VVUQ METHODS FOR MULTIPHYSICS CODES

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ABSTRACT

Physics and engineering experiments are both expensive and time consuming, and as a result, scientists rely heavily on computational models to study their dynamics. Simulations of these experiments are filled with various errors and uncertainties. Verification, Validation, and Uncertainty Quantification (VVUQ) are essential to computational modeling, as they ensure that simulations accurately predict real-world phenomena. This mini-symposia encourages contributions related to understanding these errors and uncertainties as they relate to VVUQ.

Verification focuses on the numerical accuracy of the solutions that a physics code produces and can be broken down into two categories: code verification and solution verification. Code verification uses exact solutions to determine numerical error due to discretizing the governing equations. Solution verification focuses on numerical error estimation when exact solutions do not exist. Relevant contributions may involve standard mesh resolution techniques or other advanced mathematical methods.

Validation involves determining sources of error by comparing the simulation directly against experimental data. Validation efforts identify modeling choices that need improvement and establish uncertainties between models and experimental results. Assessing model accuracy is difficult as there are uncertainties associated with both the model predictions and the experimental measurements. Relevant contributions may involve determinations of model error or discussions of how quantities of interest are compared with experimental results.

UQ quantifies the propagation of uncertainty from inputs, assesses uncertainty from the mathematical models used to produce outputs, and conducts sensitivity analysis to determine important variables. Surrogate models, such as Gaussian processes and Machine Learning (ML) models, can be leveraged as tools for UQ due to their ability to approximate complex simulations in a cost-effective manner. Relevant contributions may span a broad set of sensitivity methods, reduced order models, and data-driven methods.