Mixed-Layer Model Assessment of Boundary Layer Convergence and the Madden-Julian Oscillation

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Boundary layer convergence plays an important role in the transition from suppressed to enhanced convection in the MJO, providing moisture to the lower free troposphere and helping to support low-level convective heating. It also provides a potential source of moist static energy. Here we use the linear mixed-layer model (MLM) of Back and Bretherton 2009 to identify the key processes driving boundary layer convergence associated with the MJO, and investigate its relationship to MJO SST anomalies.

The MLM is able to accurately reproduce the strength, geographical distribution, and evolution of observed MJO surface winds and boundary layer convergence throughout the MJO lifecycle. The MLM shows that basin-scale MJO boundary layer convergence results primarily from free tropospheric processes that are communicated downward to the boundary layer, and secondarily from processes originating in the boundary layer itself. This is in contrast to climatological boundary convergence. These results are supported by a basic scale analysis.

The MLM is then used to investigate the role that MJO SST anomalies play in driving boundary layer convergence. Results indicate that basin-scale composite SST anomalies do not play a dominant role in modifying boundary layer temperature and convergence, and suggest that SST anomalies must be of greater magnitude and/or smaller spatial scale to drive first order convergence in the context of the MJO. Preliminary findings regarding the role of SST and convergence features of this scale are presented.