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Accelerating Heatwaves Intensify Spatial Synchronization of Compound Drought and Heatwave Events

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Compound droughts and heatwaves (CDHWs) exert substantial socio-economic and ecological impacts, with their impacts reach epidemic proportions when CDHWs manifest simultaneously across multiple locations. Recent studies have begun to understand CDHWs, but their spatial compounding effects are not yet explored. This study utilizes weekly precipitation and temperature data to investigate the spatial synchronization of CDHWs and its changes. We define drought and heatwave weeks using the Standardized Precipitation Index (SPI 3-weekly) and the 90th percentile threshold of weekly temperatures. Our analysis reveals an unprecedented increase in the global land area and the number of regions experiencing concurrent CDHWs, particularly notable post-2000. The frequency of globally synchronized CDHWs (more than 5 regions affected simultaneously) has surged from 3 weeks (1982-1992) to 18 weeks (2012-2022), which is primarily attributed to a simultaneous global rise in temperatures driven by climate change. Analyzing CDHWs from observed data and counterfactual scenarios, where temperature data is detrended, we noted significantly higher likelihood of synchronization in observations due to intensified heatwaves in a warmer world. Notably, certain region pairs exhibit a higher likelihood of CDHW synchronization regardless being geographically distant. Spearman correlation and Granger causality analyses highlight major climatic modes, including El-Nino Southern Oscillation, Atlantic Multidecadal Oscillation, Western Tropical Indian Ocean, and Mode-2 of global Sea Surface Temperature, influencing changes in the areal extent of CDHWs globally as well as regionally. These insights are useful to predict the CDHWs and to quantify their socio-ecological impacts.