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Compound extreme events are a combination of two or more contributing events which in themselves may not be extreme but through their joint occurrence produce an extreme impact. Compound events are noted in the latest IPCC report as an important type of extreme event that have been given little attention so far. As part of the CE:LLO project (Compound Events: muLtivariate statisticaL mOdelling) we are developing a multivariate statistical model to gain an understanding of the dependence structure of certain compound events. One focus of this project is on the interaction between drought and heat wave events.
Soil moisture has both a local and non-local effect on the occurrence of heat waves where it strongly controls the latent heat flux affecting the transfer of sensible heat to the atmosphere. These processes can create a feedback whereby a heat wave maybe amplified or suppressed by the soil moisture preconditioning, and vice versa, the heat wave may in turn have an effect on soil conditions. An aim of this project is to capture this dependence in order to correctly describe the joint probabilities of these conditions and the resulting probability of their compound impact.
We will show an application of Pair Copula Constructions (PCCs) to study the aforementioned compound event. PCCs allow in theory for the formulation of multivariate dependence structures in any dimension where the PCC is a decomposition of a multivariate distribution into a product of bivariate components modelled using copulas. A copula is a multivariate distribution function which allows one to model the dependence structure of given variables separately from the marginal behaviour.
We firstly look at the structure of soil moisture drought over the entire of France using the SAFRAN dataset between 1959 and 2009. Soil moisture is represented using the Standardised Precipitation Evapotranspiration Index (SPEI). Drought characteristics are computed at grid point scale where drought conditions are identified as those with an SPEI value below -1.0. We model the multivariate dependence structure of drought events defined by certain characteristics and compute return levels of these events. We initially find that drought characteristics such as duration, mean SPEI and the maximum contiguous area to a grid point all have positive correlations, though the degree to which they are correlated can vary considerably spatially. A spatial representation of return levels then may provide insight into the areas most prone to drought conditions. As a next step, we analyse the dependence structure between soil moisture conditions preceding the onset of a heat wave and the heat wave itself.