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Evidence of some impacts from the electric field on thunderstorm microphysical development simulated with an Explicit Microphysics Model

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The effect on the anvil glaciation from the modification of collection efficiencies by a hypothesized electric field in a thunderstorm observed near Florida during the Cirrus Regional Study of Tropical Anvils and Cirrus Layers - Florida Area Cirrus Experiment (CRYSTAL-FACE) is assessed with an advanced version of the Explicit Microphysics Model (EMM).

An intensification of the warm rain process and a 30-40% reduction in the anvil ice concentration occur when an evolving height-dependent electric field, typical of electrified thunderstorms, is prescribed when evaluating the collection efficiencies for coagulation processes. The electric dependence of the collision efficiency for drop-drop collisions is the cause. There is a 150% increase in the broad peak of average mixing ratio of rain near the freezing level. This boosts the mixing ratio of precipitation-sized ice in the lower half of the mixed phase region, changing the number of charging collisions and depleting the supercooled cloudwater. Primarily because of the high sensitivity of the Hallett-Mossop (H-M) process of ice particle multiplication, the total charge separated is reduced by about an order of magnitude when these electric fields are applied to the coagulation processes. This suggests a net negative feedback may exist between the electrification, warm rain process and H-M process in real continental storms that are similar to this particular model cloud. Overall, this electric sensitivity of the warm rain process is comparable to its sensitivity with respect to inclusion of turbulent enhancement.

Furthermore, the total charge separated is reduced by an order of magnitude, when the

updraft speed is reduced by 40%, at each electric field strength assumed for coagulation. This is because graupel particles are smaller and H-M splinters are fewer. Some implications for the land-ocean contrast in lightning occurrence are discussed.