Drag reduction (or pumping) by streamwise traveling wave

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Abstract

We review some of the recent studies related to the streamwise traveling wave control proposed by Min et al. [1]. The primary mechanism for drag reduction by Min's control is not the "active cancellation," but an active production of nominally negative Reynolds shear stress in near-wall regions, which is directly responsible for the turbulent friction drag [2, 3]. First, we introduce some theoretical concerns on the power saved by this control [4, 5]. Then, we introduce the pumping mechanism by Min's control input in the absence of mean pressure gradient and discuss the difference between the case of blowing/suction and the case of wall deformation [6]. We also introduce a linear analysis on the phase relationship between the streamwise and wall-normal velocity component induced by control input and show that the influence layer is scaled similarly to the Stokes' second problem [7]. Finally, we briefly introduce our recent DNS studies of turbulent channel flow controlled by using wall-deformation [8] and plasma actuators [9] (instead of blowing/suction) as a discussion toward the practical implementation of Min's control.

References