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STOCHASTIC MODEL REDUCTION AND MULTISCALE MODELING WITH UNCERTAINTY

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We describe model reduction adapted to the polynomial chaos approach for characterizing and propagation uncertainty in physics-based models. In such circumstances model reduction will generally pertain to a reduction with respect to both uncertainty and physics. Standard approaches to uncertainty analysis are generally limited in their ability at UQ reduction to moment truncation. Polynomial chaos constructions, on the other hand, have access to a full complement of mathematical structure, such as projections and best approximations.

We describe procedures for model reduction of uncertain systems that capitalize on these Polynomial chaos constructions. Specifically, we describe a recent approach, and demonstrate its significance to problems involving multiscale and multiphysics interactions. This approach focuses on a particular quantity of interest (QoI) and recognizes that in several important cases, these QoI are low-dimensional. We describe classes of problems where reduction to one-dimensional approximations yields very good approximations to the original high-dimensional problem. The significance of these algorithms on applications is transformative as they enable the resolution of problems that could otherwise be deemed prohibitive.