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Velocity-vorticity correlation structures (VVCS) in spatially developing compressible turbulent boundary layer[1] SHI-YAO LI, ZHEN-SU SHE, JUN CHEN, State Key Lab. for Turb. Complex Sys., College Engg., Peking Univ., Beijing 100871, China — A velocity-vorticity correlation structure (VVCS) analysis is applied to the direct numerical simulation (DNS) of compressible turbulent boundary layer (CTBL) at Mach numbers, $Ma = 2.25$, 4.50 and 6.0. It is shown that the VVCS analysis captures the geometry variation in the streamwise direction during the transition and in the wall-normal direction in the fully developed regime. Specifically, before transition, the VVCS captures the instability wave number, while in the transition region it displays a distinct scaling change of the dimensions. The fully developed turbulence regime is characterized by a nearly constant spatial extension of the VVCS. Particularly, after turbulence is well developed, a multi-layer structure in the wall normal direction is observed in the maximum correlation coefficient and in the length scales of the VVCS, as expected from a recent symmetry-based theory, the ensemble structure dynamics (SED). The most interesting outcome is an observed linear dependence of the length scale of the VVCS from $y^+ \approx 50$ to 200, which is a direct support to Townsends attached-eddy theory. In conclusion, the VVCS analysis quantifies the geometrical characteristics of the coherent structures in turbulent compressible shear flows throughout the whole domain.

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