

Observed Trends in Various Aspects of Compound Heat Waves across China from 1961 to 2015

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1. Introduction

In existing literatures, While one-day extremes of warm days/nights were widely investigated, comparably little work has been done to assess HWs comprehensively, notably in China. In China, a finite number of studies concerned on definitions and changes of heat waves, in which consideration of HWs was mostly confined to high daytime heat. However, long-lasting extreme weathers tend to trigger severer disasters, so indices measuring duration and intensity are also warranted. Furthermore, in existing studies in China, changes in HW frequency seemed the primary concern, while other equally important indicators, such as duration, spatial coverage and intensity, were substantially under-emphasized. In this context, a systematic estimation of compound HWs in China is still desirable. Our study aims to narrow above-mentioned gaps of heat wave studies in China. Specifically, quantitative assessments would be performed with respect to changes of various aspects of compound HWs, including their frequency, number of days involved, duration, intensity, and spatial extent.

2. Data and Method

Data: Observational daily Summertime (June-August) daily maximum temperature (Tmax) and daily minimum temperature (Tmin) between 1961 and 2015 are used in this study. This dataset is gained from the National Meteorological Information Center (NMIC), China Meteorological Administration (CMA).

A dataset covering 376 stations is finally selected for analyses.

Four indices are designed to quantify heat waves:

Heat wave number (HWN) – the occurrence frequency of heat wave events;

Heat wave day frequency (HWF) – the total number of days involved in all heat wave events;

Heat wave duration (HWD) – the length of each heat wave;

Heat wave intensity (HWI) – the amplitude of a heat wave calculated as accumulated exceedances of both Tmax and Tmin above thresholds during its duration.

