Effects of parameterized boundary layer structure on vortex and shear interaction and spin-up dynamics in HWRF forecasts of Hurricane Earl (2010)

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This study evaluates the role of boundary-layer structure in regulating hurricane intensity change. Boundary-layer structure is modified using two different setups of boundary-layer vertical eddy diffusivity (K_m) in numerical simulations of Hurricane Earl (2010) using the Hurricane Weather Research and Forecast (HWRF) Model. As a follow-up of our previous work on evaluating the impact of K_m on axisymmetric structure at the onset of hurricane rapid intensification (RI), the present study evaluates the asymmetric vortex-scale and convective-scale structure. In addition, an angular momentum budget is conducted to evaluate how Km affects hurricane spin-up dynamics. It is found that the vortex and shear interaction in terms of vortex tilt is affected by Km in that the vortex tends to align more quickly with smaller K_m than with larger K_m. The axisymmetric and asymmetric distributions of deep convection are also affected by the change in the boundary layer structure. In the Earl forecast with small Km, most of the strongest convection is located inside the radius of the maximum wind (RMW), while this convection is mainly located outside the RMW in the forecast with large K_m. The horizontal distribution of the convection is more symmetric in the eyewall region in the low Km forecast than the high K_m forecast. The angular momentum budget analysis indicates that the convergence of angular momentum in the boundary layer is the key for spin-up of the hurricane vortex which is modulated by K_m. This study emphasizes the importance of multiscale interaction process on hurricane intensification, which should be considered during physics upgrade in hurricane models.