Plain Language Summary: The inverted charge structure of a mesoscale convective system is simulated using the Weather Research and Forecasting (WRF) model coupled with electrification and discharge processes. The evolution of a normal–inverted–normal charge structure in the convective region can be reproduced only by the rime accretion rate (RAR)-based electrification scheme. The results reveal that the inverted charge structure is caused by the strong updraft, high LWC and high RAR, which appear above the height of the $-20^\circ$C layer.

Figure 1. Vertical cross-sections of total charge density (nC m$^{-3}$; shaded) in different time with the RAR-based scheme. The horizontal lines represent the isotherm lines of $-20$, $-10$ (dashed lines), and $0^\circ$C (solid line). The solid line labeled “5” represents the contour line of 5 dBZ.

- The evolution process of a normal–inverted–normal charge structure in the convective region of a mesoscale convective system is successfully simulated by an electrification and discharge model.
- A positive graupel charging region is generated above $-20^\circ$C layer due to the strong updraft ($>16$ m s$^{-1}$), high LWC ($>2$ g m$^{-3}$) and high RAR ($>4.5$ g m$^{-2}$ s$^{-1}$), resulting in the inverted tripole charge structure.
- In the high plains of the United States, the microphysical-derived mechanism is responsible for inverted charge structure, while the dynamical-derived inverted charge structure is more likely in North China.