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Mechanism for skin friction reduction in temporally accelerated turbulent pipe flow[1] JAE HWA LEE, RONALD J. ADRIAN, Arizona State University — Direct numerical simulations of temporally accelerating turbulent pipe flow are performed to examine the modification of the coherent structures due to acceleration and its relationship to the reduction of turbulent skin friction. Two types of simulations are performed: a) fully developed turbulent flow subjected to constant mean acceleration, and b) evolution of a single hairpin eddy subjected to the same acceleration. The initial eddies are extracted by conditional averaged flow fields associated with second-quadrant Reynolds shear stress events from DNS data of the fully developed turbulent pipe flow at the initial Reynolds number. In the case of fully turbulent initial flow, the temporal acceleration increases the Reynolds number from Re_D =5,300 to 26,500, and the response of the turbulence is found to be delayed relative to the response of the mean flow, as also reported by previous studies. The delay causes the ratio of velocity induced by the hairpin to the mean velocity to decrease below the threshold value for nonlinear formation of new hairpin vortices from the initial hairpin. The autogeneration of new hairpin vortices is suppressed, resulting in reduction of turbulent transport and, consequently, reduction of skin friction.

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