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Space-Time Correlation of Large-Scale Structures in a Turbulent Boundary Layer

NICOLAS BUCHMANN, CALLUM ATKINSON, MATTHIAS KUEHN, JULIO SORIA, Department of Mechanical and Aerospace Engineering, Monash University, Victoria 3800, Australia — Taylor’s hypothesis is often used to project temporal data into the spatial domain and has been used in the past to show the presence of large-scale structures (> 10δ) in the log and lower wake region of the turbulent boundary layer (TBL). To investigate the spatial and temporal evolution of such large-scale structures, the present study employs time-resolved Particle Image Velocimetry (PIV) in several streamwise-spanwise planes in the log-layer of a TBL (Reθ = 2,000). In order to capture the full extent of these structures, four high-speed, high-resolution PIV systems are combined to span a region of approximately 3δ × 12δ and a continuous time sequences of ≈ 50δ/U. Such data sets are currently unavailable from previous experimental investigations and reveal the existence of long and very long (> 8δ) low- and high-speed structures. Two-point space-time correlations are employed to examine the temporal extent and meandering nature of these structures with respect to their size and spacing in the log-layer. Furthermore, the validity of Taylor’s hypothesis is tested for such long projection distances.

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