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Giant Raindrops in Mid-latitude Cumuli

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The Convective Precipitation Experiment (COPE) took place during the summer months of 2013 in SW England. Among the objectives of COPE was to better understand the interplay between warm rain and ice processes, particularly secondary ice production, and their relative importance in producing heavy convective rainfall. Implicit in this objective is to be able to describe the production of warm rain prior to the initiation of ice. For this reason, aircraft observations were focused on obtaining measurements near tops of clouds as they penetrated through levels from 0 to -12 deg C.

On several days, observations from optical array probes onboard the University of Wyoming King Air research aircraft reveal ∼3 mm drops in the core of updrafts at temperatures colder than -7 deg C. On one day, observations of drops 8 mm in diameter, equal to the largest ever reported, were found in similar regions. These observations are unique for a number of reasons. All previous observations of such large drops were obtained in tropical conditions near or below cloud base. The observations in COPE were several km above cloud base, in the middle and upper portions of cloud. The largest drops in COPE were located within the high vertical velocity core (15 m s-1) in regions of liquid water content greater than 2 g m-3, and were collocated with polarimetric ground-based radar measurements.

In this study we investigate the conditions that led to the development of very large raindrops in the updraft cores compared to the much more common observations of moderate sized raindrops (3 mm) in the same general cloud regions and conditions. Further, we investigate the development of elevated high reflectivity cores and high-ZDR 'columns' from the ground-based radar in context with the in situ observations and calculations from a 1D warm rain model. Finally, we consider that the conditions that lead to the production of giant drops may necessarily result from warm processes only.