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Low-dimensional models for coherent states in viscoelastic turbulent shear flows ANSHUMAN ROY, University of Michigan, Ann Arbor, ALEXANDER MOROZOV, WIM VAN SAARLOOS, Leiden University, RONALD LARSON, University of Michigan, Ann Arbor — We present low-dimensional models for the sustenance of turbulence in shear flows of viscoelastic liquids. We develop these models by systematically investigating the effect of incremental amounts of elasticity on the self-sustaining process maintaining turbulence in shear flows. The recently proposed (Waleffe, 1997) self-sustaining process for shear flows consists of streamwise rolls leading to redistribution of the mean shear into spanwise streaks. A Kelvin-Helmholtz instability of the spanwise streaky flow then results in the regeneration of the streamwise rolls via nonlinear interactions. With the help of our low-dimensional model, we are able to identify which part of the cycle is interrupted or enhanced by the presence of elasticity. Additionally, we explore the effect of fluid rheology on the flow kinematics, particularly the role played by the first and second normal stress differences. For Newtonian liquids, such low-dimensional models have demonstrated their utility by helping to understand the features of full numerical solutions of turbulent flows. We believe that our low dimensional model for viscoelastic turbulent flow will help interpret experiments and direct numerical simulations of turbulent drag reduction by polymers.

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