Quantification of Chain Aggregate Morphology in Recent Field Campaigns

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Ice crystal chain aggregates have been observed in both summertime convective clouds and wintertime storms; however, the environmental conditions for their formation differ markedly. During the 2019 Cape Experiment (CapeEx19) near Cape Canaveral, Florida, chain aggregates were observed in mid- to upper-level cirrus anvils associated with deep summertime convection. In contrast, the Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms (IMPACTS) field campaign sampled chain aggregates within wintertime nor'easters and extra-tropical storms, which exhibited weaker convection and limited electrical activity. While laboratory studies suggest that strong electric fields (> 60 kV m^{-1}) favor chain aggregation, the wintertime IMPACTS observations imply that significant electric fields may not be necessary.

This research quantitatively compares the morphological properties of chain aggregates observed in two campaigns using images collected by the Cloud Particle Imaging (CPI) probe during IMPACTS, and the Particle Habit Imaging and Polar Scattering (PHIPS) probe during CapeEx19. The probability distributions of key morphological parameters (e.g., maximum dimension, circularity, complexity, curl, compactness) are computed. A comparison between the distributions enables a qualification of the similarities of the observed chain aggregates from the two field projects. This comparative approach allows us to assess whether differences in cloud dynamics and the inferred electric field strengths between summertime Florida convection and wintertime mid-latitude storms are reflected in aggregate morphology. The results provide insight into the relative importance of electric fields for chain aggregation, and may reveal additional microphysical mechanisms contributing to aggregate formation. Ultimately, such an understanding of chain aggregation is valuable for the proper simulation of cloud radiative and precipitative processes.