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Experimental Studies of Streamwise Response of the Turbulent Boundary Layer to a Periodic Actuation MITCHELL LOZIER, FLINT O. THOMAS, STANISLAV GORDEYEV, Department of Aerospace and Mechanical Engineering, University of Notre Dame — It has been established that the dynamics of large-scale structures (LSS) in turbulent boundary layers (TBL) and near-wall small-scale turbulence are correlated. In these studies, a plasma based active flow control device was placed at sixty percent of the boundary layer thickness to introduce periodic disturbances into the wake region of the turbulent boundary layer. The boundary layer Reynolds number was low enough, Reτ =700, so no natural large-scale structure was present. Via actuation, a synthetic large-scale periodic shear-layer-like structure was introduced into the boundary layer, and the TBL response to this synthetic structure at various wall-normal and streamwise locations downstream of the actuator was studied using a single hot-wire. Due to the periodic nature of the forcing, a phase-locked triple Reynolds decomposition of velocity was used to analyze the data. The modal component of velocity corresponding to the actuation frequency and the residual turbulence levels are the parameters of interest in this study. The dynamics of the LSS and small-scale structures were quantified using several modulation coefficients that correlate changes in modal velocity and residual turbulence with respect to phase. These modulation coefficients show a strong positive correlation in the inner and log region of the boundary layer. By measuring these quantities at several streamwise locations, the evolution of the synthetic large-scale structure and its modulating effect on the near-wall turbulence can be described.

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