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Effects of mean and fluctuating pressure gradients on turbulence in boundary layers[1] PRANAV JOSHI, XIAOFENG LIU, JOSEPH KATZ, Johns Hopkins University — This study focuses on the effect of mean and fluctuating pressure gradients on boundary layer turbulence. The mean favorable pressure gradient (FPG) is imposed by a sink flow. The streamwise and wall-normal (x,y) components of the material acceleration (Du/Dt and Dv/Dt, respectively) are calculated from time resolved 2D PIV data, and integrated spatially to obtain the pressure distribution. The mean FPG prevents vortical structures from rising away from the wall, decreasing the Reynolds stresses in outer region. Large scale pressure fluctuation gradients involve three dimensional flow structures. In both, zero pressure gradient (ZPG) and FPG boundary layers, large scale fluctuating adverse pressure gradients (∂p'/∂x>0) are preferentially associated with sweeps, as fluid approaching the wall is decelerating. Consequently, the outward transport of small-scale turbulence is suppressed, and the near-wall enstrophy increases. Conversely, ejections, high wall-normal enstrophy flux, and viscous vorticity production occur mostly during ∂p'/∂x<0 as the fluid accelerates by moving away from the wall. The near-wall enstrophy flux peaks due to the inherent near wall 3D structures when ∂p'/∂x<0 and u'>0.

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