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The link between convective organization and extreme precipitation in a warming climate

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The rate of increase of extreme precipitation in response to global warming varies dramatically across simulations of warming with different climate models, particularly over the tropical oceans, for reasons that have yet to be established. Here, we propose one possible mechanism: changing organization of convection with climate.

Recently, self-organization of convection has been studied in global radiative-convective equilibrium climate model simulations. We analyze a set of 20 simulations forced by fixed SSTs at 2 degree increments from 287 to 307 K with the Community Atmosphere Model version 5 (CAM5). In these simulations, a transition from unorganized to organized convection occurs at just over 300 K. Precipitation extremes increase steadily with warming before and after the transition from unorganized to organized states, but at the transition the change in extreme precipitation is much larger. We develop a metric for convective organization in conjunction with the characteristics of extreme precipitation events (defined as events with precipitation over a percentile threshold of daily rainfall accumulation): the number of events, their area, their lifetime, and their mean rainfall, and use this to explore the connection between extreme precipitation and organization. We also apply this metric to CMIP5 simulations to evaluate whether our mechanism has bearing on the range of tropical ocean extreme precipitation response across this set of comprehensive climate models.