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Completion of partially known second-order statistics of turbulent flows ARMIN ZARE, MIHAILO JOVANOVIC, TRYPHON GEORGIOU, University of Minnesota — Second-order statistics of turbulent flows can be obtained either experimentally or via direct numerical simulations. The statistics are relevant in understanding fundamentals of flow physics and for the development of low-complexity turbulence models. For example, such models can be used for control design in order to suppress or promote turbulence. Due to experimental or numerical limitations it is often the case that only partial flow statistics are reliably known. In other words, only certain correlations between a limited number of flow field components are available. Thus, it is of interest to complete the statistical signature of the flow field in a way that is consistent with the known dynamics. Our approach to this inverse problem relies on a model governed by stochastically forced linearized Navier-Stokes equations. In this, the statistics of forcing are unknown and sought to explain available velocity correlations. Identifying suitable stochastic forcing allows us to complete the correlation data of the velocity field. While the system dynamics impose a linear constraint on the admissible correlations, such an inverse problem admits many solutions. We use nuclear norm minimization to obtain correlation structures of low complexity. This complexity translates into dimensionality of filters that can be used to generate the identified forcing statistics. The ability of our approach to reproduce statistical features of a turbulent channel flow is demonstrated using stochastic simulations of the linearized dynamics.

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