Poster #172

Computational Bayesian Framework for Quantification of Predictive Uncertainty in Environmental Modeling
SBR Early Career Award

Ming Ye[1]

[1] Department of Scientific Computing, Florida State University, Tallahassee, FL 32306

Contact: Ming Ye [mye@fsu.edu]

A computational Bayesian framework has been developed for quantification and reduction of uncertainty in environmental modeling. In this year of the project, we continue our research on sensitivity analysis under not only parametric uncertainty but also model uncertainty and scenario uncertainty. A new sensitivity index is developed for identifying important system processes, when the processes can be modeled by competing models due to model uncertainty. The process sensitivity index answers the question that how to select the important system processes when it is uncertain how to model the processes. This new method of sensitivity analysis should be of particular use at the early stage of model development when the process model uncertainty is the largest. We demonstrate this concept of important process identification using a synthetic model of groundwater reactive transport. We have collaborated with Anthony Walker at the Oak Ridge National Laboratory to use the process sensitivity index for his ecological modeling. In addition, we have also developed a new sensitivity index that can be used to identify important model components. Using the concept of Bayesian network, an environmental model is decomposed into various components, and the components can be grouped together for a sensitivity analysis. We have collaborated with Xingyuan Chen at the Pacific Northwest National Laboratory to apply the new sensitivity index to her modeling at the Hanford Site.

We have also made progress on computational evaluation of Bayesian evidence, which is critical for evaluating relative plausibility of multiple models (a more plausible model has larger Bayesian evidence). We develop a method called multiple one-stepping stone (MOSS) method that can improve accuracy of the Bayesian evidence calculation. This method has been demonstrated using an example of groundwater reactive transport modeling. On the other hand, to reduce the computational cost, the sparse grid methods are used to build cheap-to-evaluate surrogates of computationally demanding models. Using the surrogates, we compared several methods of evaluating the Bayesian evidence, including an improved nested sampling method. The future research will be focused on using the developed methods for a set of uranium reactive transport models developed for the Naturita Site in Colorado.