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Quantifying Uncertainties in high-fidelity Scale-Resolving Simulations of Wall Turbulence[1] PHILIPP SCHLATTER, SALEH REZAEIRAVESH, RICARDO VINUESA, KTH Mechanics — We investigate how the accuracy and certainty of the quantities of interest (QoIs) of canonical wall-bounded turbulent flows are sensitive to various numerical parameters and time averaging. The scale-resolving simulations are performed by Nek5000, an open-source high-order spectral-element code. Different uncertainty quantification (UQ) techniques are utilized in the study. Using non-intrusive polynomial chaos expansion, portraits of error in the QoIs are constructed in the parameter space. The uncertain parameters are taken to be the grid spacing in different directions and the filtering parameters. As a complement to the UQ forward problems, global sensitivity analyses are performed with the results being quantified in the form of Sobol indices. Employing Bayesian optimization based on Gaussian Processes, the possibility of finding optimal combinations of parameters for obtaining QoIs with a given target accuracy is studied. To estimate the uncertainty due to time averaging, the use of different techniques such as classical, batch-based and autoregressive methods is discussed and suggestions are given on how to efficiently integrate such techniques in large-scale simulations. Comparisons of the certainty aspects between high-order and low-order codes (OpenFOAM) are given.

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Philipp Schlatter
KTH Mechanics

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