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Optimal Turbulence Closures in Galerkin Models BARTOSZ PROTAS, McMaster University, BERND NOACK, Institut PPRIME, CNRS — In the present study we propose a variational optimization technique to determine an optimal eddy viscosity for a Galerkin model of a fluid flow. Analogously to LES and RANS, such models require suitable closure strategies to account for the effects of unresolved dynamics and ensure stability of long-time integration. A commonly used ansatz involves a linear dissipation term with the magnitude controlled by an eddy viscosity. While the eddy viscosity is often assumed constant or a linear function of the state, there is in fact a lot of evidence that nonlinear eddy viscosities perform better. We show how an optimal form of a nonlinear eddy viscosity can be determined such that the corresponding trajectories of the Galerkin model best match available data. The eddy viscosity is assumed to depend on the fluctuating kinetic energy only, so that our optimal closure results in an autonomous dynamical system. The eddy viscosity is reconstructed in the continuous setting using a non-parametric structure identification method which does not involve any assumptions other than smoothness. The method is applied to a reduced-order model of a mixing layer and the optimal eddy viscosities found reveal nontrivial insights about the behavior of the model.

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