Scalable Uncertainty Quantification and Parameter Estimation for High-Dimensional Environmental and Biological Systems

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Experience suggests that uncertainties often play an important role in quantifying the performance of complex systems. Therefore, uncertainty needs to be treated as a core element in modeling, simulation and optimization of complex systems. In this talk, a new block-triangular preconditioning technique for stochastic Galerkin method will be introduced to improve the solver efficiency for stochastic PDEs, which combines multilevel techniques in both stochastic and spatial domain. Additionally, a new simulated stochastic approximation annealing with square-root cooling schedule will be presented for efficient parameter estimation with application in both subsurface porous media and climate models. Finally, an adaptive ANOVA probabilistic collocation Kalman filter method will be discussed for high-dimensional stochastic inverse problem in subsurface porous media. Several specific examples on parameter estimation in both subsurface porous media and climate models will be presented to illustrate the main idea of our approach.