Initiation processes of the tropical intraseasonal variability simulated with aqua-planet experiments: Implication for the onset of the Madden-Julian Oscillation.

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The onset of the Madden-Julian Oscillation (MJO) is characterized as large-scale convective organization over the warm pool at the intraseasonal time scale. Although various kinds of mechanisms focusing on dynamic and thermodynamic environments have been proposed for MJO initiation, it seems to be difficult to understand what processes are essentially important for its onset due to the diversity of MJO behavior related to seasonality or land-sea distribution. Aiming to get an intrinsic insight into initiation processes of the MJO, we investigated the realization mechanism of convective activities associated with the tropical intraseasonal atmospheric variability (MJO-like disturbances) simulated in 10-year aqua-planet experiments using the Nonhydrostatic Icosahedral Atmospheric Model (NICAM) with a 56-km horizontal mesh. A zonally non-uniform fixed-SST distribution and explicit cloud microphysics can lead to the generation of MJO-like disturbances. We constructed the detective method of MJO-like disturbances in terms of convective activities and grasped their initiation processes continuously with a lagged-composite analysis. It is found that the horizontal moisture advection associated with a Rossby response to suppressed convection and a mixed-Rossby gravity wave can help moisten the mid-troposphere on the western warm pool about 10 days before the initiation, which makes a favorable condition for deep convective activities. After that, active convection of MJO-like disturbances is triggered by large-scale boundary layer convergence caused by the intrusion of a circumnavigating Kelvin-wave with negative sea level pressure anomalies into the moist region. It is also clarified that surface latent heat flux (LHF) and cloud-radiation feedbacks play a role in organization of triggered convection. Furthermore, sensitivity experiments suggest that a circumnavigating Kelvin-wave can efficiently determine the period of MJO-like disturbances and that the LHF feedback contributes to rapid convective organization. These results may provide us with important clues about an interpretation of the real MJO.

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