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A novel installation to impose unsteady pressure gradients on a turbulent boundary layer AADHY PARTHASARATHY, THERESA SAXTON-FOX, University of Illinois at Urbana-Champaign — A $0.45m$ long flexible ceiling panel located above a fully-developed flat plate turbulent boundary layer (TBL) is rapidly deformed using a mechanism with pneumatic actuators. The actuation results in a temporal deformation of the ceiling panel to the shape of a convex curve. This creates a temporally-strengthening pressure gradient (favorable and adverse in spatial sequence) on the flat plate TBL beneath. The changing curvature profiles of the ceiling panel in time are extracted from high-speed videos, and the resulting pressure gradient (PG) profiles imposed on the TBL are characterized using 5 unsteady pressure sensors flush-mounted on the flat plate. The range of unsteady time scales accessible with this installation are $0.05 - 0.3s$, corresponding to equivalent reduced frequencies, k_{eq}, of $0.15 - 0.9$. This range is relevant to the physics of dynamic stall, flow over turbomachinery, wind turbine blades, etc. The range of PG strengths accessible (in terms of acceleration parameter, K) are $3.5 \times 10^{-6} - 6 \times 10^{-6}$, which are classified as strong PGs relevant to engineering flows of interest. The effects of the resulting temporally- and spatially-varying PGs on coherent structures in the TBL will be studied using time-resolved PIV in future experiments.

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