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DATA-DRIVEN LES FOR THE FLOW AROUND A 5:1 RECTANGULAR CYLINDER

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The analysis and control of complex high-Reynolds-number flows of industrial and practical interest is one of the most distinctive open challenges that the scientific community has to face for fluid mechanics applications in the coming decades. Modelling bias and uncertainty limit the predictive / analytic capabilities of both numerical simulations and experimental measurements. Under this perspective, data-driven tools from Data Assimilation, and, in particular, sequential tools such as the ensemble Kalman filter (EnKF), have been recently used to obtain a precise estimation of the physical flow state accounting for bias or uncertainty in the performance of the investigative tool.

A newly developed sequential Data Assimilation algorithm, combining multi-grid aspects and the ensemble Kalman Filter, has recently been presented in [1]. The so-called MGEnKF algorithm (Multi-Grid Ensemble Kalman Filter) exploits multiple grids in order to perform a set of low-fidelity simulations of the flow in parallel to a unique high-fidelity simulation on the finest mesh. The state estimation obtained at the coarse level and the associated ensemble statistics are used to filter the finest mesh and optimise a set of parameters describing the model (boundary conditions, model parameters…). This procedure allows to i) reduce the computational costs of the EnKF and ii) ensure the conservativity and the smoothness of the final solution.

The strategy is tested and validated against the international benchmark known as BARC (Benchmark of the Aerodynamics of a Rectangular 5:1 Cylinder) [2]. This configuration is a simplified model of problems of interest in civil engineering. In spite of the simple geometry, the flow is complex being characterized by shear-layer separation from the upstream edges, unsteady reattachment on the cylinder side and vortex shedding in the wake. A Data assimilation experiment is performed where the predictive capabilities of an intermediate-fidelity LES of the flow around the cylinder are improved by integrating reference data from a high-fidelity LES using the MGEnKF algorithm. The results show a better agreement with the reference solution when the MGEnKF algorithm is used.

REFERENCES

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