On the relationships between the vertical distribution of precipitation in deep convection and the large-scale environment

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Attenuation, multiple scattering (MS), non-uniform beam filling (NUBF) and Particle Size Distribution (PSD) variability are major sources of uncertainty in the estimation of precipitation from spaceborne radar observations. For observations associated with deep strong convection, the attenuation correction process might become unstable and result in precipitation rate estimates that significantly increase with range. While random artifacts are acceptable, the errors in GPM Combined and DPR precipitation estimates associated with deep strong convection appear to be systematic as, from microphysical and dynamic perspectives, systematic increases in precipitation rates with range are not obviously natural. To investigate whether the estimated precipitation rate with range trend in deep strong convection is real, a synthetic observation experiment is conducted. Specifically, idealized mesoscale convective systems are simulated using the CM1 model and GPM radar observations are computed from the model output. A standard Hitschfeld-Bordan attenuation procedure is used to correct for attenuation and derive precipitation estimates, and the impact of MS, NUBF and PSD variability on the mean error is analyzed. To investigate the impact of large-scale environment on the errors and the vertical distribution of precipitations, multiple environments are considered. The model is initialized using thermal perturbations and an environment conducive to deep convection and restarted with various environments one hour after convection initiation. This procedure minimizes differences between simulations related to difficulties related to the model initialization. The investigation suggests that current range trends in the GPM deep convective precipitation estimates are artificial and facilitates the development of better parameterizations.