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Characteristics of Moderately Deep Tropical Convection Observed by Dual-Polarimetric Radar

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Moderately deep cumulonimbus clouds (often erroneously called congestus) over the tropical warm pool play an important role in large-scale dynamics by moistening the free troposphere, thus allowing for the upscale growth of convection into mesoscale convective systems. Direct observational analysis of such convection has been limited despite a wealth of radar data collected during several field experiments in the tropics. In this study, the structure of isolated cumulonimbus clouds, particularly those in the moderately deep mode with heights of up to ∼8 km, as observed by RHI scans obtained with the S-PolKa radar during DYNAMO is explored. Such elements are first identified following the algorithm of Powell et al (2016); small contiguous regions of echo are considered isolated convection. Within isolated echo objects, echoes are further subdivided into core echoes, which feature vertical profiles reflectivity and differential reflectivity that is similar to convection embedded in larger cloud complexes, and fringe echoes, which contain vertical profiles of differential reflectivity that are more similar to stratiform regions.

Between the surface and 4 km, reflectivities of 30–40 (10–20) dBZ are most commonly observed in isolated convective core (fringe) echoes. Convective cores in echo objects too wide to be considered isolated have a ZDR profile that peaks near the surface (with values of 0.5–1 dB common), and decays linearly to about 0.3 dB at and above an altitude of 6 km. Stratiform echoes have a minimum ZDR below of ∼0–0.5 dB below the bright band and a constant distribution centered on 0.5 dB above the bright band. The isolated convective core and fringe respectively possess composite vertical profiles of ZDR that resemble convective and stratiform echoes. The mode of the distribution of aspect ratios of isolated convection is approximately 2.3, but the long axis of isolated echo objects demonstrates no preferred orientation.

An early attempt at illustrating composite radial velocity profiles within isolated convection is made. When the mean flow (determined from sounding data) is subtracted, a clear picture of radial velocities inside a composite representation of convection is obtained. As expected, Doppler radar data shows convergence in the lowest 1–2 km of isolated convective elements and divergence in the upper portions of the clouds. The composite velocity profiles can be used to compute crude profiles of horizontal divergence. Because the analysis uses data along radar rays (with gate size of 150 m) instead of data interpolated to a Cartesian grid, features in composited clouds can be observed at high vertical and horizontal resolution.