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The effects of an external body force on drag reduction in turbulent channel flow up to $Re_\tau \approx 1000$[1] HAYDEN ANG KIN HOE, JAE SUNG PARK, University of Nebraska - Lincoln — Reducing turbulent drag at high speeds is a subject of great interest due to the potential benefits, especially in aircraft. As an alternative to the passive vortex generators that tend to create some amount of cruise penalty, an innovative plasma actuator has been recently proposed. As the plasma actuator imposes a body force-type effect on a surrounding flow, we have developed and performed direct numerical simulations (DNS) of turbulent channel flow up to $Re_\tau = 1,014$ with an external body force having four control parameters. Firstly, while drag reduction appears to scale inversely with Reynolds number, an optimal combination of the control parameters at different Reynolds numbers is yet to be concluded. Secondly, we have found an intriguing observation on fluctuations of the skin friction coefficient, where the fluctuation of the controlled cases is larger than the uncontrolled cases for $Re_\tau < 550$, while still displaying drag reduction. For $Re_\tau > 550$, the trend becomes flipped. The relationship between an external body force and the fluctuation of skin friction will be further discussed and investigated. This observation could be crucial in that it may lead to a further fundamental understanding of the drag reduction process at high Reynolds numbers.

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Jae Sung Park
University of Nebraska - Lincoln

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