

## Uncertainty quantification methods in CFD and FSI problems

In the last decades the increase in computer power has resulted in a significant increase of the accuracy of numerical simulations. Compared to the reduced numerical errors in computational Fluid Dynamics (CFD) simulations, the effects of uncertainty in the input data are nowadays relatively large. This is especially true for effects of input uncertainty on the long-term behavior of dynamical interactions between flow and structure. Therefore, input uncertainties should also be taken into account in fluid-structure interaction (FSI) simulations.

Due to the relative large amount of computational costs for complex CFD and FSI simulations, a Monte Carlo approach for quantifying the uncertainties is impractical. Good alternatives are Polynomial Chaos methods, which are capable of resolving the output distribution with the same accuracy as a Monte Carlo simulation but at a fraction of the costs. These methods have been extensively applied to Computational Structural Mechanics (CSM) problems, but are relatively new for CFD and FSI. Application of Polynomial Chaos methods to computational fluid dynamics problems is an active field of research because of the different nature of CFD (non-linearities, approximate turbulence models, millions of unknowns). For FSI problems existing Polynomial Chaos methods even have difficulty resolving the long-term stochastic dynamical behavior correctly.

Polynomial Chaos methods employ the Polynomial Chaos expansion, which is a global polynomial expansion in probability space in terms of independent random variables and deterministic coefficients. The deterministic coefficients can be solved for numerically by applying the Stochastic Galerkin method or the Probabilistic Collocation method. In the Stochastic Galerkin method the basis functions are orthogonal polynomials. The Galerkin projection in probability space results in a coupled system of deterministic equations. In Probabilistic Collocation the uncertainty quantification problem is collocated in suitable Gauss points in probability space. The basis polynomials are Lagrange polynomials through the collocation points. Probabilistic Collocation leads to a non-intrusive approach in which uncoupled deterministic problems are solved for various parameter values.

In this mini-symposium we seek innovative contributions on uncertainty quantification methods for CFD and FSI problems. Abstracts on Polynomial Chaos methods (including the stochastic Galerkin method and the Probabilistic Collocation method) as well as other uncertainty quantification techniques are welcome.