Quantification of Uncertainty in Permeability and Porosity for Predictive Simulation of Subsurface Flows

V. Ginting[1], F. Pereira[1], and A. Rahunanthan[1]

[1]Department of Mathematics and Center for Fundamentals of Subsurface Flow, School of Energy Resources, University of Wyoming, Laramie, WY 82071, USA

ABSTRACT: One of the most difficult tasks in subsurface flow simulations is the reliable characterization of properties of the underlying rock formations. A typical situation employs dynamic data integration such as sparse (in space and time) measurements to be matched with simulated responses associated with a set of pairs of permeability and porosity fields. Among the challenges found in practice are proper numerical approximation of multiphase flows, persisting heterogeneity, and the uncertainties inherent in it. We extend an existing, computationally efficient, two-stage Monte Carlo Markov Chain (MCMC) method to sample a set of pairs of realizations of permeability and porosity from the posterior distribution that are conditioned on production and static (measured) data. We model permeability and porosity fields such that they share the same spatial structure, but ad-hoc correlations between them are not assumed. We focus our discussion on the reliable numerical approximation of the governing systems of partial differential equations of multiphase flows in multiscale heterogeneous formations along with accurate predictions for problems of practical interest: contaminant transport, two-phase (oil-water) flow, and CO2 sequestration.