Impact of Organization of Convection on Cloud Feedbacks in RCEMIP

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Models and observations agree that when tropical convection is more organized, there is reduced high cloud coverage, a drier environment, and thus enhanced top of atmosphere radiative cooling. Estimates of climate sensitivity and cloud feedbacks may thus be affected by the degree of convective organization in models. We use the ensemble of cloud-resolving models in the Radiative-Convective Equilibrium Model Intercomparison Project (RCEMIP) to study the dependence of cloud feedbacks, computed using cloud radiative kernels, on the existence of organized convection, the degree to which convection within a domain organizes, and the change in organized convection with warming. We find that, when RCE simulations with organized convection are compared to RCE simulations without organized convection, the propensity for convection to organize causes cloud feedbacks to have larger magnitudes due to a broader population of cloud types, accompanied by a much larger inter-model spread. While we find no dependence of the cloud feedback on changes in organization with warming, models that are, on average, more organized have less positive, or even negative, cloud feedbacks than those those that are less organized. This is because strongly organized models exhibit a thickening of high clouds with warming, causing the shortwave cloud optical depth feedback to be more positive. Less organized models instead exhibit a thinning of high clouds.