B203

Future Changes of Extreme Precipitation and Related Atmospheric Conditions under Global Warming Projected in Large Ensemble Climate Prediction Data

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1. Introduction

Extreme precipitation is expected to become a more serious hazard to human health, world economies, and the ecosystem and are projected to significantly increase in both intensity and frequency under future climate. However, the mechanisms of the future changes of extreme precipitation remain unclear. This work assessed the historical performance and future changes of extreme precipitation and related atmospheric conditions over East Asia using a large ensemble climate prediction dataset, the database for Policy Decision-making for Future climate change (d4PDF).

2. Data

The d4PDF is a large-ensemble climate simulation dataset designed for climate change risk assessments. The global atmospheric climate model of d4PDF is MRI-AGCM3.2, with a horizontal resolution of 60 km and 12 vertical layers. Climate simulations for the past historical period (1951-2010) and 60-year future period with a +4 K warming scenario were used. For the future simulation, climatological SST warming patterns of 6 CMIP5 RCP8.5 experiments are added to the detrended observational SST. The historical and future experiments have 100 and 90 ensemble members respectively, generated by perturbing the initial conditions.

3. Results

The future climate projection indicates that both the frequency and intensity of heavy precipitation events over East Asia will increase compared with those in the present climate (Fig.1). When the atmospheric conditions in the historical and future climates are compared for the same precipitation intensity range, the future climate indicates drier, weaker upward motion and less cloud water content, which negatively affect the generation of extreme precipitation events (Fig.2). The atmospheric moisture content will increase in the future; however, cases with the same precipitable water contents between the historical and future climates indicate weaker future precipitation intensity (Fig.3). The analysis suggests that the same conditions will result in weaker intensity in the extreme precipitation range. The future increase in extreme precipitation is primarily due to the increase in precipitable water vapor, which counteracts the negative conditions.

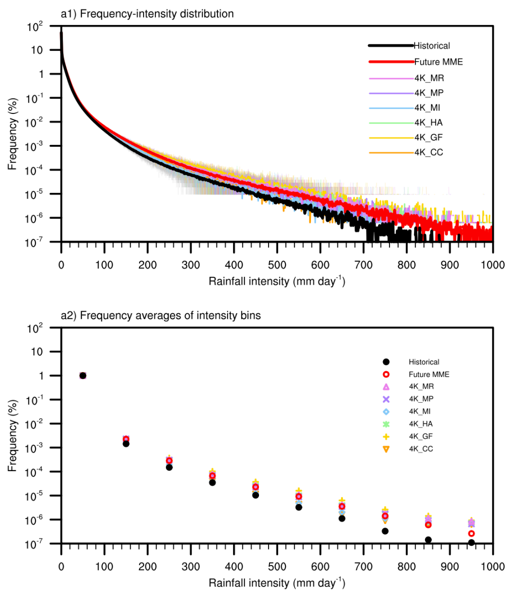

Fig1. The frequency distribution of the precipitation

intensity (mm day^{-1}) in the d4PDF historical and future +4 K simulation. Lower panel for the frequency averages in 100 mm day^{-1} bins in intensity. Black lines (markers) indicate the historical simulation (1951–2010), red lines (markers) indicate the future MME simulation (2051–2111), and thin lines indicate the ensemble members of each simulation. Six colored lines (markers) denote the ensemble means of six warming SST patterns.

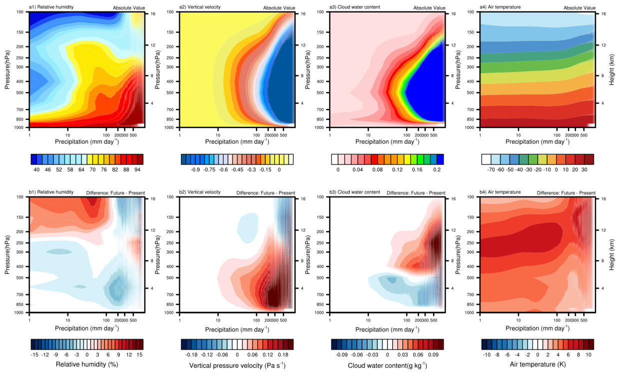

Fig 2. Composite vertical profiles of relative humidity (left column), vertical pressure velocity (middle left column), cloud water content (middle right column), and air temperature (right column) with respect to precipitation intensity in the d4PDF future simulation data (top row) and the difference between the future- and present-climate simulations (bottom row).

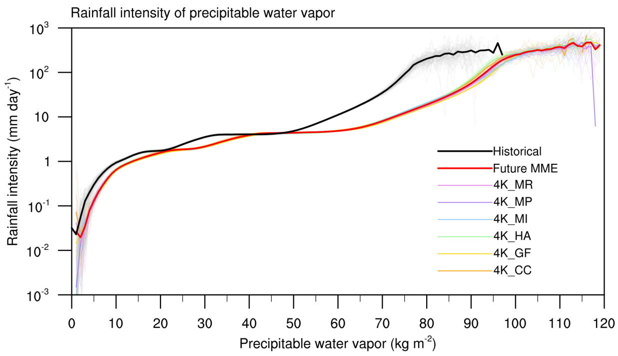

Fig3. The distribution of precipitation intensity as a function of precipitable water vapor in d4PDF. The black line indicates the historical simulation results (1951–2010), and the red line indicates the future MME simulation results (2051–2111). The six colored lines are the ensemble means of six warming SST patterns. Thin lines represent the individual ensemble members of the corresponding simulation.