Mortar multiscale stochastic numerical modeling of flow in porous media

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We discuss a multiscale stochastic framework for uncertainty quantification in flow in porous media. The governing equations are based on Darcy's law with stochastic permeability represented with a Karhunen-Loève (KL) expansion. We consider a domain decomposition formulation with different KL expansions in different subdomains. This approach allows to model efficiently heterogeneous media with different rock types. The approximation is based on multiscale mortar mixed finite elements in the spatial domain coupled with stochastic collocation. We precompute a multiscale basis, which involves solving subdomain problems with for each realization of the local KL expansion. The basis is then used to solve the coarse scale mortar interface problem for each global KL realization. The resulting algorithm is orders of magnitude faster than a global stochastic collocation approach. Error analysis for the statistical moments of the pressure and the velocity is performed and experimentally verified with numerical simulations of single phase flow in porous media.

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