The Kinematic and Microphysical Structure of Two-Day Rain Events during the Active Stage of the Madden-Julian Oscillation

Eleven rain events have been identified in the 24-hour running mean timeseries of total rain accumulation observed by the S-PolKa S-band radar on Addu Atoll from 1 October 2011 – 15 January 2012. Previous studies have shown that each of these rain events occur during the active stage of the Madden-Julian Oscillation. Additionally, it has been demonstrated that the mesoscale cloud population of each rain event consists of a two-day cycle that is initially dominated by deep convective cores, then wide convective cores, and finally by extremely large stratiform regions. The present study extends upon this mesoscale analysis by examining the kinematic and microphysical structure of each of the eleven events and comparing them to existing conceptual models for the convective and stratiform regions of mesoscale systems developed from GATE, TOGA-COARE, and MISMO. The kinematic structure of the larger MCSs have overturning layers similar to these earlier models as well as to analytical and numerical models of such systems (e.g. that of Moncrieff 1992). Doppler data show layers of lower-tropospheric momentum rising in the form of jump or overturning mesoscale updrafts. A mid-level inflow layer centered at approximately 5 km occurs within mesoscale stratiform regions. The mid-level inflow layers often start under the anvil and may exceed 10 m s^{-1} in magnitude, descend to the surface within the precipitating region, and exhibit a rear overturning current. Additionally, convective cells propagating into preexisting stratiform regions often experience a brief increase in intensity, which is consistent with observations from MISMO (Yamada et al., 2010). Polarimetric data is used to add the microphysical structure to the conceptual models of tropical oceanic mesoscale systems. The sloping layers of lower-tropospheric momentum rising in updrafts often are characterized by moderate reflectivity (dBZ) and slightly positive differential reflectivity (ZDR) above the freezing layer, which suggests that these regions contain dry ice aggregates. The most intense convective updrafts often also have slightly positive differential reflectivity (ZDR), but high reflectivity (dBZ) in their cores suggests that graupel is present.