3. Results

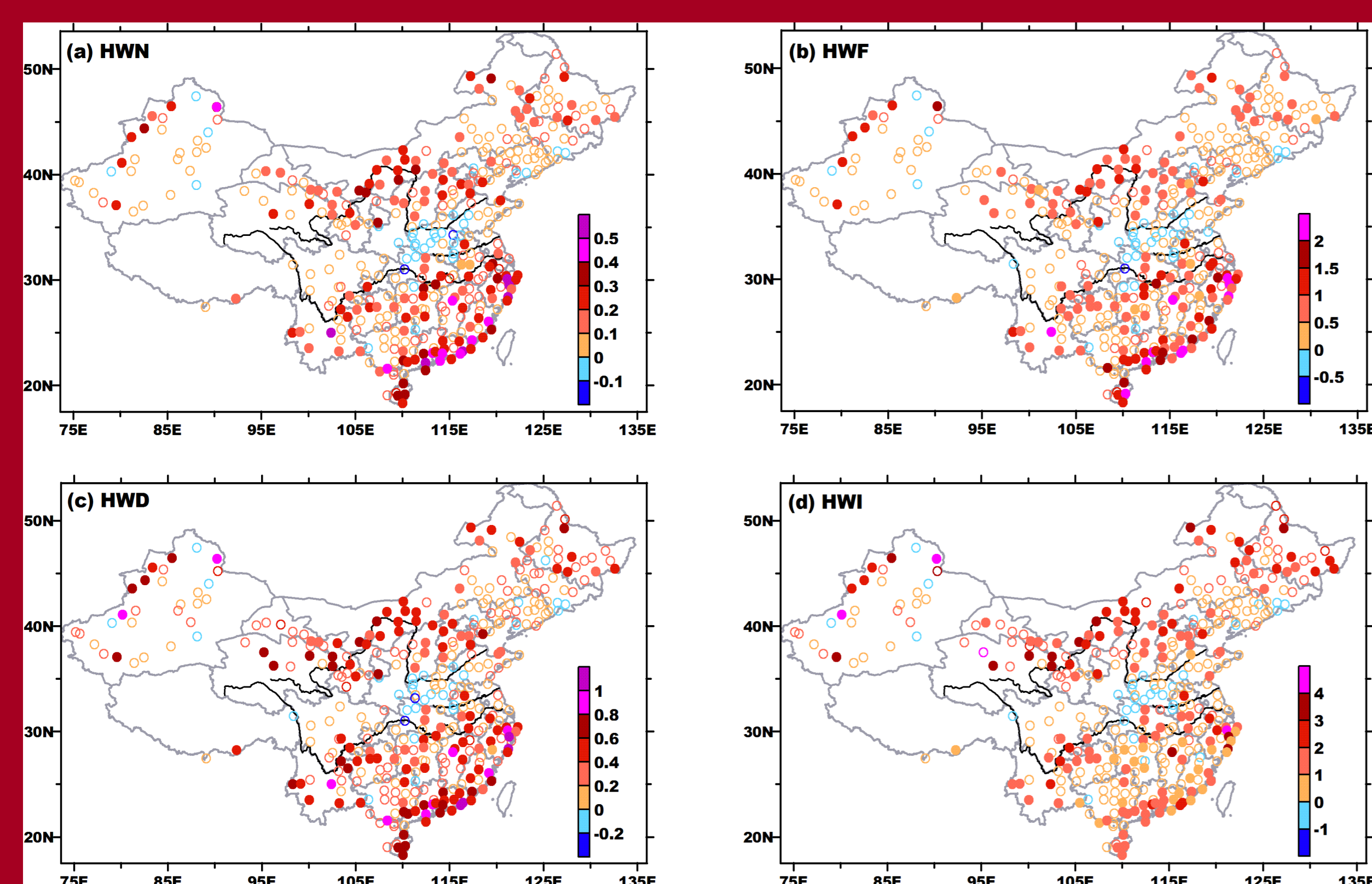


Figure 1 Linear trends for (a) HWN (frequency decade⁻¹), (b) HWF (days decade⁻¹), (c) mean HWD (days decade⁻¹), and (d) mean HWI (°C decade⁻¹). The filled dots indicate trends significant at 0.05 levels.

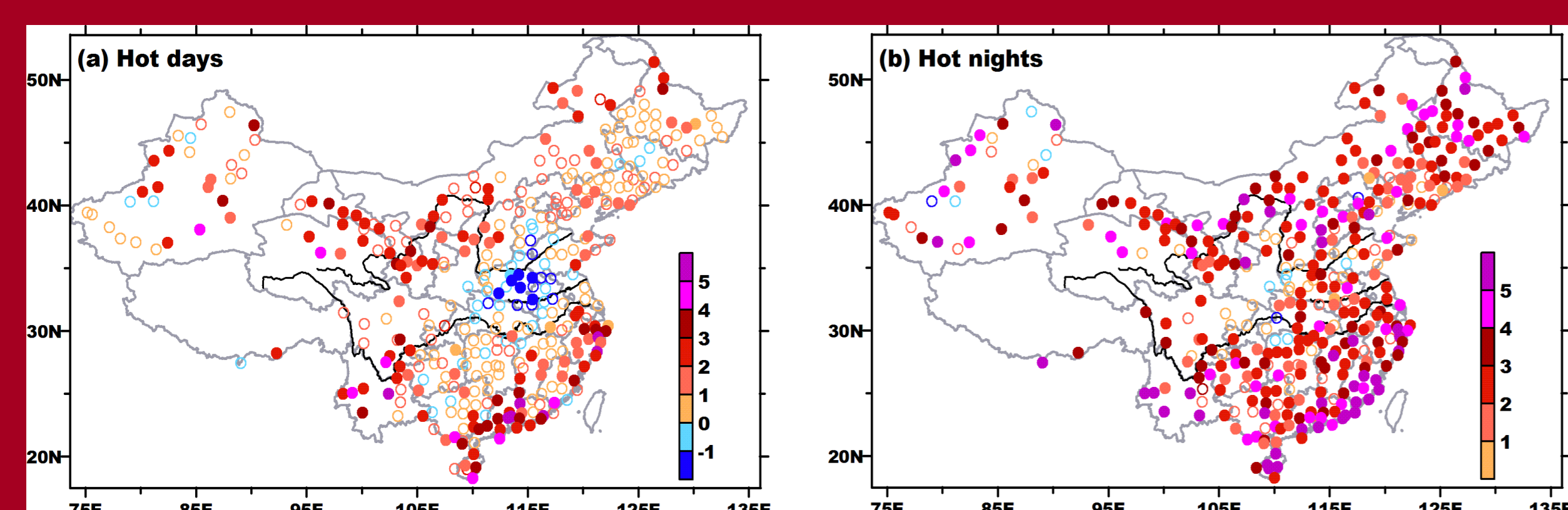


Figure 2 Linear trends for (a) hot days frequency (days decade⁻¹), (b) hot nights frequency (days decade⁻¹). The filled circles indicate trends significant at 0.05 level.

