seismics (down to ∼4 km). Secondly, we performed a sensitivity analysis investigating the effects of varying physical fluid and rock properties on the subsurface temperature field.

The results of this study show, that the structural configuration of model units exerts the highest influence on the geothermal field (up to ± 23 K at 1000 m below sea level). Here, the Rupelian clay aquitard, displaying a heterogeneous thickness distribution, locally characterized by hydrogeological windows (i.e. domains of no thickness) enabling intra-aquifer groundwater circulation has been identified as major controlling factor. The new structural configuration of this unit (more continuous, less numerous hydrogeological windows) also leads to a reduction of the influence of different boundary conditions and heat transport mechanisms considered. Additionally, the models results show that calculated temperatures highly depend on geophysical properties of model units whereas the hydraulic conductivity of the Cenozoic succession was identified as most dominant, leading to changes in groundwater circulation patterns and the associated convective heat transport (up to ± 20 K at 1000 m below sea level).