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Resolvent analysis of suboptimal control for turbulent skin friction drag reduction SATOSHI NAKASHIMA, KOJI FUKAGATA, Keio University, MITUL LUHAR, University of Southern California — We study the drag reduction mechanisms of suboptimal control (Lee et al. 1998) via the resolvent formulation developed by McKeon and Sharma (2010). Under this formulation, the nonlinear term in the Navier-Stokes equations is regarded as a forcing which acts upon the linear dynamics to output a velocity response across Fourier space. This analysis enables targeted analyses of the effects of the control on modes resembling dynamically important coherent structures such as the near-wall (NW) cycle. Suboptimal control generates blowing and suction at the wall that is proportional to the streamwise (Case ST) or spanwise (Case SP) wall shear-stress, with the magnitude of blowing and suction being a design parameter. Both Case ST and SP can suppress resolvent modes resembling the NW cycle. However, for Case ST, the analysis reveals that the control leads to substantial increase in amplification for structures that are long in the spanwise direction. High actuation of such energetic spanwise structures was confirmed by conducting limited direct numerical simulations. In addition to the study of modes resembling the NW cycle, we will discuss modes of varying propagating speed and wavelength to provide insight into the effects of suboptimal control across spectral space.

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