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Characteristics and changes of regional wet and dry heat wave events in China during 1960-2013

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Using observed surface maximum/minimum temperature and relative humidity (RH) data from 534 meteorological stations in China, the geographical patterns and temporal variations of heat wave (HW) events over the 54 years (1960-2013) were investigated. The HW events were classified into two groups by mean RH: dry HW and wet HW. In total, 211 wet HW events and 64 dry HW events were identified. Wet HW events were commonly located in the southeastern China in the monsoon area, while dry HW events occurred mostly in the northwestern China and North China. Wet HW events occurred from April to September and mostly in July and August, while dry HW events occurred from May to August and mostly in June. The average duration of wet HWs was longer than those of dry HWs, while the average intensity of the wet HWs was lower than those of dry HWs. The annual occurrences of wet HW events and dry HW events increased significantly during 1960-2013, with magnitudes of 0.54 and 0.34 times per decade, respectively. The comprehensive index (C_i) of wet HWs showed a significant positive trend, indicating an increasing severity of wet HWs. The strong wet HW events and dry HW events became more frequent and stronger significantly in the 54 years. The decadal changes in HWs are remarkable, with significant transition points for the frequencies of the wet HWs and dry HWs at 2002 and 1996, respectively. A remarkable increasing trend of frequencies of HWs occurred after the 1990s. Stations with significant positive trends for the annual number of days of the wet HWs were widespread over southern China. The wet HWs in 2003 and 2013 summer were among the top three events in China in the study period, and a large number of sites in East China were affected. The HW event in 2013 lasted shorter and affected less area than that in 2003, but was more intense with higher temperature anomaly during the duration. The rare extreme heat wave in the summer of 2013 occurred in the middle and lower reaches of the Yangtze River in China. The stable and strong West Pacific Subtropical High (WPSH) was the direct cause for the heat wave. The more frequent and stronger HW events in the recent years may be partly due to global warming. However, different variations in the dry and wet HW events existed, and possible reasons might be the strong interdecadal and interannual variations in different regional atmospheric circulations.