A Comparison of Layered Lightning and Ice Processes in Stratiform Precipitation

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Overview

- Stratiform ice can be formed through two growth mechanisms: deposition and aggregation
- Stratiform lightning tends to layer horizontally
- Charged regions are often formed by ice particles colliding and separating, causing a slight separation of charge that builds over time
- This project studied inferring hydrometeor types based on three dual-polarization radar variables: horizontal reflectivity ($Z_H$), differential reflectivity ($Z_{DR}$), and correlation coefficient (CC)
- This project also studied how the placement of lightning layers compared to the hydrometeor types present at the time of the flash

Key Findings

- Based on $Z_H$, $Z_{DR}$, and CC (Fig. 3), the dominant hydrometeors were
  - Ice crystals above 8km
  - Aggregates between 4-8km
  - A mixture of rain and melting (wet) aggregates between 2.5-4km
- Where ice crystals/aggregates were dominant, deposition (aggregation) seemed to be the dominant growth mechanism
- In 2 cases, a region of increased $Z_{DR}$ and decreased CC is seen around -15°C, likely associated with enhanced deposition (Fig. 3)
- In case 1, there was a lightning layer at 4km. In case 2 (Fig. 4), there were two layers: one at 4km and one centered at 7km. In case 3, there were three layers: one at 2.5km, one at 6km, and one at 10.5km

Methodology

- 3 Mesoscale Convective Systems (MCS) were chosen based on their proximity to the KHTX radar in Hytop, AL
- 3 flashes were chosen from within the stratiform region of the MCS’s based on their proximity to the Lightning Mapping Array (LMA) sensors
- Dual-Polarization radar data were manually and visually analyzed from 2.5km to the top of the storm using GR2Analyst to build vertical profiles for $Z_H$, $Z_{DR}$ and CC
- Vertical profiles were used to infer hydrometeor types and were compared to LMA data using XLMA and temperature profiles from soundings

Conclusions

- There were lightning layers in all three cases either where aggregation was the dominant growth mechanism or in the melting layer
- All of the regions contain mixed hydrometeor types that could be conducive to charge build up via ice particle collisions or other mechanisms
- Future work could study the polarity of the charge layers and where they commonly are within the cloud

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