MAP: AN ANALYSIS PLATFORM FOR MULTISCALE HYDROGEOLOGIC MODELING WITH EMPHASIS ON HYBRID MULTISCALE METHODS

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Over the past five years, we have been developing and testing the utility of hybrid multiscale modeling methods for simulation of coupled pore- and darcy-scale reactive transport in porous media. Hybrid multiscale methods have been developed and applied in other disciplines, principally materials sciences, but their application to hydrogeologic problems is in its infancy. However, the multiscale nature of hydrogeologic processes and properties has long been recognized and addressed through a variety of approaches, most notably upscaling methods and multiresolution solvers. Nevertheless, even the most sophisticated simulation tools existing today employ relatively coarse grids with upscaled process models and parameters that depend on approximations and assumptions that are not well understood and may be restrictive or invalid for some important problems. These issues commonly manifest themselves as apparent scale-dependence of model parameters (e.g., hydraulic conductivity, dispersivity, reaction rates), multi-rate mass transfer models, and unexplained early arrivals or long tails in breakthrough curves. Although hybrid multiscale methods offer an avenue to address some of these problems, it has been our experience (and that of our colleagues in other disciplines) that among the plethora of multiscale modeling methods it is very difficult to identify which method or methods are best for a particular problem and to adapt the selected method to that problem.

In an effort to reduce the confusion associated with multiscale modeling methods and encourage more systematic understanding and application, we have developed the "Multiscale Analysis Platform" or MAP. The MAP comprises a series of questions that guide the user to one of several multiscale simulation "motifs." Each motif in turn encompasses one or more multiscale simulation methodologies and the associated software tools for their implementation. In this presentation, we will walk through the MAP, discussing the criteria that lead one to each of the given motifs, and briefly describing (with examples) the methodologies and tools that embody each motif. It is our objective that the MAP will serve as a platform for development of a comprehensive set of multiscale simulation tools that will enable their wider adoption by the hydrogeological modeling community.