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COMPARISON OF UNCERTAINTY QUANTIFICATION METHODS FOR MATHEMATICAL AND MECHANICAL PROBLEMS IN INTERMEDIATE DIMENSIONS

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Since about fifteen years, the CFD community has devoted an increased attention to the influence of uncertain parameters on the quantities of interest (QoI) extracted from numerical simulations. ONERA has used various methods to quantify uncertainties, including surrogate based Monte-Carlo, stochastic collocation and generalized polynomial chaos (gPC) methods [1, 2, 3].
In the process of moving from low (1 to 3) towards intermediate (4 to 6) numbers of uncertain variables for realistic applications, this study aims first to compare (UQ) methods for seven analytic functions and two probability density functions. The series of methods includes tensorial Gaussian quadrature, Smolyak's sparse grids, basic projection gPC and compressed sensing gPC. In a first step, the exact means and variances are derived for the partly classical and partly new test functions for both uniform distribution and beta(2,2) distribution. The Smolyak sparse grids appear to be very efficient to calculate the mean and the variance for the functions with a strong coupled influence of the input variables. Conversely the compressed sensing collocation (gPC) appears to be an efficient strategy when the input variables have a weak joint influence. Also discussed are the impact of the regularity of the (QoI) and the choice of the underlying 1D rule in Smolyak sparse grids.
Finally, a corresponding 2D (UQ) aerodynamic test case is to be presented.

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