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Speeding up posterior inference of an high-dimensional groundwater flow model from two-stage MCMC simulation and polynomial chaos expansion

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This study presents a novel strategy for accelerating posterior exploration of highly parameterized and CPU-demanding hydrogeologic models. The method builds on the stochastic collocation approach of Marzouk and Xiu (2009) and uses the generalized polynomial chaos (gPC) framework to emulate the output of a groundwater flow model. The resulting surrogate model is CPU-efficient and allows for sampling the posterior parameter distribution at a much reduced computational cost. This surrogate distribution is subsequently employed to precondition a state-of-the-art two-stage Markov chain Monte Carlo (MCMC) simulation (Vrugt et al., 2009; Cui et al., 2011) of the original CPU-demanding flow model. Application of the proposed method to the hydrogeological characterization of a three-dimensional multi-layered aquifer shows a 2-5 times speed up in sampling efficiency.