PARAMETER ESTIMATION AND UNCERTAINTY QUANTIFICATION OF MULTIPHASE SUBSURFACE FLOW MODELS BY A NEW ADAPTIVE DELAYED ACCEPTANCE METROPOLIS HASTINGS ALGORITHM

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The aim of this research is to estimate the parameters of large scale multiphase subsurface flow models that occur in geothermal reservoirs. Our methodology is based on Markov chain Monte Carlo (MCMC) sampling, within the framework of Bayesian inference. In this framework, all feasible parameters that are consistent with the measured data are summarized by the posterior distribution, and hence parameter estimation and uncertainty quantification are both given by calculating expected values of statistics of interest over the posterior distribution.

It appears to be computationally infeasible to use the standard Metropolis-Hastings algorithm (MH) to sample the high dimensional computationally expensive posterior distribution. To improve the sampling efficiency, a new adaptive delayed-acceptance Metropolis Hastings algorithm (ADAMH) is implemented to adaptively build a stochastic model of the error introduced by the use of a reduced order model. This use of adaptivity differs from existing adaptive MCMC algorithms that tune proposal distributions of the Metropolis Hastings algorithm (MH), though ADAMH also implements that technique.

For the 3D geothermal reservoir models we present here, ADAMH shows a great improvement in the computational efficiency of the MCMC sampling, and promising results for parameter estimation and uncertainty quantification are obtained. This algorithm could offer significant improvement in computational efficiency when implementing sample-based inference in other large scale hydrology problems.