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Response of the East Asian climate system to 1.5/2 °C global warming

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Response of the East Asian climate system to 1.5/2 °C global warming

To mitigate the pace of global warming and avoid irreversible damage to the climatic and social systems, the Paris Agreement pursues efforts to hold the increase in global average temperature to well below 2.0°C and even 1.5°C, above the pre-industrial level. Against this backdrop, the Ministry of Science of Technology of the People's Republic of China funded a research project (Response and Ensemble Projection of the East Asian Climate System under the Global Warming of 1.5°C) for the period 2017–2021. This project brings scientists together to investigate the response and mechanism of East Asian climate system to the 1.5/2.0°C global warming. This editorial issue sums up the recent research progresses of this project, with a particular focus on the different climate responses (e.g., temperature and precipitation regimes, climatic extremes, haze episodes…), under stabilized/transient global warming scenarios and different global warming targets.

Recent study suggests that the react of climate system to global warming is largely dependent on the warming scenarios, e.g., stabilized 1.5°C, 1.5°C overshoot, stabilized and transient 2.0°C (Cao et al. 2020). Using the earth system model (NUIST-ESM) developed by Nanjing University Information Science & Technology, Cao et al. (2020) elaborately designed four above-mentioned ensemble experiments on 1.5/2.0°C global warming scenarios. The global surface air temperature is projected to follow the 'Northern Hemisphere-warmer-than-Southern Hemisphere' pattern, and the 'land-warmer-than-ocean' patterns. Moreover, some significant differences between the transient and stabilized warming simulations are obtained, even under the same magnitude of global warming. The projected change in the Northern Hemisphere land monsoon precipitation is 30% larger in the transient 2.0°C experiment compared with that in the stabilized 2.0°C experiment. This study further indicated that such differences are mainly due to the enhanced land–sea thermal contrast and interhemispheric temperature difference.

The occurring frequency of the extreme hot summers tends to increase, along with the climate warming. Shi et al. (2020) discussed the risks of temperature extremes over China under 1.5°C and 2.0°C global warming based on transient simulations. The once-in-100-year annual maximum of daily maximum and minimum temperature events are expected to occur about every 5 and 2 years over China, respectively. Tibetan Plateau, Northwest China, and the Yangtze River are found to be the hotspots sensitive to global warming, which were at greater risk of heat extremes. Yin et al. (2020) reported that the mid-summer surface air temperature over China would increase by 1.1°C and 2.0°C under 1.5 and 2°C global warming, respectively, in comparison to surface air temperature in 1986–2005. If global warming has been limited well below the target of 1.5□, an effectively reduction in the intensity of extremely hot months will generate in Northwest China (Yin et al., 2020). Drought often comes along with a hot and dry summer. Li et al. (2020) using 12 CMIP6 models based on transient simulations to project future changes in drought conditions in Northwest China. Under the intermediate development pathway (SSP2+RCP4.5) and the high development pathway (SSP5+RCP8.5), a rapid increase in drought severity is projected for the next 100 years, especially under the high development pathway.

The projections also focus on the changes of heatwave and haze episodes under 1.5°C and 2.0°C global warming based on stabilized warming scenarios. Zhang et al. (2020) used a specially

designed dataset, i.e. the Community Earth System Model simulations (namely CESM low-warming), which can reflect the climate response when global warming stabilized at the 1.5/2°C targets at the end of 21st century, to investigate the response and mechanism of extreme heat events in China. It indicated that the average warming rate over China would exceed the global warming rate (e.g., 1.63 °C and 2.24 °C in response to 1.5 °C and 2.0 °C global warming). Compared to the present-days (1976–2005), the frequency and duration of extreme heat events in southern China will undergo a faster growth than the other sub-regions. Moreover, a 2.0 °C warmer future will further enlarge the impact of extreme heat in Northeast and Northwest China, due to the weakened upper zonal westerly wind in northern China and the enhanced continental high pressure under the 2.0 °C warming scenario (Zhang et al., 2020). Therefore, restricting the global warming to 1.5°C will facilitate to eliminate the occurrence of extreme heat, especially for northern China. Qiu et al. (2020) project the changes of weather conditions conducive to winter haze episodes in Beijing by stabilized 1.5°C and 2.0°C global warming using Haze Weather Index. It can be seen that the haze episodes have become very frequent in Beijing over the past decade. Comparing to the year 2006–2015, the frequency of haze episodes in Beijing is projected to increase by 14% (27%) for regular haze episodes and 21% (18%) for severe haze episodes at 1.5°C (2.0°C) global warming. An additional warming of 0.5°C will primarily enhance the persistence of weather conditions conducive to haze episodes.

Global warming has also accelerated the rise of sea-level, which poses a considerable threat to human settlements. Based on the climate simulations of CMIP5 dataset, Qu et al. (2020) projected the sea level of China's coastal zone by 2100 to be 38–49 cm higher than the average in 1986–2005, under the 1.5 °C warming. Such an increase in sea level will stretch to 46–57 cm if the warming threshold is set to 2.0 °C.

With the hope that all researches compiled in this collection will serve as a useful reference to the broad scientific and governmental community, this special issue provides a quick glance of the responses and mechanisms of the East Asian climate system to 1.5/2 °C global warming targets, especially under transient and stabilized warming scenarios. We aim to create an initiative to facilitate the formulation of mitigation and adaptation strategies for global warming.

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Conflict of interest

The authors declare no conflict of interest.

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