Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Non-intrusive uncertainty quantification of computational fluid
dynamics simulations: notes on the accuracy and efficiency MAGORZATA
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bury 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. Detec-
tministic and Monte Carlo integration rules are applied to a set of problems, including
ordinary differential equations and the computation of aerodynamic parameters sub-
ject to random perturbations. In particular, we analyse acoustic wave propagation
in a heterogeneous medium to study the effects of mesh resolution, transients, num-
ber 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 comprehen-
sive view of the necessary steps in UQ analysis and demonstrate some key features
of stochastic fluid flow systems.

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Date submitted: 31 Jul 2017