Diversity of Initiation Regions of the MJO Associated with the Mutual Relationship Between the Intraseasonal and Low-frequency Variability

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The Madden–Julian oscillation (MJO) is known to be the most prominent tropical intraseasonal variability. Since MJO convection canonically starts to propagate eastward from the Indian Ocean (IO), most of the previous studies about MJO initiation have proposed various kinds of the mechanisms on the premise that the IO is the source region of the MJO. Meanwhile, several works have found that the MJO is sometimes initiated around the Maritime Continent (MC) and the western Pacific (WP), which implicates that analyses alone which postulate that the MJO is realized in the IO are not enough to grasp the whole picture of MJO initiation. In fact, the reason why the MJO initiation regions are modulated outside the IO cannot be explained by the pre-existing representative mechanisms.

To understand favorable environments for MJO initiation comprehensively, this study aims to examine a potential factor of the diversity of MJO onset basins and similar features in the initiation processes of the MJO even among different basins in terms of the relationship between intraseasonal and interannual variability. MJOs are categorized as those initiated in the IO (IO-MJO), MC (MC-MJO), and WP (WP-MJO). Both observations and 15-yr numerical experiments under a perpetual boreal winter condition using a global nonhydrostatic model reveal the following two points: (i) horizontal moisture advection by equatorial intraseasonal circulations is commonly important before MJO initiation in every region, and (ii) the variety of MJO onset basins is partly derived by the difference of the location where advective moistening is more likely to occur in association with the modulation of background circulations forced by interannual SST variability. For IO-MJO cases, intraseasonal convective organization supported by climatological ascent in the MC–WP causes convective suppression around the western MC, which further leads to moisture advection to the IO via intraseasonal low-level easterly anomalies. MC-MJO cases are more favored under the eastern-Pacific (EP) El Niño-like condition, because SST-induced background suppressed convection in the eastern MC causes the eastward shift of the intraseasonal circulation and convective pattern seen in IO-MJO cases and results in efficient moistening and subsequent development of convection around the western MC. WP-MJO cases tend to occur under the central-Pacific (CP) Niño-like state and dipole SST structure in the southern IO. This is owing to selective moistening in the WP due to westward intrusion of enhanced disturbances as a result of background convective enhancement in the WP–CP and suppression in the southeastern IO and EP.

Keywords: Madden–Julian Oscillation, Air-sea Coupled System, Large-scale Circulation

