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Quasi-Stationary Shear-parallel MCS in a Near-saturated Environment

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Idealized simulations are performed to investigate a poorly-understood category of Mesoscale Convective Systems (MCSs) - quasi-stationary convective lines with upstream-building and downstream stratiform observed in very moist environments. A specific feature in the experimental design is the inclusion of a highly idealized moisture front, mimicking the water vapor variations across the large-scale quasi-stationary (Mei-Yu) front during the Asian summer monsoon, where this regime of convective organization has been frequently observed. The numerical experiment with a wind profile of significant low-level vertical shear, plus a moist thermodynamic sounding with low convective inhibition, generates a long-lasting convective system which is down-shear tilted with a morphology resembling the documented MCSs with back-building or parallel stratiform in East Asia and North America. This is the first successful simulations of the carrot-like MCS morphology, where cells initiate near the upstream edge in either back-building or forward-building form depending on the system propagation direction. A major disparity from most types of MCSs, especially the well-studied squall line, is the weak and shallow cold pool and its negligible effect on system sustenance and propagation. Instead of the cold-pool-shear interaction, it is found that convectively-excited gravity waves are responsible for the intermittent upstream initiation of convective elements. Sensitivity tests show that both the moisture front and shear are critical for this MCS category. Our study suggests that the background spatial moisture variability affects the selection of the modes of organization, and that a systematic investigation of its role in convective organization in various wind shear conditions should be explored.