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Spatial-Temporal dynamics of Newtonian and viscoelastic turbulence[1] SUNG-NING WANG, MICHAEL GRAHAM, University of Wisconsin - Madison — Introducing a trace amount of polymer into liquid turbulent flows can result in substantial reduction of friction drag. This phenomenon has been widely used in fluid transport, such as the Alaska crude oil pipeline. However, the mechanism is not well understood. We conduct direct numerical simulations of Newtonian and viscoelastic turbulence in large domains, in which the flow shows different characteristics in different regions. In some areas the drag is low and vortex motions are quiescent, while in other areas the drag is higher and the motions are more active. To identify these regions, we apply a statistical method, k-means clustering, which partitions the observations into k clusters by assigning each observation to its nearest centroid. The resulting partition maximizes the between-cluster variance. In the simulations, the observations are the instantaneous wall shear rate. Regions with different levels of drag are automatically identified by the partitioning algorithm. We find that the velocity profiles of the centroids exhibit characteristics similar to the individual coherent structures observed in minimal domain simulations. In addition, as viscoelasticity increases, polymer stretch becomes strongly correlated with wall shear stress.

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