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UNCERTAINTY QUANTIFICATION METHODS FOR FLUID FLOW SIMULATIONS AND MODELS

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ABSTRACT

Fluid flow simulations are inherently uncertain because of high sensitivity to inputs (such as domain geometries, boundary and initial conditions), to external forcing, to modelling parameters, and to model approximations when all scales and processes involved in the dynamics cannot be fully resolved. This has triggered the development of various uncertainty quantification and management methods, in order to assess the predictive level of the simulation output and eventually decide on a strategy to reduce model uncertainties, in particular through identification, inference and assimilation techniques.

The mini-symposium will aim at gathering researchers working in various areas of Computational Fluid Dynamics (CFD) and having a particular interest in uncertainty related problems. These areas include, but are not limited to, porous media flows, complex multiphase flows, combustion and reactive flows, high speed and rarefied flows, and geophysical and oceanic flows.

All these domains have in common a high complexity model, often with many uncertain parameters and generally important computational solution cost. This makes uncertainty study for these problems very expensive, with dedicated techniques to be developed. We mention here model reduction (both at the deterministic and stochastic levels), multi-fidelity and multi-level methods, surrogate acceleration (polynomial, Gaussian process,...), sparse approximations, multi-resolution analyses and domain decomposition methods (again, both at the deterministic and stochastic levels), advanced sampling methods, high performance computing and parallel implementations, ..., that have been recently proposed and adapted to various fluid flow simulations.

The objective of the mini-symposium will be to share recent methodological and technical developments proposed in different CFD application domains and promote exchanges and discussions regarding key issues and challenges faced by the researchers. Other points that we plan to discuss in the mini-symposium concerns the construction and reduction of input uncertainty models, from a known distribution or using sampled data (possibly inverse identification), as well as the post-analysis of the output uncertainty and its characterization.