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Causality and Sub-seasonal Predictability of the 2016 Yangtze River Extreme Rainfall

Xing Yuan[1], Shanshan Wang[2], and Zeng-Zhen Hu[3]
[1]*Key Laboratory of Regional Climate-Environment for Temperate East Asia (RCE-TEA), Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China*
[2]*Institute of Arid Meteorology, CMA, Lanzhou, China*
[3]*Climate Prediction Center, NCEP/NWS/NOAA, College Park, MD*

1. Introduction

In June-July 2016, a barrage of extreme rainfall hit the middle and lower reaches of Yangtze River in eastern China, which caused severe urban inundations in big cities such as Wuhan and Nanjing, and resulted in direct economic loss of 70 billion RMB (about 10 billion US dollars). The rainfall anomaly exceeded 300-400 mm within 10 days, and was ranked as the 1st heaviest 10-day rainfall since 1951 (Yuan *et al.*, 2018). Understanding the causality and predictability of the 2016 Yangtze River extreme rainfall is crucial for flooding early warning and adaptation in a changing climate.

The Yangtze extreme rainfall was supposed to be associated with the 2015/16 big El Niño, nevertheless its spatial pattern was different from the 1997/98 El Niño-induced Yangtze River extreme rainfall. The June-July mean rainfall was regressed against NINO3.4 index during preceding DJF, and it is found that the ENSO forced teleconnection pattern shifts from southeastern China to the middle and lower reaches of Yangtze River after 2000, resulting in a pattern that is similar to the 2016 extreme rainfall (Fig. 1). This suggests the northward shift of the ENSO forced teleconnection may increase the risk of extreme rainfall over Yangtze River.

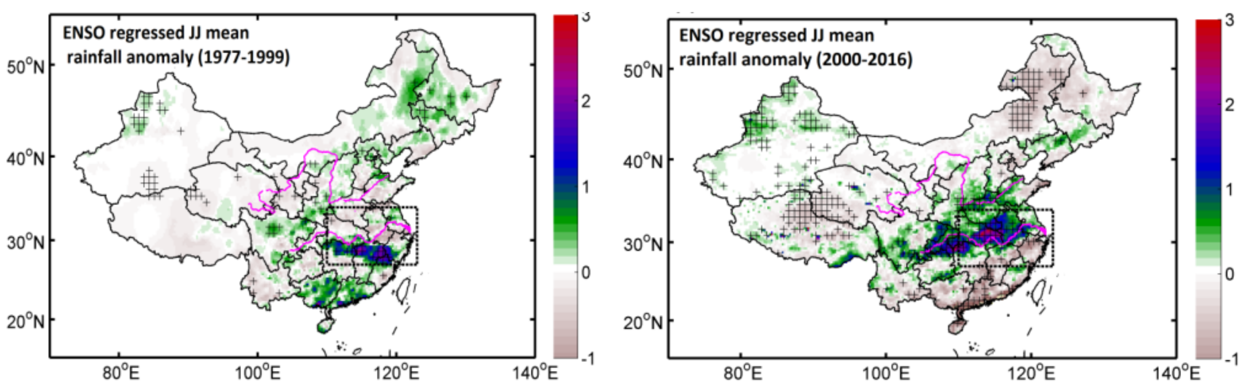

Fig. 1 Decadal change in ENSO-East Asian summer rainfall teleconnection. Regressed June-July mean rainfall anomaly (mm/day) against NINO3.4 SST in the preceding December-February during 1977-1999 and 2000-2016 respectively, where the stippling indicates a 90% confidence level.

