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Impacts of global warming on extreme rainfall and the associated mid-latitude synoptic-scale systems over East Asia as inferred from MRI-AGCM3.2S simulations

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The impacts of global warming on extreme rainfall and the associated mid-latitude synoptic-scale weather systems over the Eastern China (EC) and the Meiyu-Baiu (MB) regions in East Asia have been studied, based on simulations from the 20-km Meteorological Research Institute atmospheric general circulation model (MRI-AGCM). This model was demonstrated to give realistic Asian summer monsoon rainfall, as compared with the Tropical Rainfall Measuring Mission (TRMM), and also the Asian Precipitation-Highly-Resolved Observational Data Integration Towards Evaluation (APHRODITE) datasets. Here we used a novel wave-selection algorithm based on the 300hPa (850hPa) wind, in order to identify upper-level propagating wave (low-level southwesterly) signals in conjunction with the occurrence of extreme precipitation in either EC or MB (whenever the grid-scale daily precipitation is above the 95th percentile value). The same algorithm was applied for both the present (1979-2003) and future (2075-2099) climate simulations from this AGCM, so as to infer the impacts of global warming on the behavior of these systems. Results show that there is robust decrease of intensity of systems influencing MB (and to a lesser extent for EC) in the future climate. Their corresponding low-to-mid level circulation, as revealed by low-level convergence, relative vorticity and sea-level pressure composites, is also projected to be weakened. The weakening of these systems is likely due to changes in the background circulation in future over the East Asian mid-latitude zone, such as the increment of the seasonal mean static stability over EC and MB, weaker magnitude of the low-level meridional temperature gradient in EC, and also a reduced low-level southwesterly airstream affecting MB. However, the wave-associated anomalous precipitation over these regions intensifies in the globally warmed future. This is mainly due to enhancement in the portion contributed from extreme rainfall, which increases as the background temperature in these regions warms, largely following the Clausius-Clapeyron relation. Therefore, changes of wave-related extreme precipitation in EC and MB are mainly due to the thermodynamic effect; the latter appears to be much stronger than the dynamic effect due to the slight weakening of these weather systems.