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Variations of summer extreme high temperatures in northern Eurasia during the recent decades

Yi Fan
Nanjing University of Information Science & Technology, China (lyfanyi@163.com)

The summer extreme high temperature days (EHTDs) in the Northern Hemisphere have been frequently detected, posing a serious threat to the safety of human life, agricultural production, and the ecological environment of many countries. This study investigates the decadal variation of summer EHTDs in northern Eurasia (30°–70°N, 10°–130°E) during 1960–2018, using the EHTD index provided by Hadley Center and the atmospheric circulation and sea surface temperature (SST) data provided by NOAA. Statistical analysis shows that the first principal component of the EHTD index fluctuates slightly over a relatively low level during 1960–1994, while it increases significantly during 1995–2018. Moreover, Z-test and sliding t-test confirm that the decadal variations of the EHTD index in terms of trends and the climatological mean values change significantly around 1994/1995. Therefore, the total period is divided into two phases, i.e., fewer EHTDs and an insignificant trend during the period from 1960 to 1994, and more EHTDs with a significant increasing trend during the late period from 1995 to 2018. During 1960–1994 (1995–2018), low pressure and cyclonic (high pressure and anticyclonic) anomalies controlled Lake Baikal and the Caspian Sea, favoring more (less) cloud cover and precipitation, absent (sufficient) solar radiation and increased (decreased) EHTDs over there. Global warming and internal variability of the North Atlantic are both responsible for the decadal variations of EHTDs. On one hand, regression analysis shows that the global warming trend shows a significant influence on the positive pressure anomalies over the areas to the south of Lake Baikal. On the other hand, during 1995–2018, the anomalous Rossby wave activities induced by warmer than normal North Atlantic leads to high-pressure anomalies over the Caspian Sea, resulting in the significant anticyclonic anomaly over the area, which favors the more frequent occurrence of EHTDs than those during 1960–1994. Meanwhile, the Atlantic jet is located northward. The area around the Caspian Sea is to the right side of the jet stream exit. Under such a background, the negative vorticity advection at the upper-level troposphere would lead to the divergence anomaly and strengthen the sinking motion between lower- and higher- levels. Thus, the summer EHTD tends to be maintained over the Caspian Sea.