Reduced Order Modeling for a LES filtering approach

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ABSTRACT: We develop a Reduced Order Model (ROM) for a Large Eddy Simulation (LES) approach that combines a three-step algorithm called Evolve-Filter-Relax (EFR) with a computationally efficient finite volume method. The main novelty of our ROM lies in the use within the EFR algorithm of a nonlinear, deconvolution-based indicator function that identifies the regions of the domain where the flow needs regularization. The ROM we propose is a hybrid projection/data-driven strategy: a classical Proper Orthogonal Decomposition Galerkin projection approach for the reconstruction of the velocity and the pressure fields and a data-driven reduction method to approximate the indicator function used by the nonlinear differential filter. This data-driven technique is based on interpolation with Radial Basis Functions. We test the performance of our ROM approach on two benchmark problems: 2D and 3D unsteady flow past a cylinder. The accuracy of the ROM is assessed against results obtained with the full order model for velocity, pressure, indicator function and time evolution of the aerodynamics coefficients.