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# Intercomparison of multi-model ensemble-processing strategies within a consistent framework for climate projection in China

**Zhihong Jiang**[1], Huanhuan Zhu[1], Laurent Li[2], Wei Li[1], Sheng Jiang[1], Panyu Zhou[1], Weihao Zhao[3], and Tong Li[1]

[1]Key Laboratory of Meteorological Disaster of Ministry of Education, Collaborative Innovation Center on Forecast and Evaluation of Meteorological Disaster, Nanjing University of Information Science and Technology, Nanjing, China
[2]Laboratoire de Météorologie Dynamique, CNRS, Sorbonne Université, Ecole Normale Supérieure, Ecole Polytechnique, Paris, France
[3]School of Mathematics and Statistics, Nanjing University of Information Science and Technology, Nanjing, China

Climate change adaptation and relevant policy-making need reliable projections of future climate. Methods based on multi-model ensemble are generally considered as the most efficient way to achieve the goal. However, their efficiency varies and inter-comparison is a challenging task, as they use a variety of target variables, geographic regions, time periods, or model pools. Here, we construct and use a consistent framework to evaluate the performance of five ensemble-processing methods, i.e., multimodel ensemble mean (MME), rank-based weighting (RANK), reliability ensemble averaging (REA), climate model weighting by independence and performance (ClimWIP), and Bayesian model averaging (BMA). We investigate the annual mean temperature (Tav) and total precipitation (Prcptot) changes (relative to 1995–2014) over China and its seven subregions at 1.5 and 2 °C warming levels (relative to pre-industrial). All ensemble-processing methods perform better than MME, and achieve generally consistent results in terms of median values. But they show different results in terms of inter-model spread, served as a measure of uncertainty, and signal-to-noise ratio (SNR). ClimWIP is the most optimal method with its good performance in simulating current climate and in providing credible future projections. The uncertainty, measured by the range of 10th–90th percentiles, is reduced by about 30% for Tav, and 15% for Prcptot in China, with a certain variation among subregions. Based on ClimWIP, and averaged over whole China under 1.5/2 °C global warming levels, Tav increases by about 1.1/1.8 °C (relative to 1995–2014), while Prcptot increases by about 5.4%/11.2%, respectively. Reliability of projections is found dependent on investigated regions and indices. The projection for Tav is credible across all regions, as its SNR is generally larger than 2, while the SNR is lower than 1 for Prcptot over most regions under 1.5 °C warming. The largest warming is found in northeastern China, with increase of 1.3 (0.6–1.7)/2.0 (1.4–2.6) °C(ensemble's median and range of the 10th–90th percentiles) under 1.5/2 °C warming, followed by northern and northwestern China. The smallest but the most robust warming is in southwestern China, with values exceeding 0.9 (0.6–1.1)/1.5 (1.1–1.7) °C. The most robust projection and largest increase is achieved in northwestern China for Prcptot, with increase of 9.1%(–1.6–24.7%)/17.9% (0.5–36.4%) under 1.5/2 °C warming. Followed by northern China, where the increase is 6.0%(–2.6–17.8%)/11.8% (2.4–25.1%), respectively. The

precipitation projection is of large uncertainty in southwestern China, even with uncertain sign of variation. For the additional half-degree warming, Tav increases more than 0.5 °C throughout China. Almost all regions witness an increase of Prcptot, with the largest increase in northwestern China.