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Revisiting the scaling for the afternoon/evening transition of the convective boundary layer

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This study investigates the scaling for the decaying idealized free convective turbulence in the atmospheric boundary layer during the afternoon and evening transitions, using Large Eddy Simulations. Assuming the existence of a power law scaling regime, previous numerical and field experiments reported decay exponents in the range [-8, -6] for turbulent kinetic energy averaged over the boundary layer height. This rapid collapse is remarkable, much larger than anything reported in homogeneous isotropic turbulence studies, where the domain integrated turbulent kinetic energy decay exponents are within the interval [-2.5, -1]. We introduce a new scaling frame for decaying convective atmospheric turbulence, where the time-origin is chosen at the beginning of the evening transition, rather than the afternoon transition; the energy and time units are the convective velocity and time scales, defined at the beginning of the afternoon transition. We found scaling laws more consistent with homogeneous isotropic turbulence scaling: decaying convective atmospheric turbulence decays much slower than what was found in previous studies. Even though rigorous analytical/experimental support for the new scaling frame does not exist, we put forward arguments for its relevance. In addition, the new scaling frame leads to drastically different interpretations for turbulent kinetic energy decay rate dependencies on various bulk parameters of the atmospheric boundary layer. For instance, the dependence range of the turbulent kinetic energy decay rates on the duration of the afternoon transition is reduced. It also seems that the influence of the entrainment process on the decay rates of the turbulent kinetic energy is time dependent during the afternoon/evening transitions.