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Resolvent-based feedback control for turbulent friction drag reduction[1] AIKA KAWAGOE, SATOSHI NAKASHIMA, Keio University, MITUL LUHAR, University of Southern California, KOJI FUKAGATA, Keio University
— Suboptimal control (Lee et al. 1998) for turbulent friction drag reduction has been studied extensively. Nakashima et al. (accepted) extended resolvent analysis (McKeon and Sharma 2010) to suboptimal control, and for the control where the streamwise wall shear stress is used as an input (Case ST), they revealed the control effect across spectral space is mixed: there are regions of drag increase as well as reduction. This suggests that control performance may be improved if the control is applied for selective wavelengths, or if a new law is designed to suppress the spectral region leading to drag increase. In the present study, we first assess the effect of suboptimal control for selective wavelengths via DNS. The friction Reynolds number is set at 180. For Case ST, resolvent analysis predicts drag reduction at long streamwise wavelengths. DNS with control applied only for this spectral region, however, did not result in drag reduction. Then, we seek an effective control law using resolvent analysis and propose a new law. DNS results for this law are consistent with predictions from resolvent analysis, and about 10% drag reduction is attained. Further, we discuss how this law reduces the drag from a dynamical and theoretical point of view.

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