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Plain Language Summary: In this study, we examine the resolution dependence of convective spectrum in CAM5 (Community Atmospheric Model version 5) simulations, focusing on the transition from shallow to deep convection and the associated cloud radiative effect (CRE) change. We find that the convective spectrum is sensitive to model spatial resolution, with more deep convection in the coarser resolution runs. Moreover, the longwave component of CRE (LWCRE) is more sensitive to the change of model resolution compared to the shortwave component of CRE (SWCRE), characterized by a stronger response in the coarser resolution runs over the heavy-rain regime. The resolution dependence of convective spectrum and CRE changes highlights the importance of scale-aware cumulus parameterization design in climate models, which is not yet implemented in CAM5.

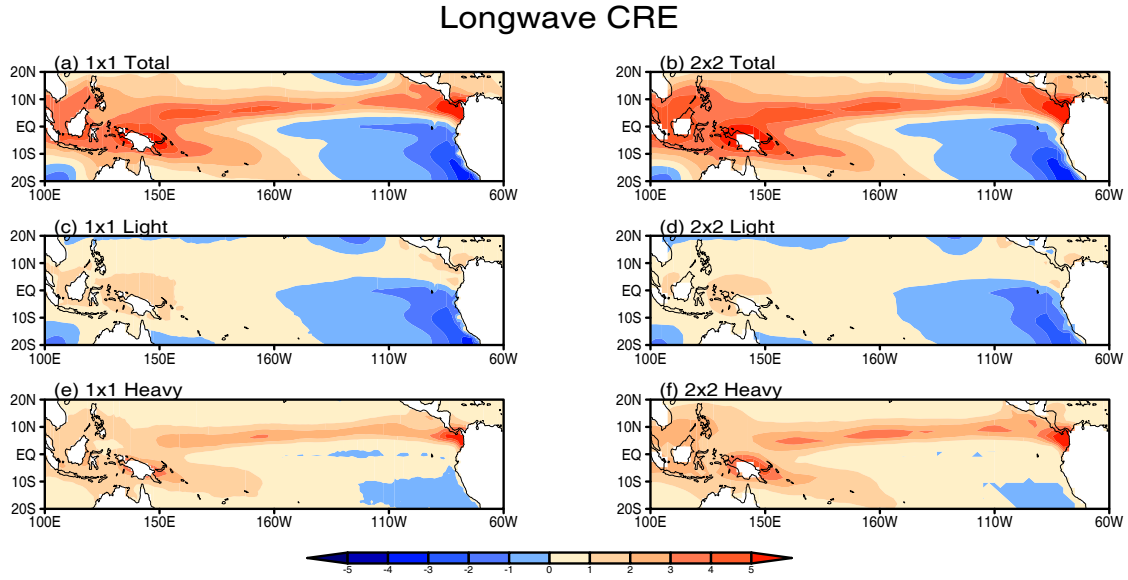

Figure 1. Spatial distribution of longwave cloud radiative effect (LWCRE) within the atmosphere averaged from the (a, b) total rain events, (c, d) light rain events (precipitation < 5 mm day^{-1}) and (e, f) heavy-rain events (precipitation > 10 mm day^{-1}) for two spatial resolutions of (a, c, e) 1° × 1° and (b, d, f) 2° × 2°. Units are W m^{-2}.

- The resolution dependence of convective spectrum in the tropics is examined based on CAM5 simulations at four different spatial resolutions.
- The critical bins marking the transition from shallow to deep convection increase as the model resolutions increase and LWCRE is more sensitive to model resolution compared to SWCRE.
- The resolution dependence of convective spectrum and CRE changes highlights the importance of scale-aware cumulus parameterization design in climate models.