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Turbulence in Accelerating Boundary Layers[1] PRANAV JOSHI, XIAOFENG LIU, JOSEPH KATZ, The Johns Hopkins University — This study focuses on favorable pressure gradient (FPG) turbulent boundary layers. 2D PIV data has been obtained in a sink flow in multiple planes and locations, at two Reynolds numbers and acceleration parameters. FPG decreases the locally normalized stresses over the entire boundary layer, but increases their magnitude close to the wall (y/δ<0.1) and decreases it in outer regions. This turbulence suppression is associated with confinement of coherent structures originated in the inner part of the boundary layer to a narrow near-wall region. Several contributors have been identified: (1) Weaker normalized strength of structures and consequently weaker self-induced wall-normal transport, (2) the negative ∂V/∂y and high ∂U/∂y, which preferentially orient inclined structures parallel to the wall. In the FPG region, almost all of the small-scale turbulence is confined to low speed streaks, where ejections bring fresh turbulence away from the wall, while sweeps bring in outer layer fluid with low turbulence. Pressure calculations based on integration of material acceleration obtained from time-resolved data show that ejections are associated with negative pressure gradients, as the upward moving fluid accelerates, while the opposite holds for sweeps.

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