Bayesian Uncertainty Quantification for Channelized Subsurface Characterization

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ABSTRACT: Uncertainties in the spatial distribution of subsurface properties play a significant role in predicting the fluid flow behavior in heterogeneous media. To quantify the uncertainties in flow and transport processes in heterogeneous porous formations, complex dynamic and static data need to be reconciled with stochastic description of subsurface properties. The dynamic data measure the flow and transport responses that are largely affected by the spatial distribution of distinct geologic facies with sharp contrasts in properties across facies boundaries. Subsurface systems represent a challenging example in which the orientation and geometric shape of the channels dominate the field scale flow behavior in the subsurface. Most existing approaches have been limited to modeling the channel boundaries with simplified (e.g., sinusoidal) functions.

In subsurface characterization, facies features need to be properly accounted when constructing prior models for subsurface properties. Furthermore, stochastic conditioning of facies distributions to nonlinear dynamic flow data presents a major challenge in underground fluid flow prediction. In this talk, hierarchical Bayesian approaches will be discussed that use level set methods for facies deformation to model facies boundaries. These prior models can be used with fast multiscale forward simulation tools and parallel multi-stage sampling techniques to explore the uncertainties in the geologic facies description and the resulting flow predictions.

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