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Asymptotic dispersion in 2D heterogeneous porous media

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We determine the asymptotic dispersion coefficients in 2D exponentially-correlated lognormally-distributed permeability fields by using parallel computing. Fluid flow was computed by solving the flow equation discretized on a regular grid and transport triggered by advection and diffusion was simulated by a particle tracker. To obtain a well-defined asymptotic regime, the characteristic size of the simulated grids was of the order of 10^3 correlation lengths with a resolution of ten meshes by correlation length. We determine unambiguously the asymptotic longitudinal and transverse dispersion coefficients on a realization basis for a broad range of heterogeneities $\sigma^2 \in [0,8]$, where σ^2 is the lognormal permeability variance. For purely advective transport, the asymptotic longitudinal dispersion coefficient depends linearly on σ^2 for $\sigma^2 <1$ and quadratically on σ^2 for $\sigma^2 >1$ and the asymptotic transverse dispersion coefficient is zero. Addition of diffusion induces a dispersion increase at low heterogeneity level. At high heterogeneity diffusion induces significant decrease of the longitudinal dispersion and increase of the transverse dispersion.