EGU24-10352, updated on 09 Feb 2025
https://doi.org/10.5194/egusphere-egu24-10352
EGU General Assembly 2024

Cloud Microphysical Characteristics Associated with Blue Corona Discharges at thundercloud tops

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Blue corona discharges are bursts of streamer discharges often observed at the top of thunderclouds, but the conditions in the clouds that generate them are not well understood.

The cloud microphysical parameters related to them are important for future empirical studies and for theoretical models and simulations. Previous studies modeled the scattering and absorption emissions from blue corona discharges by assuming mean particle radius of 10–20 μm and densities of 1–2.5 × 10^8 m^{-3}, resulting in photon mean free paths of 1–20 m.

Here we present the first-ever estimate of important microphysical parameters related to blue corona discharges based on data measurements from the CALIPSO lidar. The results showed that most blue corona discharges were associated with ice particles with a radius of □50 μm and a number density of □ 2 × 10^7 m^{-3}, resulting in a photon mean free path of □3 m.

Around 20% of the blue corona discharges coincide with Narrow Bipolar Events (NBEs) indentified from the Earth Networks Total Lightning Network.The altitudes of blue corona discharges that were identified as NBEs are derived from both the optical and radio bands. It revealed that in six out of nine cases, the R^2 value was greater than 0.85, indicating a good agreement between the two methods and supporting our estimate of the photon mean free path as 3 m. However, in the shallowest and deepest cases, there was some discrepancy between the altitudes determined by the two methods, suggesting more complex cloud microphysical parameters. Possible reasons for the discrepancy, such as the homogeneous approximation for the cloud's microphysical parameters and the simplification of the source length, will be discussed.