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Role of wall-attached structures in frictional drag reduction by streamwise[1] MIN YOON, HYUNG JIN SUNG, KAIST — The role of wall-attached structures in the frictional drag reduction by the Navier slip is explored. The wall-attached structures are extracted from the clusters of streamwise velocity fluctuations in a turbulent channel flow ($Re_\tau = 470$). The skin friction coefficient (C_f) is decreased by 35%. A dataset of the no-slip condition ($Re_\tau = 577$) is also included for comparison. The wall-attached structures extend toward the upstream in the vicinity of the wall by the slip. The convection velocity of the wall-attached structures increases near the wall, leading to the wide influence on the inner region via roll-cell motions. The vortical structures circumscribing the wall-attached structures are attenuated, since the mean shear of the structures is decreased by the slip. The contribution of the wall-attached structures to C_f is quantified through the skin friction decomposition, which can be derived from the mean vorticity equations. The advective vorticity transport and vortex stretching terms around the wall-attached structures are found to dominate the contributions to the frictional drag. The wall-attached structures are responsible for 53.2% of the total reduction of C_f.

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