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Non-intrusive uncertainty quantification of computational fluid dynamics simulations: notes on the accuracy and efficiency MAGORZATA ZIMO, ROBERT SAWKO, IBM Research UK, DAVID EMERSON, STFC Daresbury Laboratory, CHRISTOPHER THOMPSON, IBM Research UK — Uncertainty quantification (UQ) is increasingly becoming an indispensable tool for assessing the reliability of computational modelling. Efficient handling of stochastic inputs, such as boundary conditions, physical properties or geometry, increases the utility of model results significantly. We discuss the application of non-intrusive generalised polynomial chaos techniques in the context of fluid engineering simulations. Deterministic and Monte Carlo integration rules are applied to a set of problems, including ordinary differential equations and the computation of aerodynamic parameters subject to random perturbations. In particular, we analyse acoustic wave propagation in a heterogeneous medium to study the effects of mesh resolution, transients, number and variability of stochastic inputs. We consider variants of multi-level Monte Carlo and perform a novel comparison of the methods with respect to numerical and parametric errors, as well as computational cost. The results provide a comprehensive view of the necessary steps in UQ analysis and demonstrate some key features of stochastic fluid flow systems.

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