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Enhanced mixing in heterogeneous Buckley Leverett flow due to temporal fluctuations

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We consider idealised immiscible two phase displacement flow (Buckley Leverett) flow in a heterogeneous porous medium. The flow is subject to temporal fluctuations. Using perturbation and stochastic methods we derive a large scale 'mixing' parameter for horizontal Buckley Leverett flow. This effect is quantified by an effective large scale 'homogenous' dispersion term, which is enhanced by both the fluctuations in the spatial and temporal field. While temporal fluctuations do enhance mixing, we illustrate that without caution, studying such a problem numerically can yield unrealistically large predictions. These observations are consistent with previous studies that considered the transport of a passive solute within a similar flow setup. This project is motivated by a desire to understand the influence of heterogeneities on multiphase flow. Specific applications include CO2 sequestration and oil recovery.