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Patterns of Compound Drought and Heatwave Events in the Mediterranean and Their Atmospheric Circulation Drivers: Implications for Cultural Heritage

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Recent research reveals that extreme climate events arise from the complex interplay of multiple physical drivers across different spatial and temporal scales. Although traditional climate risk and impact assessments consider individual extreme events, it is the synergy of such events that can trigger cascading impacts. Compound climate events are defined as the combination of multiple drivers and/or hazards that contribute to societal or environmental risk. This work will address the field of extreme climate and weather events through the assessment of the co-occurrence of droughts and heatwave (CDHW) events, focusing on their impact on cultural heritage sites in the Mediterranean.

Large-scale circulation drivers, such as atmospheric blocking, influence the occurrence and persistence of CDHW events. The scope of this study is to evaluate the current state of climate over the Mediterranean in terms of droughts and heatwaves, focusing on their compound impacts on cultural heritage sites, and identifying their large-scale atmospheric circulation drivers. The identification of the CDHW climatology is carried out through the improvement of an index tailored to the Mediterranean region. According to the peak-over-threshold approach, CDHW events occur when two or more contributing climate indicators simultaneously exceed a relative threshold. Multiple indicator combinations are examined, and an optimum compound index is developed that successfully quantifies the interrelations of droughts and heatwaves.

Extensive statistical analysis is carried out to evaluate their frequency, duration, intensity, and trends for a 50-year period (1974-2023). The analysis is based on reanalysis products and follows a data-driven methodology. The role of large-scale atmospheric circulation drivers on the onset, duration, and intensity of CDHW events is examined using the synoptic climatology approach. This analysis provides the hot-spot regions of CDHW high-impact phenomena over the Mediterranean region and their association with large-scale atmospheric circulation, with a particular emphasis on the vulnerabilities of cultural heritage sites.