AE22A-08 Multi-scale 3D simulation of lightning and thunderstorm electrodynamics

Back to: Nikolai Lehtinen

Tuesday, 16 December 2014 12:05 PM - 12:20 PM
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Despite centuries studying thunderstorm electrodynamics, our understanding of these phenomena remains limited. The difficulty lies partly in the large number of processes and their mutual dependency and the wide range of temporal and the spatial scales involved. In this study we combine two numerical models to move toward a simulation that addresses these broad scales. First, we use a 3D numerical model to calculate the large scale quasi-electrostatic (QES) fields and charge distributions built up by updrafts in the thundercloud. This model self-consistently accounts for the conductivities, particle densities, large scale currents and charging mechanisms inside a thundercloud in the atmosphere. Second, we use a time-domain fractal lightning (TDFL) model developed that takes into account both the thermodynamics and electrodynamics of leader development and the return stroke on small time and spatial scales (Liang et al. 2014). The QES model simulates slow thunderstorm charging dynamics, and then passes the state to the TDFL model when a flash is ready to trigger. Using this combined simulation, we explain some recently observed patterns of lightning inside a thunderstorm and within a flash (e.g. Zoghzoghy et al. 2013, 2014). We attempt to constrain properties of the thundercloud like the size and shape of the charge pockets removed from the thundercloud, the flash rate and updraft currents, the relative occurrence rate of different types of lightning, and the cloud charge distribution structure effects on the lightning type.

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