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Influence of large-scale low- and high-speed structures on the near-wall vortical motions in turbulent boundary layer[1] JINYUL HWANG, HYUNG JIN SUNG, KAIST — Direct numerical simulation data of turbulent boundary layer ($Re_\tau = 1000$) are used to investigate the large-scale influences on the vortical structures in the near-wall region. The streamwise swirling strength (λ_x) depends on the strength of large-scale streamwise velocity fluctuations (u_l). The amplitude of λ_x decreases under the negative u_l rather than the positive u_l, analogous to the amplitude modulation of the velocity fluctuations. The dependence of λ_x on u_l is due to the opposite spanwise motions in the footprints of low- and high-speed structures, which are congregative and dispersive, respectively. Conditionally averaged fields conditioned on λ_x under the negative- and positive-u_l events show that the swirling motions lie within the congregative and dispersive motions. The dispersive motion is more intense than the congregative motion because the sweep of high-momentum fluid under $u_l > 0$ splats on the wall while the spanwise motions under $u_l < 0$ decrease as the flows come close to each other. Due to the strong dispersive motion, the small-scale spanwise velocity fluctuations (w_s) are strengthened, whereas w_s are relatively weak (attenuated) under $u_l < 0$. As a result, the wall-normal components are also enhanced under $u_l > 0$, which contributes to the amplification of λ_x.

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Jinyul Hwang
KAIST

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