2. Causality and potential sub-seasonal predictability

To explore the causality of the risk change, CMIP5 model simulations with all and natural only forcings were used. CMIP5 models seem to over-represent the ENSO-seasonal mean rainfall teleconnection and under-represent the ENSO-extreme rainfall teleconnection, but the models' simulations on the teleconnection pattern can be improved to some extent with the consideration of anthropogenic forcings, suggesting that anthropogenic climate change may play an important role in influencing the likelihood of the Yangtze River

Correspondence to: Xing Yuan, Key Laboratory of Regional Climate-Environment for Temperate East Asia (RCE-TEA), Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing 100029, China;
E-mail: yuanxing@tea.ac.cn

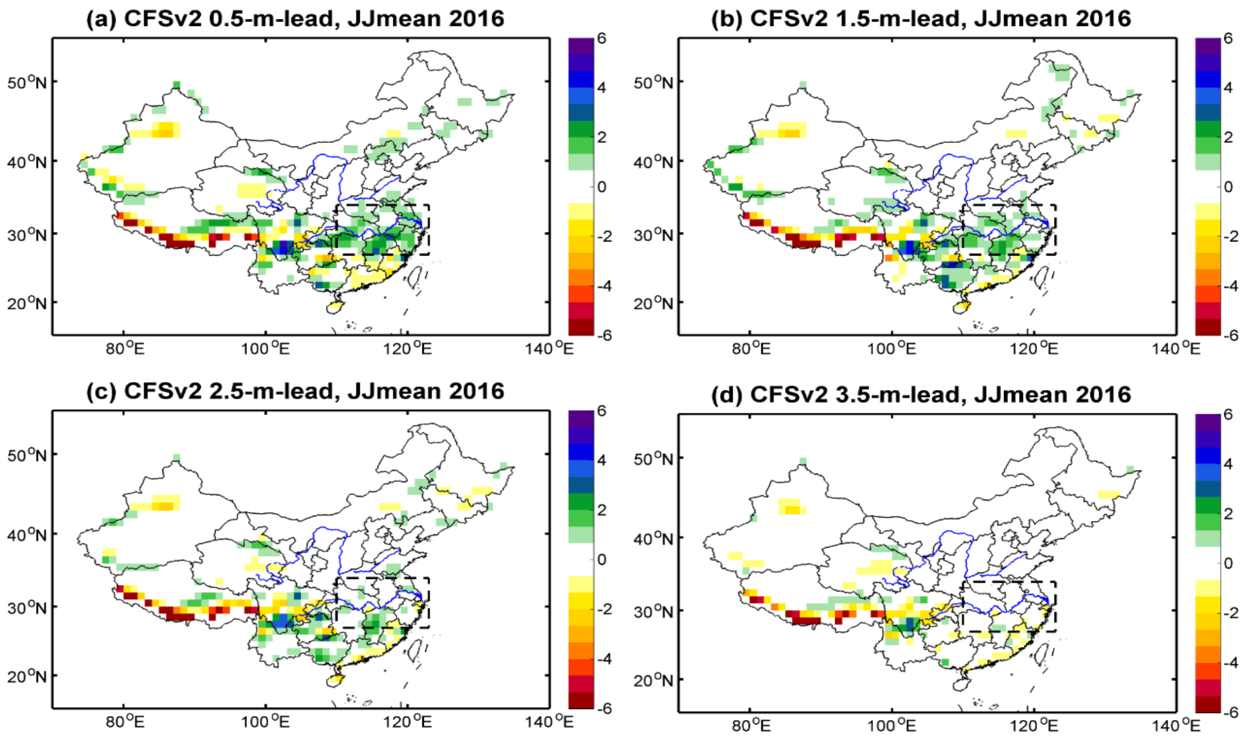

Fig. 2 June-July mean rainfall anomaly in 2016 predicted by CFSv2 at different lead times.

extreme rainfall. In fact, anthropogenic climate change has increased risk of 2016 Yangtze River extreme summer rainfall by 1/3, and it could reach 2/3 in El Niño years (please see Yuan *et al.* 2018 for details).

CFSv2 model roughly captured the rainfall anomaly at 1.5-month lead, with an underestimation of the magnitude (Fig. 2). The sub-seasonal predictability of the Yangtze River extreme rainfall was investigated by using CFSv2 hindcasts and real-time forecast with a "perfect model" assumption. It is found that the potential predictability of atmospheric moisture flux, which is a key factor for extreme rainfall, is higher than the potential predictability of the extreme rainfall at sub-seasonal time scale (Wang and Yuan 2018). This suggests that atmospheric moisture flux may also be a good indicator for extreme rainfall prediction such as 2016 at sub-seasonal scale.

References

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