A Mysterious Convective "Explosion" and an Equatorial Low Pressure System During MJO Initiation in DYNAMO

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Understanding the role of convective organization in MJO initiation over the Indian Ocean is one of the objectives of DYNAMO. Interactions between convective systems and their large-scale environment are highly complex because they involve processes on a wide range of temporal and spatial scales. On 28 November 2011, a series of remarkable meteorological events provided a unique opportunity to examine the complex relationship between organized convective clusters and synoptic-scale circulations during the early phase of an MJO event. A vigorous equatorial synoptic-scale low pressure system developed near 90°E/3°S on 26 November. This low moved to the southwest on 28 November while multiple MCSs developed within the broad cyclonic circulation. The gyre traversed the DYNAMO array from northwest to southeast, providing the opportunity to sample a potent Indian Ocean equatorial synoptic-scale low pressure system and the associated active mesoscale convective clusters with unprecedented detail. A mysterious, solitary "convective explosion" occurred near the center of the gyre during a lull of general convective activity on 28 November. Observations show that this large MCS was unique in its magnitude, rapid development, and areal extent.

The goal of this study is to explain the dynamic forcing behind this unique explosive MCS and its role in the complex relationship between organized convection and synoptic-scale gyres during the onset stage of an MJO event. This study uses a comprehensive set of observations from a variety of surveillance platforms and instruments available during DYNAMO. In particular, dropsondes released from the NOAA P-3 aircraft, measurements from ships and land stations (e.g. soundings, radar) and satellite imagery will be used to document and analyze the meteorological developments on 28 November. Furthermore, forecast fields from the ECMWF model complete the coverage and provide continuous data in space and time since the area of strongest convection could not be directly sampled by the aircraft or ships.

The data obtained from the sounding array indicate that the explosive MCS and secondary convective clusters were intimately linked to the vigorous equatorial low. Sounding-derived quantities like lower tropospheric convergence and upper tropospheric divergence peak on 28 November when the gyre is centered in the DYNAMO array and the solitary MCS reaches peak intensity. The dynamic forcing seemed to be a key player in sustaining and igniting new convection. Model forecast fields furthermore hint at a special dynamic structure of the explosive MCS. A tight rotational wind field, robust warm core signature and a nearly saturated environment provide an explanation for the unique convective signature seen in both observations and model forecast.

These finding highlight the important role of convective organization by synoptic-scale gyres during the onset stage of the MJO. The large scale dynamic and thermodynamic forcing is necessary for sustaining deep convection and the explosive MCS would not have developed without the vigorous gyre moving through the DYNAMO array.