MJO Initiation Processes during CINDY/DYNAMO Field Campaign Period

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Abstract

The precursor signals of convection initiation associated with three Madden-Julian Oscillation (MJO) events (namely, MJO I, II and III) during the CINDY/DYNAMO field campaign period (October 2011 - January 2012) were investigated through the diagnosis of the ERA-interim reanalysis. The western equatorial Indian Ocean (WIO) is a key initiation region for MJO I and II, whereas the central equatorial Indian Ocean is a key initiation region for MJO III.

For the MJO I event, it is noted that intraseasonal ascending motion appeared in the lower troposphere 10 days prior to the convection initiation. A warm temperature advection anomaly in planetary boundary layer was responsible for the upward motion during the initiation stage. The vertical motion anomaly continued strengthening and deepening, and caused the increase of lower-to-middle tropospheric specific humidity. As a result, the atmosphere became convectively more unstable; eventually, it led to onset of deep convection. A diagnosis of the lower-tropospheric heat budget shows that the warm advection was primarily attributed to the advection of mean temperature by anomalous MJO flows. The anomalous flows during the initiation stage were the Rossby wave response to a preceding MJO convection over the South China Sea - western Pacific region.

The precursor signals associated with the initiation of MJO II are primarily related to the increase of specific humidity in the lower troposphere. A moisture budget analysis shows that the anomalous advection of mean specific humidity by MJO easterlies and the anomalous vertical advection of mean specific humidity by anomalous vertical motion are the primary cause of the moistening and thus the setup of convectively unstable stratification. A further examination shows that the anomalous easterlies arose from the Rossby wave response to a preceding suppressed-phase MJO that was located over the eastern Indian Ocean.

Different from the first two MJO events, MJO III was initiated over the central equatorial Indian Ocean (around 70-80E). A marked increase of specific humidity and temperature appears in the lower troposphere 5 days prior to the convection initiation. Both the increased low-level moisture and temperature are responsible for the establishment of a convectively unstable stratification and thus the onset of the MJO III convection.