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Evolution of MJO Convection during DYNAMO Deduced from the Atmospheric Sounding Network

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A major field campaign was conducted in the Indian Ocean from October 2011 through March 2012 to investigate the initiation of the Madden-Julian Oscillation (MJO). Principal partners in this experiment were Japan (CINDY2011: Cooperative Indian Ocean experiment on intraseasonal variability in the Year 2011) and the United States (DYNAMO: Dynamics of the MJO, and AMIE: ARM MJO Investigation Experiment). A primary component of the observing system was an atmospheric sounding network comprised of two sounding quadrilaterals, one north and one south of the equator over the central Indian Ocean.

During the intensive observing phase of the experiment, which ended in mid-December, two prominent MJOs were observed, one in October and one in November. Over the northern sounding array (centered near 3 N) both MJOs were characterized by moistening of the low- to midtroposphere over one-to-two week periods followed by rapid midlevel drying after moderately strong low-level westerly wind bursts. Conditions over the southern array (centered near 4 S) were quite different, with less distinct modulation of the moisture field by the MJOs and more persistent convection due to the presence of a southern ITCZ.

Preliminary results from moisture budget analyses indicate that during the convectively inactive phase of the MJO in the first half of October, shallow cumulus populations were prevalent over the Indian Ocean. These clouds served to moisten the lowest 2-3 km of the atmosphere and counteract the drying effects of subsidence and horizontal advection during that period. In mid-October progressively deeper convection ensued, leading up to the active phase of the MJO later in the month. However, rather than a smooth evolution of the moistening, the relative humidity field during October was characterized by a stepwise progression of the moistening in three stages, though interrupted at times by disturbances on a roughly two-day time scale. The depths of the moistened layers suggest a sequence of convection: shallow cumulus, followed by cumulus congestus, and finally deep cumulonimbus clouds. A similar progression was observed during the November, though the transition from shallow to deep convection occurred more rapidly. This pattern of convective evolution resembles that observed in TOGA COARE as well as in other studies since.

It is premature to fully evaluate the moistening processes and relate them to the evolving cloud populations observed by ground-based radars in DYNAMO; however, preliminary moisture budget results are now available and will be presented at the meeting.