Abstract Submitted
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Toward Understanding Underlying Mechanisms of Drag Reduction in Turbulent Flow Control[1] ALEX ROGGE, JAE SUNG PARK, University of Nebraska - Lincoln — The ability to control the amount of drag reduction in turbulent flow is important for industries to reduce costs and save energy. In this study, three control methods are investigated to better understand the underlying mechanisms behind drag reduction in a turbulent flow. These methods include imposing an external body force, adding long-chain polymers to a fluid, and utilizing slip surfaces. Direct numerical simulations are performed and analyzed based on the lifetime of turbulent phases represented by the active and hibernating phases of minimal channel turbulence (Xi & Graham PRL 2010). The hibernating phase is referred to as a low-drag state, while others are active phases. Depending on the drag reduction percentages of control methods, the low drag reduction (LDR) and high drag reduction (HDR) regimes are classified for detailed analysis. In terms of temporal dynamics of hibernating phases, such as its frequency and duration, for LDR, the polymer and slip methods are similar, while the body force method is different. For HDR, however, a similar mechanism is observed for all methods. To elucidate drag-reducing mechanisms of three control methods, the vortex structures at LDR and HDR are analyzed to relate it to the temporal dynamics of hibernating phases.

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