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Simulation of convectively coupled Kelvin waves

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This study investigates the major factors for the realistic simulation of convectively coupled Kelvin waves (CCKWs) using the National Centers for Environmental Prediction (NCEP) Climate Forecast System (CFS) models. CFS simulations employing simplified Arakawa-Schubert (SAS) and relaxed Arakawa-Schubert (RAS) cumulus parameterization schemes show that the latter generates the observed Kelvin wave signature more realistically than the former does. CFS RAS reveals the preconditioning of low-level moistening and heating for the later development of flare-up of deep convection, and the top-heavy diabatic heating profile due to subsequent considerable stratiform heating. The effects of convective downdraft, subgrid-scale convective rain evaporation, and large-scale rain evaporation on the CCKWs are assessed to be negligible. However, the maximum variance of the CCKW's convection is reduced by ~40% when shallow convection is disabled in the CFS RAS simulation. More importantly, the removal of the convective detrainment at cloud top results in the greatest reduction in the CCKW's activity (by more than 50%). To summarize, these results suggest that shallow convection and the convective detrainment to the environment and stratiform precipitation processes are the most crucial factors for the successful simulation of the CCKWs.