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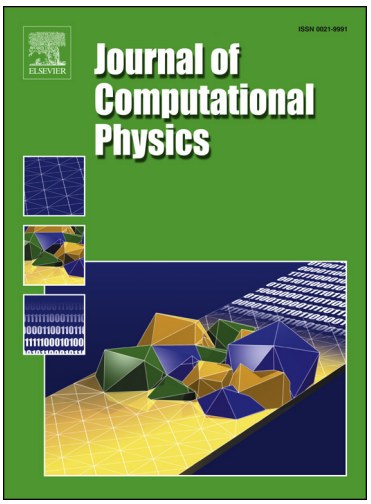

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Bayesian and Variational Bayesian approaches for flows in heterogenous random media

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Abstract

In this paper, we study porous media flows in heterogeneous stochastic media. We propose an efficient forward simulation technique that is tailored for variational Bayesian inversion. As a starting point, the proposed forward simulation technique decomposes the solution into the sum of separable functions (with respect to randomness and the space), where each term is calculated based on a variational approach. This is similar to Proper Generalized Decomposition (PGD). Next, we apply a multiscale technique to solve for each term (as in [1]) and, further, decompose the random function into 1D fields. As a result, our proposed method provides an approximation hierarchy for the solution as we increase the number of terms in the expansion and, also, increase the spatial resolution of each term. We use the hierarchical solution distributions in a variational Bayesian approximation to perform uncertainty quantification in the inverse problem. We conduct a detailed numerical study to explore the performance of the proposed uncertainty quantification technique and show the theoretical posterior concentration.

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