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A unified shallow-deep mass flux cumulus parameterization based on a stochastic multicloud model

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Cumulus parameterization (CP) in state-of-the-art global climate models (GCM) is based on the quasi-equilibrium assumption (QEA). This view contradicts the observed organization and dynamical interactions across multiple scales of cloud systems in the tropics. The last two decades have seen a surge in novel ideas to represent key physical processes of moist convection-large-scale interaction to overcome the QEA. This led to new breakthroughs in CP. The stochastic multicloud model (SMCM) CP, in particular, mimics the dynamics of multiple cloud types that characterize organized tropical convection. Here, the SMCM is used to modify the Zhang-McFarlane (ZM) CP by changing the way the bulk mass flux is calculated. We build in a stochastic ensemble of plumes characterized by randomly varying detrainment level distributions based on the cloud area fraction (CAF) predicted by the SMCM and propose a new way to calculate entrainment and detrainment rates. The SMCM is extended to include shallow cumulus clouds resulting in a unified shallow-deep CP. The new stochastic multicloud plume CP is validated against the control ZM scheme in the context of the single column Community Climate Model of the National Center for Atmospheric Research using know test-cases.

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