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Underlying Mechanisms of Drag Reduction in Turbulent Flows[1]

ALEX ROGGE, JAE SUNG PARK, University of Nebraska - Lincoln — Turbulent flow control is of great importance in fundamentals and applications due to the potential benefits associated with it, particularly regarding drag reduction for energy savings. In this study, we will investigate three strategies to better understand their underlying mechanisms for drag reduction in turbulent channel flows. These strategies include using a spanwise body force, adding a small concentration of long-chain polymers into the fluid, and using a superhydrophobic surface on the channel walls. Direct numerical simulations were performed to elucidate the mechanisms at play. Analysis is based on the lifetime of turbulent phases represented by the active and hibernating phases of minimal channel turbulence (Xi and Graham PRL 2010). Given similar drag reduction percentages, the polymer and slip cases show similar mechanisms, while the body force case shows a different mechanism. The polymers and slip surfaces cause hibernating phases to happen more frequently, while the phase duration remains almost constant. The body forces prolong the duration of hibernating phases, while these phases become less frequent. Lastly, these drag reduction mechanisms and their various behaviors with respect to control parameters will be further discussed and analyzed.

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