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Towards reduced-order SPOD-Galerkin models for turbulent flows TIANYI CHU, OLIVER T. SCHMIDT, Department of Mechanical and Aerospace Engineering, Jacobs School of Engineering, UCSD, 9500 Gilman Drive, La Jolla, CA 92093-0411, USA — We explore the use of spectral proper orthogonal decomposition (SPOD) to construct reduced-order Galerkin models of turbulent flows under a linear time-invariant approximation. The motivation behind this particular modeling approach is the theoretical correspondence between the empirical SPOD technique and operator-based resolvent analysis, which considers optimal responses to a stochastically forced linear system. For the example of a Mach 0.9 turbulent jet, a recent study found a surprising agreement between SPOD modes computed from large-eddy simulation data and mean flow-based resolvent analysis. The same data is used in this work. Since the SPOD modes are orthogonal in a space-time inner product, the time-domain Galerkin model requires an oblique projection of the data onto the non-orthogonal modal basis. The resulting reduced-order model for the expansion coefficients is advanced in time by the linearized Navier-Stokes operator, and closed-loop control techniques, such as minimal-energy feedback control, are employed to calibrate the reduced-order model. To offset the difference between the linear approximation and the true, non-linear solution, we further incorporate the forcing statistics, inferred from applying the discrete linear operator to the data, into the model.

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