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Process-level differences between two PBL schemes used in NOAA's GFS model

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The behavior of two eddy-diffusivity mass-flux (EDMF) planetary boundary layer (PBL) schemes used in NOAA's Global Forecast System is examined at the level of mixing processes. The examination is performed by comparing the two schemes in 1-D simulations of convective PBL growth using the same physics configuration and two sets of initial atmospheric states extracted from three-dimensional (3-D) GFS initial conditions. All simulations show that the TKE-EDMF scheme mixes more and leads to less CIN and CAPE than the Hybrid-EDMF scheme. The excessive mixing of the TKE-EDMF scheme is consistent with that seen in the 3-D GFS forecasts compared with radiosonde data. Diagnosis using process perturbation sensitivity experiments indicates that the mass-flux term is more dominant in the TKE-EDMF than in the Hybrid-EDMF scheme. Quantitative aspects of the local eddy diffusivity are also different between the two schemes, pointing to uncertainty in the physical partition of local and non-local mixing in the EDMF formulation of the two schemes. Additional sensitivity experiments show essential parameters that can be optimized according to observations and/or large-eddy-simulation results that provide a more realistic partition of local and non-local mixing.