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Variational Data Assimilation for Incompressible RANS Closure Models OLIVER BRENNER, PASHA PIROOZMAND, PATRICK JENNY, ETH Zurich — Flow simulations based on the Reynolds-averaged Navier-Stokes (RANS) equations have attractively low requirements for computational cost, but only provide averaged quantities and depend on turbulence modelling. Recently, data driven closure models have been proposed to overcome some weaknesses of existing methods. Our approach is based on performing variational data assimilation (DA) on the eddy viscosity using sparsely distributed velocity reference data. In particular, we enhance the result of existing turbulent viscosity models through DA. The discrete adjoint method is used for DA since its computational cost is independent of the large number of parameters. A gradient based optimizer is then applied to modify the eddy viscosity, such that the reference data is matched as close as possible. A fully coupled solver is extended to solve the adjoint equations. Some simplifications are applied when computing the adjoint gradient to reduce the computational effort. The novelty of our approach is the way of computing the adjoint gradient without a costly finite difference approach. Due to the high dimensionality of the problem, many evaluations of the forward problem can thus be avoided. We demonstrate our method by applying it to the incompressible stationary periodic hill case using the k-epsilon model and literature LES reference data. An emphasis is put on the analysis of different reference data types, reference data distributions, and regularizations.

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