Hierarchical Model Development for Uncertainty Quantification in Complex Systems

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Understanding and quantifying the impact of uncertainties in complex dynamical systems requires the development of a hierarchy of models to effectively explore high-dimensional parameter spaces and identify regions of critical importance.

In this talk we discuss two techniques to develop such models. A first one, combining ideas from reduced order modeling with techniques from machine learning, results in models of full physical fidelity with evaluation costs that are substantially below that of the full model. We shall demonstrate this for fluid flows.

To further reduce the computational cost, we discuss a data driven approach to learn low-dimensional models for spatially averaged quantities, obtained from full scale models. This results in simple coupled models that can be evaluated a very little cost, yet with predictive value for the dynamical behavior of the full problems. We shall demonstrate this approach on a problem of plasma physics exhibiting behavior to an L-H transition.