Atmos. Chem. Phys. Discuss., 15, C10939–C10941, 2015
www.atmos-chem-phys-discuss.net/15/C10939/2015/

Atmospheric Chemistry and Physics Discussions

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ACPD

15, C10939–C10941, 2015

Interactive comment on "Anvil microphysical signatures associated with lightning-produced NO_x" *by* J. L. Stith et al.

Anonymous Referee #2

Received and published: 29 December 2015

This is a clear, well-written paper that outlines an interesting relationship between anvil ice microphysics and lightning-NOx in thunderstorm anvils observed during the Deep Convective Clouds and Chemistry (DC3) experiment. Several case studies relating ground based radar and lightning observations to DC3 aircraft cloud particle images and trace gas observations are shown to support the argument that enhanced storm electrification is related to the production of frozen drop aggregates in the storms analyzed. In addition, one case contrasting characteristics observed in two storms with varying lightning activity was used to further elucidate the relationship between microphysics and electrification. However, there are some important shortcomings of this study that should be addressed for this manuscript to be considered for publication, which are outlined below.

As outlined in the abstract, the primary conclusion presented in this study is “The abundance of frozen drop (chain) aggregates vs. individual frozen droplets in the central anvil region of the strong thunderstorms that were studied appears to be related to the degree of electrification (marked by increased lightning flash rates).” While the 6 June and 15 June case studies presented best demonstrate this potential relationship, the 25 May storm comparison presented casts significant doubt on this relationship. In particular, the weaker storm (that with lower lightning activity) shows the highest concentrations of particles identified as frozen drop aggregates of any storm observed during DC3, which the authors readily admit. An alternative argument would be that the microphysical characteristics observed (specifically the production of frozen drop aggregates) are more directly related to storm dynamics. This is evidenced by the distribution of individual frozen drops and frozen drop aggregates in the the anvil and the concentration of individual drops in the weaker and stronger cells. The intensity of the updrafts (and thus the microphysical composition of the storm) would likely be related to the lightning frequency, so it is not surprising that some semblance of a relationship would be found.

Some additional analysis and/or literature review could better elucidate the roles of electrification and dynamics on the microphysical composition of these storms. I am not an expert on the formation of chain-like aggregates, but perhaps there is sufficient laboratory evidence for linkages between their rate of formation and the degree of electrification. The analysis could be improved if some additional details on storm evolution and strengthening between in situ observations and remotely sensed observations (i.e., radar, lightning) were presented. For example, many DC3 cases included samples in the anvil regions of a single storm at increasing range, which could reveal more information on the history of an individual storm and allow for more comprehensive ties between storm dynamics, lightning activity, and microphysical characteristics. In addition, cases where dual-Doppler velocities are available (such as 6 June) can be made stronger by improved linkages between the in situ and remotely sensed observations, which are somewhat vague in the current version of the mansucript. In particular, use of a trajectory model and the dual-Doppler wind fields would better tie the historical convective core to the in situ observations.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 31705, 2015.