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Effect of pressure gradient fluctuations on boundary layer turbulence[1] PRANAV JOSHI, JOSEPH KATZ, Johns Hopkins University, XIAOFENG LIU, Baltimore Aircoil Company — The present study focuses on the effect of large-scale pressure gradient fluctuations on turbulence in both, zero pressure gradient (ZPG) and mean favorable pressure gradient (FPG) boundary layers. Time-resolved, two-dimensional PIV data in the streamwise-wall-normal plane enables us to calculate the instantaneous pressure distributions by integrating the planar projection of the material acceleration of the fluid. In both boundary layers, sweeps ($u' > 0$, $v' < 0$) mostly occur during periods of adverse pressure gradient fluctuations ($\partial p'/\partial x > 0$), while favorable pressure gradient fluctuations ($\partial p'/\partial x < 0$) accompany ejections ($u' < 0$, $v' > 0$). Conditional averaging indicates that in the ZPG boundary layer, large-scale $\partial p'/\partial x > 0$ events accompanying sweeps lead to the formation of a growing region of ejection downstream, in a phenomenon resembling adverse-pressure induced flow separation. This phenomenon is much less pronounced in the FPG boundary layer, as the large-scale $\partial p'/\partial x > 0$ events are for the most part significantly weaker than the mean FPG. Conditional sampling and instantaneous data in the ZPG boundary layer also confirm that although some of the ejections are preceded, and presumably initiated, by regions of adverse pressure gradients and sweeps, others are not. In the FPG boundary layer, there is no evidence of sweeps or adverse pressure gradients immediately upstream of ejections. The mechanisms initiating these structures presumably occur far upstream of the peak in favorable pressure gradient fluctuations.

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