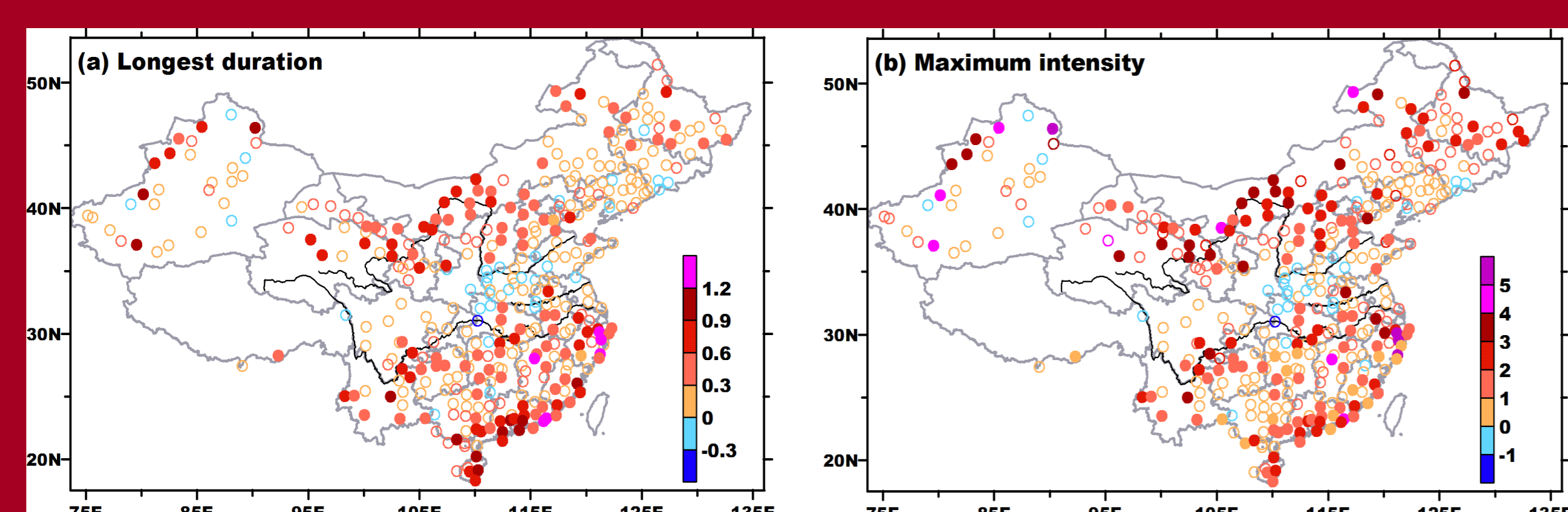


Figure 3 Linear trends for (a) longest duration (days decade⁻¹), (b) the maximum intensity (°C decade⁻¹) in every station. The filled circles indicate trends significant at the level.

