Evolution of the Population of Precipitating Convective Systems over the Equatorial Indian Ocean in Active Phases of the Madden-Julian Oscillation

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Three-dimensional radar reflectivity fields from a dual-wavelength Doppler polarimetric radar (S-PolKa) deployed in the equatorial Indian Ocean during the Dynamics of the Madden-Julian Oscillation (DYNAMO) field project and the Atmospheric Radiation Measurement (ARM) Program's MJO Investigation Experiment (AMIE) are used to evaluate the composition of the population of convective cloud elements during active phases of the MJO. The rainfall in active periods was highly intermittent, occurring in eleven episodes of ~2-4 days duration, separated by several days of non-rainy conditions. Data for these two-day periods were composited relative to the time of maximum rainfall during the episode. Composited ECMWF ERA-interim reanalysis data and three-hourly atmospheric soundings indicate that the 2-to-4 day episodes were related to the passage of equatorial waves. Analysis of the S- PolKa data shows the makeup of the convective population during the rainfall episodes associated with the passage of waves. Four types of echo structures were analyzed statistically for the 11 rainfall episodes: shallow convective echoes (SHC), deep convective cores (DCC), wide convective echo cores (WCC), and broad stratiform (BSR) echo regions. SHC and DCC events were most frequent before the maximum rainfall, with the peak frequency of SHC leading that of DCC's. WCC 's were most frequent during the rainfall maximum, and BSR regions were most frequent in the later part of the rainfall episode. In the early part of a rainfall episode, the wave-passage conditions were unstable favoring deep penetrating convective elements, while in the later period the wave divergence profile was commensurate with convective systems in late anvil-producing stages. These results support the stretched building-block notion of tropical convection and confirm satellite-based interpretations of SHC, DCC, WCC, and BSR statistics of the composition of the convective population in terms of these types of radar echo structures.