Abstract Submitted
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Correlations of Surface Deformation and 3D Flow Field in a Compliant Wall Turbulent Channel Flow.[1] JIN WANG, CAO ZHANG, JOSEPH KATZ, Johns Hopkins Univ — This study focuses on the correlations between surface deformation and flow features, including velocity, vorticity and pressure, in a turbulent channel flow over a flat, compliant Polydimethylsiloxane (PDMS) wall. The channel centerline velocity is 2.5 m/s, and the friction Reynolds number is $2.3x10^3$. Analysis is based on simultaneous measurements of the time resolved 3D velocity and surface deformation using tomographic PIV and Mach-Zehnder Interferometry. The volumetric pressure distribution is calculated plane by plane by spatially integrating the material acceleration using virtual boundary, omni-directional method. Conditional sampling based on local high/low pressure and deformation events reveals the primary flow structures causing the deformation. High pressure peaks appear at the interface between sweep and ejection, whereas the negative deformations peaks (dent) appear upstream, under the sweeps. The persistent phase lag between flow and deformations are presumably caused by internal damping within the PDMS. Some of the low pressure peaks and strong ejections are located under the head of hairpin vortices, and accordingly, are associated with positive deformation (bump). Others bumps and dents are correlated with some spanwise offset large inclined quasi-streamwise vortices that are not necessarily associated with hairpins.

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