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Relating microphysical and statistical parameters of rainfall for real-time downscaling

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Precipitation downscaling from satellite observations or from coarse-resolution numerical models remains a subject of continuous research as it is known that the small-scale rainfall variability is important for the accurate prediction of other fluxes, such as evapotranspiration and runoff. In statistical downscaling schemes, a remaining challenge is that of relating the statistical parameters of the downscaling scheme to physical observables which can be used as predictors in real-time downscaling applications. Previous studies, based on limited observations, have suggested that the statistical scaling structure of rainfall can be parameterized in terms of thermodynamical descriptors of the storm environment and such dependence has been successfully implemented in downscaling applications. Based on the recent results of Parodi and Emanuel (2009), we suggest that it is possible to adopt the raindrop terminal velocity as a physical parameter which explains the statistical variability of convective rainfall over a range of scales. We examine this assertion by analysis of high resolution simulations of an atmosphere in radiative convective equilibrium performed using the Weather Research and Forecasting (WRF) model and prescribing different rain terminal velocity settings corresponding to small/slowly falling drops and large/fast falling drops respectively. The analysis has focused on the study of the dependence of some basic statistics of rainfall fields (probability distribution of convective rain cell areas, power spectra and multifractal statistics) on the raindrop terminal velocity.