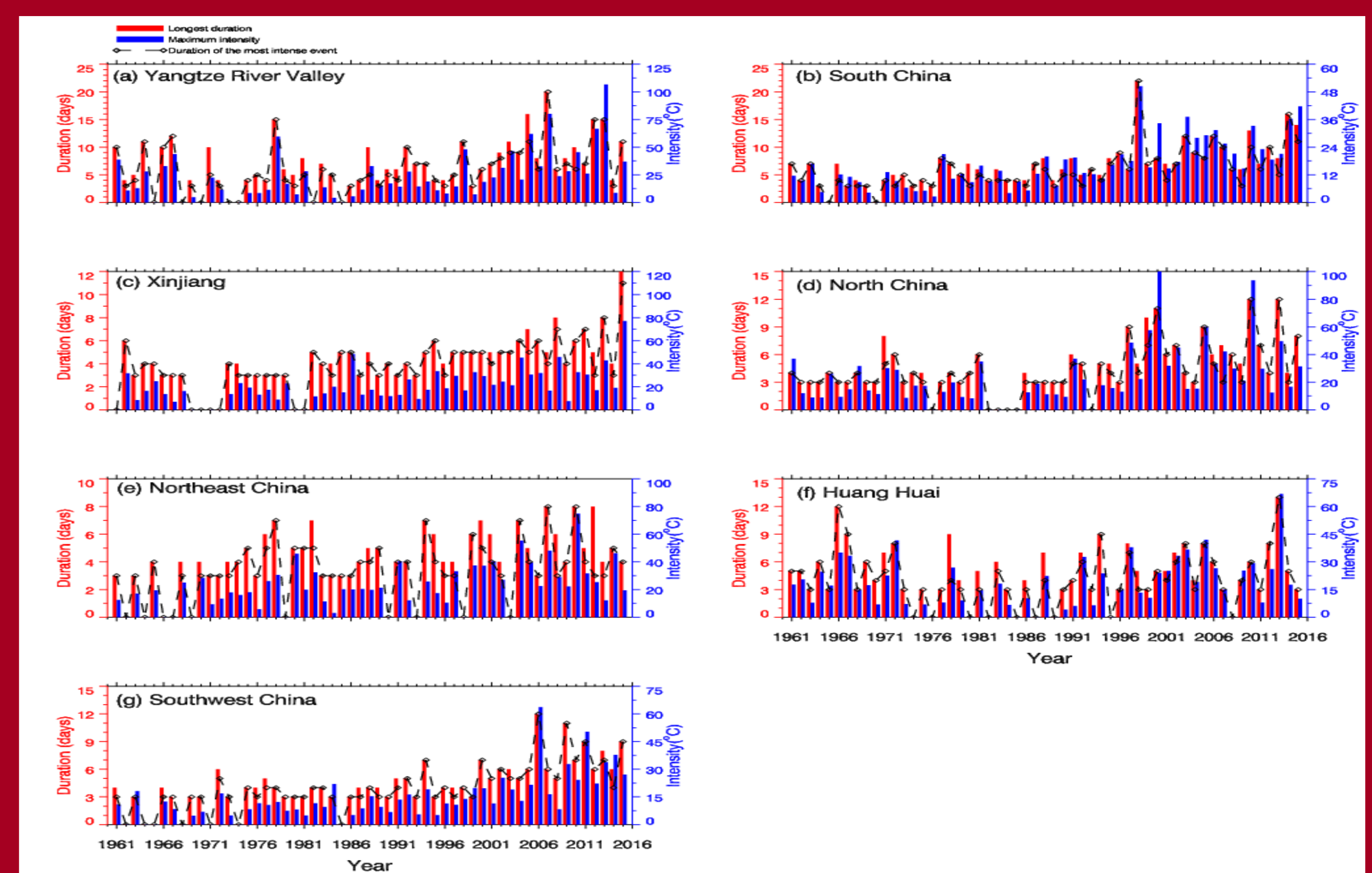


Figure 4 Severe heat waves with longest duration (red bars and left y-axis) and maximum intensity (blue bars, right y-axis) in each sub-region. The durations for strongest events (left y-axis) are illustrated by based lines.

In the past few decades, large areas of China have experienced longer, stronger, and more frequent compound heat waves.

✓ A compound heat wave is defined, and then changes in multiple aspects of such heat waves in China are estimated between 1961 and 2015.(Fig. 1-Fig.2) .

✓ Northern China has witnessed dramatic intensity increases, with a maximum amplification over 5° C decade⁻¹; while remarkable lengthening in duration has been mostly recorded in the south, with a maximum trend over 1 day decade⁻¹ (Fig. 3).

✓Severe compound heat waves in northern China are characterized by excessively high intensity within short duration, while long duration determines great disaster-causing potential of severe events in the south(Fig. 4).

✓The spatial extent affected by compound heat waves has significantly expanded since the 1960s, with the largest expanding rate over 6% decade⁻¹ detected in North China and Northeast China.

4. References

[1]. Li, Y., Y. H. Ding, and W. J. Li, 2016: Observed trends in various aspects of compound heat waves across China from 1961 to 2015. *J. Meteor. Res.*, doi: 10.1007/s13351-017-6150-2.