Initiation processes of the tropical intraseasonal variability simulated in an aqua-planet experiment: Implication for MJO onset

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To understand the intrinsic onset mechanism of the Madden-Julian Oscillation (MJO), we simulated a set of initiation processes of MJO-like disturbances in 10 year aqua-planet experiments using a global atmospheric model (NICAM) with a 56 km horizontal mesh and an explicit cloud scheme. Under a condition with a zonally nonuniform sea surface temperature (SST) in the tropics, we reproduced MJO-like disturbances over the western warm pool region. The lagged-composite analysis of detected MJO-like disturbances clarifies the time sequence of three-dimensional dynamic and moisture fields prior to the onset. We found that midtropospheric moistening, a condition that is favorable for deep convection, is particularly obvious in the initiation region 5–9 days before onset. The moistening is caused by two-dimensional horizontal advection due to cross-equatorial shallow circulations associated with mixed Rossby-gravity waves, as well as anomalous poleward flows of a negative Rossby response to suppressed convection. When the midtroposphere is sufficiently moistened, lower tropospheric signals of circumnavigating Kelvin waves trigger active convection. The surface latent heat flux (LHF) feedback contributes to the initial stages of convective organization, while the cloud-radiation feedback contributes to later stages. Sensitivity experiments suggest that circumnavigating Kelvin waves regulate the period of MJO-like disturbances because of efficient convective triggering and that the LHF feedback contributes to rapid convective organization. However, the experiments also reveal that both conditions are not necessary for the existence of MJO-like disturbances. Implications for the relevance of these mechanisms for MJO onset are also discussed."