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Pore-scale study of Horton-Rogers-Lapwood convection in porous media: Effect of microscale thermophysical heterogeneity on the onset of convection HAMID KARANI, CHRISTIAN HUBER, Georgia Inst of Tech — A direct-numerical-simulation is employed on a 2-dimensional Horton-Rogers-Lapwood convection problem in a regular porous medium. High resolution numerical simulation is performed by the thermal lattice-Boltzmann method. The governing equations are solved at the pore-scale level in both the fluid and solid phases while conserving the appropriate conjugate boundary condition at the solid-fluid interface. This allows us to calculate continuum-scale parameters such as the permeability and the stagnant thermal conductivity of the medium very accurately without using any empirical formulations. Also, the regular arrangement of the solid blocks allows us to calculate the intrinsic-averaged temperatures of each phase in the porous medium. This information is used to test the assumption of local thermal equilibrium between the fluid and solid phases. Our model is then used to probe the effect of contrasting thermal properties between the two phases. We observe that increasing the contrast in thermal conductivities leads to a departure from local thermal equilibrium between the two phases. This indeed causes a shift for the onset of convection in terms of critical Rayleigh number and a modification of the Nusselt-Rayleigh number correlation after the onset of convection.

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