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The Mean Velocity of Solute Plumes in Transport in Heterogeneous Aquifers

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Flow of mean velocity U takes place in a heterogeneous aquifer of random spatially variable conductivity K. A solute plume is injected instantaneously along a plane normal to U, over a large area relative to the logconductivity integral scale I (ergodic plume). Transport is by advection by the spatially variable Eulerian velocity. The study is focused on the derivation of the mean plume velocity in the four modes set forth by Kreft and Zuber [1978] for one dimensional flow in a homogeneous medium. In the resident injection mode the mass is initially distributed uniformly in space while in the flux mode it is proportional to the local velocity. In the resident detection mode the mean velocity pertains to the plume centroid, whereas in flux detection it is quantified with the aid of the BTC and the corresponding mean arrival time. In agreement with the literature, it is shown that URR, and UFF ,pertaining to same injection and detection modes, either resident or flux, are equal to U. In contrast, in the mixed modes the solute velocity may differ significantly from U near the injection plane, approaching it at large distances relative to I. These effects are explained qualitatively with the aid of the exact solution for stratified aquifers.