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Connections between large-domain Newtonian turbulence and minimal-channel exact coherent states[1] ANUBHAV KUSHWAHA, MICHAEL GRAHAM, Univ of Wisconsin, Madison — Direct numerical simulations (DNS) of plane Poiseuille flow of a Newtonian fluid are performed in a large domain at transitional Reynolds numbers. In this Reynolds number regime, turbulent trajectories in minimal channels move chaotically between lower and upper branch invariant solutions known as exact coherent states (ECS). It is found that while they spend most of the time in a core region of the state space, fluctuating about the upper branch ECS, they occasionally escape the core region and pass through the vicinity of lower branch solutions. One particular set of the lower branch solutions form the lower bound of the turbulent trajectory with regard to flow properties like wall shear stress, energy dissipation rate and turbulent kinetic energy. We compare the evolution of wall shear stress in minimal channels with those in patches the size of minimal channels in a large domain and find that they are not only indistinguishable but also bounded on the lower end by the same set of lower branch ECS. This suggests that localised regions in a large box approach the travelling wave solutions in a way similar to minimal channels. We also show that low and high drag regions occur spatiotemporally when the turbulence trajectory approaches the lower and upper branch ECS, respectively.

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