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# Spreading of Multiphase Flows in Heterogeneous Porous Media under the Influence of Buoyancy

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We study the combined effect of spatial heterogeneity and buoyancy on the dispersion of the saturation of a displacing fluid during vertical injection into another immiscible fluid. By using a stochastic modeling framework, we define a dispersion coefficient, which quantifies the actual spreading of the saturation front in a typical medium realization. The effective large-scale flow equation for the saturation of the displacing fluid is characterized by a nonlocal dispersive flux term as well as a nonlocal additional advective flux. The advective flux does not occur in the absence of buoyancy effects and is solely attributed thereto. Our analysis demonstrates that the transition zone dispersion coefficient consists of two parts, one constant contribution similar to the case without buoyancy effects and a second contribution that grows linearly in time that can be attributed to the additional advective flux. Correct assessment of the spread of the saturation front is of importance to several applications, including for example the assessment of the sequestration potential of a carbon dioxide storage site as spreading enhances the surface area between the fluids.