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Environmental conditions on the selection of MJO and moist Kelvin waves

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Moist Kelvin waves and Madden-Julian Oscillations (MJO) are dominant precipitation systems in the tropics which consist of mesoscale cloud clusters and move eastward along the equator. Not only have they different propagating velocity and convective profiles, but also they seem to prefer different environmental conditions. For example, observational studies show that moist Kelvin waves and MJO are strongly affected by different phases of the El Nino Southern Oscillation (ENSO). In this study, environmental conditions which select the development of moist Kelvin waves or MJO are examined, and then associated features of disturbances are discussed.

Intraseasonal perturbations of NOAA-OLR with eastward wave number 2 to 4 were divided into moist Kelvin waves and MJO, according to their equivalent depths. Environmental condition was defined with 3-months running mean variables of JRA reanalysis data. With regard to seasonal and zonal variations, MJO amplitude has a larger longitudinal dependency compared to seasonal variation; with local intensification from the Indian Ocean to the western Pacific Ocean, corresponding to the distribution of mid tropospheric relative humidity and vertical shear of zonal wind. On the other hand, moist Kelvin wave amplitudes and sea surface temperature (SST) show very similar intensifications from April to June at all longitudes in equatorial region. Correspondingly, in years with relatively stronger MJO amplitude compared to moist Kelvin waves, environmental midlevel relative humidity from the maritime continent to the western Pacific Ocean has high anomaly compared to an average year, indicating a La Nina pattern. In contrast, in years with relatively weaker MJO amplitude, there exist low relative humidity anomaly at midlevels in the Indian Ocean to the maritime continent and high SST anomaly in the central to eastern Pacific Ocean, indicating an El Nino pattern.

Comparing vertical profiles of the perturbations, MJO convection have deeper low level convergence than that of moist Kelvin waves. In addision, analysis of precipitation property about each continuous precipitation areas in the TRMM 2A25 PR data shows that stratiform rain ratio to total rain of mesoscale cloud systems embedded in MJO is higher than those in moist Kelvin waves. This suggests that MJOs consist of more organized mesosystems than moist Kelvin waves. These differences about convective characteristics seem to affect to the relationship between perturbations and environmental conditions such as mid tropospheric humidity or SST.

Keywords: MJO, moist Kelvin wave, ENSO