Convective Cold Pool Structure and Boundary Layer Recovery Time in DYNAMO

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One of the key factors controlling convective cloud systems in the Madden6Julian Oscillation (MJO) over the tropical Indian Ocean is the atmospheric boundary layer. Convective downdraft and precipitation from the cloud systems produce cold pools in the boundary layer and at the ocean surface, which can be inhibitive for subsequent development of convection. The boundary layer recovery time may affect the variability of the convection on various time scales during the initiation of MJO. This study examines the convective cold pool structure and boundary layer recovery using the NOAA WP63D aircraft observations, which include the flight-level, Doppler radar, and GPS dropsonde and ABXT data, collected during the Dynamics of MJO (DYNAMO) field campaign from November-December2011. In this study, the depth and strength of convective cold pools are defined by the negative buoyancy, which can be computed from the dropsonde data. Flight level and radar reflectivity data are analysed to identify the areas of convection where cold pools would likely be found. Based on the proximity to convection and colder surface temperature, a cold pool dropsonde is chosen; each cold pool dropsonde is paired with a nearby ABXT that provide the sea surface temperature (SST). An environmental dropsonde outside the convective area is used to compare with the cold pool sondes. Buoyancy, cold pool intensity, sensible and latent heat fluxes and the recovery time are calculated for each pair of cold pool and environmental sondes. Given that the water vapor and surface winds are distinct for the convectively active and suppressed phases of MJO over the Indian Ocean, the aircraft data are stratified by the two different large-scale regimes of MJO. The results show that the cold pool depth and strength are strongly affected by the environmental water vapor due to entrainment by convection. Mid-level dry air observed during the convectively suppressed phase of MJO seems to enhance convective downdraft by increasing evaporation and, therefore, the strength of the downdraft and cold pools. Recovery of the cold pools in the boundary layer is determined by not only the strength and depth of the cold pools but also the air-sea heat and moisture fluxes that are a function of surface wind speed. During the active phase, cold pools are generally shallower and weaker, with some exceptions; the environment is relatively moist and the recovery times are less than 466 hrs for the cases where surface wind speeds are greater than 263 m/s. During the suppressed phase, the mid-level dry air enhanced the depth and strength of cold pools, which resulted in recovery times mostly longer than 466 hrs and some > 24 hrs. In general, cold pool recovery times calculated from the aircraft data in DYNAMO are from less than an hour to over 30 hrs, with the long recovery times being associated with relatively low surface wind speeds of less than 263m/s.