A Synoptic Assessment of Climate Models' Representation of Summer Precipitation Extremes over East China

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The large-scale circulation anomalies associated with extreme precipitation events over the middle reaches of Yangtze River (MRYR) in early summer (June and July) are classified into three canonical synoptic patterns via hierarchical clustering. All clusters indicate a distinct connection between the MRYR extreme precipitation and anomalous moisture convergence driven by 1) low-level anomalous southwesterlies associated with the expansion of the Western Pacific Subtropical High, and 2) the anomalous northerlies tied to three distinct extratropical circulation anomalies ranging from zonally-elongated barotropic to developing baroclinic disturbances. The reproduction of these canonical patterns and their ties to extreme precipitation are found only in a subset CMIP5 models, where underestimates of the occurrence frequency of these patterns are largely responsible for underestimates of the occurrence frequency of extreme precipitation over East China in boreal summer. Our analysis also reveals that a few CMIP5 models simulate a reasonable rain rate spectrum in this region through a series of synoptic patterns that are not seen in observations. The differences in the potential responses among various synoptic patterns to greenhouse-gas forcing suggest the need of validating and better constraining climate model simulations of extreme events from a synoptic and weather perspective in order to achieve a more realistic projection of the near term changes in these events of tremendous societal impacts.

Keywords: extreme precipitation, synoptic assessment, CMIP models

