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# Observed and Simulated Changes in Extreme Precipitation and cold surges in China: 1961-2005

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## ABSTRACT

In the present work, precipitation and temperature related climate extremes are examined, with a focus on Mainland China. The objectives of this study are a) to identify targeted climate extremes and their changes during the last decades, and b) to examine the ability of current global climate models to reproduce identified patterns of change.

The observed change in extreme precipitation from 1961 to 2000 is investigated using a set of indices, and the change simulated by global climate models is evaluated. In order to find an appropriate gridding method for the extreme indices in model evaluations, the effects of two different methods for estimating indices from station data are examined: one set interpolated from indices at stations ( $EI_{STA}$ ) and the other calculated from gridded precipitation ( $EI_{GRID}$ ). Results show that there is a large difference between the two, especially at coarser resolution, and suggests that  $EI_{GRID}$  indices are more appropriate to evaluate model simulated precipitation extremes. During the period in question, observed extreme precipitation amounts increased in most parts of China, the only exception being northern China, where there was a decreasing trend. The trend of consecutive dry days (CDD) observed there is generally opposite to that of extreme precipitation elsewhere in China, except in southeast China, where both extreme precipitation and CDD increased. Most of the studied global climate models tend to overestimate extreme precipitation amounts but underestimate CDD. The pattern of precipitation extremes is generally well captured in western China, while in eastern China, where the combination of the monsoon system and human activities (e.g., anthropogenic changes in land use and aerosols) affects climate variation, with the result that climate patterns are reproduced poorly by comparison.

In regard to temperature-related extremes, the variation in the occurrence of winter cold surges in southeast China for the period from 1961 to 2005 is investigated. The identified cold surges are divided into 5 different groups based on the evolution pattern of the Siberian High (SH). Associated evolutions of the large-scale atmospheric circulation are investigated. Results suggest the importance of a SH amplification and pre-existing specific synoptic systems to the occurrence of cold surges. Investigating the long-term changes in cold surges of different groups, it is found that the SH-related cold surges (33%) have decreased in the last 20 years, while cold surges more closely associated with background atmospheric circulation systems, which often have a larger impact area (i.e., stronger cold air outbreak) than the SH-related ones, have increased since the early 1980s. Although the intensity of SH was relatively weak with warmer surface air temperatures over China during the period from 1980 to 2005, the total number of cold surges in this period was nearly identical to that of previous decades. This implies that future occurrences of cold surges in southeast China may remain at current levels, provided that the contribution from the SH-related surges does not change dramatically.

**Keywords:** Climate extremes, Precipitation, Cold surge, Siberian High, CMIP5, reanalysis, atmospheric circulation