



A historical perspective of the extremely hot 2013 summer in East-central China

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An extreme hot summer occurred over East-central China in 2013. Its duration of continuous, highest temperature anomalies was the longest on record for the time period of 1948-2013. Several modeling studies have attempted to identify the causes and did not obtain conclusive findings, in large part due to their limited scopes of the problem. Here, we conducted a multi-scale and multi-factor analysis of this extreme event using observational data of 600 monitoring stations over China and global reanalysis data for the period of 1981-2013. Our results suggested that the number of heatwave days (NHD) (defined as a day with daily maximum temperature $\geq 35^{\circ}\text{C}$) over East-central China experienced an increasing trend of 3.44 days per decade since 1981 and reached the record maximum (34.1 days) in 2013, with significant inter-annual variability superimposed on the trend. It should be noted that this increasing trend in NHD was consistent with that of the intensity of the Western Pacific Subtropical High (WPSH) linked to global warming as suggested in the literature. There were also strong correlations between NHD over East-central China, WPSH, and global mean temperature (GT) on interannual scales. The extremely hot 2013 summer could not be explained by global warming and associated enhanced WPSH alone as GT and WPSH intensity were not record high in that summer. Further analysis suggested that large scale air-sea interaction over the Pacific region could have played a critical role. Specifically, enhanced convection over the Philippine Sea and along Indonesian islands in summer 2013 appeared to be strongest for the study period. This convection could cause a strong local feedback among precipitation, cloud cover, and net radiation, which could further weaken upper- and lower-level circulation via the tropical-extratropical teleconnection and Rossby wave propagation. This feedback was likely the direct cause of the extremely hot 2013 summer.