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NONLINEAR EXPRESSION FOR SOLUTE DISPERSIVE FLUX IN POROUS MEDIA

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Summary. Fick's law is the basic relationship used to describe nonconvective mass flux of a solute in a porous medium. This equation prescribes a linear relationship between the dispersive mass flux and the concentration gradient through a dispersion coefficient. There is a mounting amount of evidence questioning this approximation not only at large scale, but also at column scale, where anomalous, non-Fickian transport has been observed. We compute the term responsible for hydrodynamic dispersion, namely the volume average of the product of fluctuations of pore-scale concentration and velocity; this computation is conducted directly by upscaling pore-scale simulations of non-reactive solute transport. We investigate the conditions for this term to be approximated by a Fickian form, and test the ability of nonlinear theories (Hassanizadeh 1996 and references therein) that postulate a nonlinear form of the dispersive solute flux. This equation is coupled to the mass transport equation and they are solved simultaneously by a modified-Picard iteration method. We analyze the solution in a 1D domain and compare against averaged dispersive flux obtained from 2D pore-scale simulations.