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Signature of large-scale motions on turbulent/non-turbulent interface in boundary layers.
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Summary: The effect of large-scale motions (LSMs) on the turbulent/non-turbulent (T/NT) interface is examined in a turbulent boundary layer. Using flow fields from direct numerical simulation, the shape of the interface and near-interface statistics are evaluated conditional on the position of the LSM. The T/NT interface is identified using the vorticity magnitude and a streak detection algorithm is adopted to identify and track the LSMs. Two-point correlation and spectral analysis of variations in the interface height show that the spatial undulation of the interface is longer in streamwise wavelength than the boundary-layer thickness, and grows with the Reynolds number in a similar manner to the LSMs. The average variation in the interface height was evaluated conditional on the position of the LSMs. The result provides statistical evidence that the interface is locally modulated by the LSMs in both the streamwise and spanwise directions. The modulation is different when the coherent structure is high- versus low-speed motion: high-speed structures lead to a wedge-shaped deformation of the T/NT interface, which causes an anti-correlation between the angles of the interface and the internal shear layer. On the other hand, low-speed structures are correlated with crests in the interface. Finally, the sudden changes in turbulence statistics across the interface are in line with the changes in the population of low-speed structures, which consist of slower mean streamwise velocity and stronger turbulence than the high-speed counterparts.

MSC:

76F40 Turbulent boundary layers

Keywords:

intermittency; turbulence simulation; turbulent boundary layers

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