Markov Chain Monte Carlo Methods Applied to Subsurface Flow Problems: A Convergence Study

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Abstract

In subsurface characterization using a history matching algorithm, subsurface properties are reconstructed with a set of limited measured data. Here we focus on the characterization of the permeability field in an aquifer using the Markov chain Monte Carlo algorithms, which are reliable procedures for such reconstruction. The MCMC method is serial in nature due to its Markov property. Moreover, the calculation of the likelihood information in the MCMC is computationally expensive for subsurface flow problems. Running a long MCMC chain for a very long period makes the method less attractive for the characterization of the subsurface. In contrast, several shorter MCMC chains can substantially reduce computation time and can make the framework more suitable to subsurface flows. However, the convergence of such MCMC chains should be carefully studied. In this paper, we consider multi-MCMC chains for a single-phase flow problem and analyze the chains aiming at a reliable characterization. We consider both single-stage and two-stage MCMC algorithms in our study.