全球暖化下熱帶對流的變化
(Changes of Tropical Convection under Global Warming)

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Abstract

Understanding the response of precipitation to temperature changes, including its scale and distribution, is essential in shaping the earth's future hydrological cycle. In this study, we examine future changes of tropical precipitation based on simulation results from CMIP5 and HiRAM models to investigate the possible mechanisms for such changes. Under global warming, moisture increases relatively homogeneously in space following the Clausius–Clapeyron (CC) scaling. In contrast, precipitation changes exhibit marked regional discrepancies with a mix of positive and negative anomalies over both the mean ascending and mean descending regions. A moisture budget analysis suggests that changes of tropical precipitation are controlled mainly by dynamic effect, with a minor contribution from thermodynamics effect. We find that precipitation changes agree with the "wet-get-wetter" mechanism only over the regions where dynamic and thermodynamic effects share the same sign. Convection structure changes attributing to positive precipitation anomalies appear to be very different depending on the regions. Over the mean ascending region, the positive precipitation anomaly is associated with the deepening of convection; while over the mean descending region, the positive precipitation anomaly is a result of enhanced convection throughout the troposphere.

The HiRAM and CMIP5 simulations also project distinct precipitation increases (≈20% K−1), much exceeding the CC scaling (≈7% K−1), over the equatorial Pacific (5◦S-5◦N,150◦E-90◦W). Analyses of the gross moist stability anomalies show that theses distinct precipitation increases must come from two different convection types. Over the mean ascending region (5◦S-5◦N,150◦E-170◦W), the precipitation increases are mostly due to the enhancement of deep (top-heavy) convection; while over the mean descending region (5◦S-5◦N,170◦W -90◦W), the precipitation increases are mainly a result of enhanced shallow (bottom-heavy) convection.

Key word: global warming, regional precipitation changes