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Active and hibernating turbulence in minimal channel flow of Newtonian and polymeric fluids LI XI, MICHAEL GRAHAM, University of Wisconsin-Madison — The experimental observation of minute amount of polymers reducing turbulent drag has been long established. In this study, we isolate the turbulent self-sustaining process by conducting direct numerical simulations (DNS) in minimal flow units (MFU). These solutions obtained at various polymer parameters recover all key transitions in viscoelastic turbulent flows reported previously in experiments at much higher Re, including the onset of drag reduction, low degree of DR (LDR), high degree of DR (HDR) and maximum drag reduction (MDR). At MDR, the mean velocity profile is insensitive to changing polymer parameters. The LDR-HDR transition is characterized by a sudden increase in the minimal box size of sustaining turbulence, which may correspond to a qualitative change in the self-sustaining mechanism. Dynamics of turbulence show intermittent appearance of "hibernation" periods, which are characterized by long-lasting flow structures with low instantaneous wall shear stress and low turbulence intensity. These periods appear both in Newtonian and viscoelastic fluids; however they are observed much more frequently in HDR and MDR stages, which contribute substantially to the relatively high level of DR. Instantaneous velocity profiles during hibernation periods resemble the Virk MDR profile, including the disappearance of the log-law layer and a comparable slope with the Virk MDR asymptote.

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