

Fidelity of the precipitation and reanalysis datasets and global climate models in representation of extreme precipitation in East China

*He Sicheng¹, Jing Yang^{1,2,3}, Qing Bao^{4,5}, Lei Wang⁵

1. Faculty of Geographical Science, Academy of Disaster Reduction and Emergency Management, Beijing Normal University, Beijing 100875, China, 2. Key Laboratory of Environmental Change and Natural Disaster, Ministry of Education, Beijing Normal University, Beijing 100875, China, 3. State Key Laboratory of Earth Surface Processes and Resource Ecology (ESPRE), Beijing Normal University, Beijing 100875, China, 4. Institute of Atmospheric Physics, Laboratory of Numerical Modeling for Atmospheric Sciences and Geophysical Fluid Dynamics(LASG), Chinese Academy of Sciences, Beijing 100029, China, 5. University of Chinese Academy of Science, Beijing 100029, China

Disasters caused by extreme precipitation account for 70% of the natural disasters in China. Reliable prediction of extreme precipitation is vitally important in disaster prevention and mitigation. Realistic reproduction of historical extreme precipitation events has been challenging for both data reanalysis and global climate models (GCMs) simulation. This work aimed to assess the fidelities of the combined gridded observational precipitation datasets, reanalysis datasets and GCMs (CMIP5 and the FGOALS-f2) in representing extreme precipitation over East mainland China. The assessment uses 756 stations rain gauge data as ground truth, and focuses on the probability distribution function of daily precipitation as a function of intensity and the spatial structure of the extreme precipitation days. The TRMM satellite observation displays similar rainfall intensity–frequency distributions as the station data. However, three combined gridded observational precipitation datasets, four reanalysis datasets and most of the CMIP5 models are unable to capture the extreme precipitation exceeding 150 mm/day and all underestimate the frequency of heavy rainfall. The observed spatial distribution of extreme precipitation exhibit two centers of maximum rainfall, which are located over the lower-middle reach of Yangtze River Basin and the deep South China region, respectively. The gridded observations and the JRA-55 model captured these two centers, but the ERA-Interim, MERRA and CFSR and almost all the CMIP5 models failed to capture the two centers. The percentage of heavy rainfall in the total amount of rainfall is generally underestimated by 25–75% in all CMIP5 models. Higher resolution models tend to have a better performance than the lower resolution models; and physical parameterization may be crucial for simulating correct heavy rainfall, especially those exceeding 150 mm/day. The performances are significantly improved in the newly released FGOALS-f2 model as a result of increased resolution and more realistic simulation of the moisture and heating profiles in the troposphere. This work pinpoints the common biases in the current compiled datasets and reanalysis data sets and suggests ways to improve models' performance in representing extreme precipitation, which is critical important for reliable projection of future changes in the extreme precipitation.

Keywords: Extreme precipitation, Reanalysis, CMIP5