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Investigation of MJO-Related Variability of Tropical Deep Convective Systems around the Maritime Continent

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Deep Convective Systems (DCSs) play a significant role in the hydrological cycle and energy budget of the tropical atmosphere. These systems are often enhanced and suppressed in association with the large-scale circulation and convective anomalies of the Madden-Julian Oscillation (MJO). However, our understanding of the mechanisms behind the modulation of DCS activities by the MJO remains limited. This study analyzes how DCSs around the Maritime Continent are modulated throughout the life-cycle of the MJO using the Tracking Of Organized Convection Algorithm using a 3D segmentation v2.08 (TOOCAN) DCS dataset from the Institut Pierre-Simon Laplace. We focus on the days when the MJO amplitude exceeds one during boreal winter from 2016 to 2020. During active MJO periods (MJO phases 4-5), a higher DCS cloud fraction is observed for the same mean daily precipitation rate compared to weak MJO periods (MJO amplitude less than one), this tendency is more pronounced during phase 5. DCS size and frequency exhibit marked difference between phase 4 and phase 5, whereas DCS duration shows no significant difference. Regarding DCS size, both the mean and maximum sizes are larger in phase 5 than in phase 4. Conversely, the frequency of DCS occurrence was higher (25.28%) in phase 4. However, for the same number of systems, a larger amount of rainfall is observed in phase 5. Therefore, it is inferred that convection becomes more organized, producing DCSs with larger mean and maximum sizes during the active peak. This organization is interpreted as the reason for the greater mean daily precipitation in phase 5.

Keywords: Deep Convective System (DCS), Madden-Julian Oscillation (MJO), Tropical Meteorology, Maritime continent