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Low-dimensional modelling of high-Reynolds-number shear flows incorporating constraints from the Navier-Stokes equation MACIEJ BALAJEWICZ, Stanford University, EARL DOWELL, Duke University, BERND NOACK, Institut PPRIME — We generalize the POD-based Galerkin method for post-transient flow data by incorporating Navier-Stokes equation constraints. In this method, the derived Galerkin expansion minimizes the residual like POD, but with the power balance equation for the resolved turbulent kinetic energy as an additional optimization constraint. Thus, the projection of the Navier-Stokes equation on to the expansion modes yields a Galerkin system that respects the power balance on the attractor. The resulting dynamical system requires no stabilizing eddy-viscosity term–contrary to other POD models of high-Reynolds-number flows. The proposed Galerkin method is illustrated with three test cases: two-dimensional flow past a stationary cylinder, two-dimensional flow inside a square lid-driven cavity and a two-dimensional mixing layer. Generalizations for more Navier-Stokes constraints, e.g. Reynolds equations, can be achieved in straightforward variation of the presented results.

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