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A Multivariate Description of Compound Events of Meteorological Drought and Heat Waves

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Compound events (CEs) are extreme impacts driven by multiple events or variables that in themselves may not be extreme but through their joint occurrence produce an extreme impact. We focus here on compound events arising from the concurrence of meteorological drought and heat waves. Meteorological drought can lead to a deficit in moisture availability for evapotranspiration from soil and so induce land surface feedbacks, whereby reductions and increases may occur in latent and sensible heat fluxes respectively, leading to an amplification of temperature extremes.

We take an events based approach where we define events in time and space, relative to a given location, using characteristics of both meteorological drought and heat waves such as duration, spatial extent and a measure of severity. We employ Pair Copula Constructions (PCC) to define the multivariate distribution of these characteristics. Copula are multivariate distribution functions that allow one to model the dependence structure of given variables separately from their marginal behaviour. PCCs then allow in theory for the formulation of a multivariate distribution of any dimension that is decomposed into a product of marginal probability density functions and two-dimensional copula, of which some are conditional.

We show here the variables used and their dependence structure that comprise the compound event arising from the concurrence of meteorological drought and heat waves relative to a location of interest. We provide physical interpretation to the multivariate distribution defined and show potential applications of this approach.