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# Investigating the Diurnal Phase of Tropical Precipitation Using a Hierarchy of Models

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Global climate models generally do not capture the diurnal cycle of convection: their peak precipitation over both land and oceans in the tropics occurs before the peak seen in observational data. Models also err in predicting the diurnal amplitude of precipitation. These errors have significant consequences for the models' energy budgets, hydrological cycle, and overall forecast skill.

Given the present availability of computational resources, moist convection remains a sub-grid scale phenomenon in global climate models, and thus the parameterization of convection in these models is likely the major source of the precipitation bias. Previous work on this bias suggests that an inadequate evolution of the convective boundary layer in some models (penetrative downdrafts from the first precipitation events do not delay after-sunrise deep convection by stabilizing the convective boundary layer and allowing its growth; in other words, there is a lack of effective coupling between deep convection and the boundary layer) and poor communication between shallow and deep convection schemes in the models may be responsible for the precipitation bias.

Large eddy simulation (LES), as part of a hierarchy of models (models of varying complexity), provides a unique opportunity to investigate the precipitation bias because it not only resolves the convective scale, but also allows for numerical experiments over a broad parameter space. Our results show that LES can faithfully reproduce the late afternoon precipitation peak associated with tropical land convection, and the nighttime or early morning peak associated with tropical maritime convection. We use the LES and a hierarchy of models to investigate the diurnal phase of precipitation and to develop a simple model to help understand and improve the bias in the precipitation diurnal cycle seen in global climate models.