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Importance of thermal dispersion in temperature plumes

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Abstract The objective of this study is to evaluate the influence of thermal dispersion on the simulation of temperature plumes that evolve from the application of vertical ground source heat pump (GSHP) systems in aquifers. Various hydrogeological scenarios are simulated with longitudinal dispersivity ranging between 0.5 and 2 m and a Darcy velocity between 10^{-8} m s^{-1} and 10^{-5} m s^{-1}. In addition, thermal dispersivity is assumed to be scale-dependent. Based on a field scale of 10 m, the study shows that the thermal dispersion is an important factor for the prediction of shape and extension of temperature plumes in medium-grained sand to gravel aquifers. From the perspective of environmental regulators, such assumptions might be crucial for licensing applications of neighbouring GSHP systems. In contrast, ignoring thermal dispersion provides appropriate predictions of the temperature plume length for hydrogeological conditions dominated by fine sands, silts and clays.

Key words thermal dispersivity; analytical solution; ground source heat pump system; temperature plume