Observational Evidence of Mixed Rossby-Gravity Waves as a Driving Force for the MJO Convective Initiation and Propagation

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The Madden-Julian Oscillation (MJO) is known to be the most dominant intraseasonal variability in the tropics, which features large-scale convective envelopes emergening and propagating eastward slowly (~5 m s^{-1}) over the warm pool region. Since its discovery, there have been dedicated efforts to clarify mechanisms about MJO initiation and propagation in terms of large-scale low-frequency dynamics and thermodynamics and a multi-scale interaction with synoptic disturbances. As for the latter standpoint, although some recent observational and idealized numerical studies suggested that mixed Rossby-gravity waves (MRGs) can play a significant role in MJO mechanics, more detailed evidence is necessary because the realistic relationship between MJO and MRGs has had little recognition.

In this study, we examine the contributions of MRGs to the MJO convective initation and propagation in the Indian Ocean during the YMC-Sumatra 2017 field campaign (YMC: Years of the Maritime Continent). The intensive observation captured mid-tropospheric wind variations associated with MRGs, and those signals propagated westward over the Indian Ocean in the MJO suppressed phase. The transition to the MJO active phase follows tight MRG-convection coupling, which is enhanced when the wavelength becomes shorter due to weak mid-level convergence in the western Indian Ocean. Basin-scale anomalous mid-tropospheric moistening caused by MRG shallow circulations is also recognized. These processes lead to the lower-tropospheric MRG wave packet formation and successive triggering of MJO convection, with the eastward MRG group velocity corresponding to MJO propagation. This study suggests that it is worth reconsidering the MJO with a focus on MRG activities at least in the Indian Ocean.

Keywords: Madden-Julian Oscillation, equatorial waves, multi-scale interaction, the Years of the Maritime Continent

