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DIMENSIONALITY REDUCTION AND ADAPTIVE UNCERTAINTY QUANTIFICATION FOR STOCHASTIC PARTIAL DIFFERENTIAL EQUATIONS

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ABSTRACT

Many problems in physics and engineering are modeled by systems of partial differential equations (PDEs) such as the shallow water equations of hydrology, the Euler equations for inviscid, compressible flow, and the magnetohydrodynamic equations of plasma physics. The initial data, boundary conditions, and coefficients of these models may be uncertain due to measurement, prediction, or modeling errors. This minisymposium considers novel numerical methods with improved convergence properties that enhance the uncertainty quantification (UQ) and optimization pipeline, especially in comparison to conventional Monte-Carlo sampling. In particular, we are interested in computational methods for solving stochastic PDEs such as generalized polynomial chaos, the probabilistic collocation method, or stochastic Galerkin projections that yield computational schemes from which the solution’s moments and distributions can be reconstructed.

When tackling problems with a high number of stochastic parameters, many state-of-the-art UQ methods quickly become computationally prohibitive due to the *curse of dimensionality* – an exponential increase in complexity with the number of dimensions of the problem. The main focus of this minisymposium is on dimension reduction techniques such as low-rank tensor decompositions, model order reduction, machine learning and other techniques which can manage the curse of dimensionality and accelerate UQ simulations. We are also interested in adaptive uncertainty quantification methods where computational resources are allocated automatically to satisfy accuracy or efficiency considerations.

The scope of this minisymposium includes uncertainty quantification methods for high-dimensional hyperbolic PDEs and stochastic optimization as in network systems that scale to arbitrarily large graphs with specialized (e.g., temporal) uncertainty.