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The potential of subsurface heat recycling in Dresden

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In times of climate change heat increasingly accumulates in urban areas. Thus, the temperature in city centers is often several degrees higher than in the surrounding areas. This urban heat island effect (UHI) can negatively affect people and the environment. Heat islands in the subsurface (SubSUHI) due to high heat input from cities into the soil and groundwater can also be measured. This accumulated heat input could be harnessed by geothermal heat pumps contributing to the solution of two major challenges of our time: firstly, the reduction of CO_2 emissions through the decarbonization of the heating market and secondly, the cooling of the soil and groundwater to pre-industrial temperature levels and thus a possible climate protection measure.

This work attempts to investigate the heat island effect in the subsurface of the urban area of Dresden, Germany. For this purpose, various temperature measurements, such as groundwater and air temperature, are combined with geodata on land use and development. The theoretical geothermal potential for suitable areas in Dresden is calculated as well as the sustainable geothermal potential, taking into account the heat flux directed upwards as well as downwards. Several, mostly anthropogenic, heat fluxes from urban structures into the groundwater are investigated, such as heat fluxes due to buildings, tunnels, or district heating. These potentials are placed in the context of the heating requirements of the city of Dresden and thereby descripe the extent to which the installation of geothermal systems can contribute to the climate neutrality of the local heating market. In a second scenario, the heat fluxes for the year 2100 are calculated using the CMIP6 scenarios SSP245 and the SSP585 to show how climate change could potentially improve the efficiency of geothermal systems. By using Google Earth Engine as a platform, we ensure that our analysis is easily scalable and can later be applied to any city within Germany.