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Modelling the full range of rainfall events

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Recently, discussions and debates about extreme climate events have been appearing on the front page of many media outlets. This is mainly due to their large economical and human impacts, but also to the challenging scientific question of how the observed climate change would disturb the amplitude and frequency of such extreme events. Before answering such a difficult question, the statistical toolbox of climatologists has to be widened in order to adequately model past observations of extreme events in a spatio-temporal context.

Classically, extreme events are defined as maxima or exceedances above a given large threshold. These definitions allow the practitioner to apply the univariate Extreme Value Theory (EVT) to the time series of interest. But these strategies have two main drawbacks. Firstly, working with maxima or exceedances implies that a lot of observations (the ones below the chosen threshold) are completely disregarded. Secondly, the univariate modeling does not take into account of the spatial dependence. Nearby weather stations are considered independent, although their recordings can show otherwise.

To address these two issues, we propose a new statistical bivariate model that takes advantages of the recent advances in multivariate EVT. Our model is based on a non-homogeneous univariate mixture originally suggested by Frigessi et al. (2002) and whose strong point is to model the full spectrum of the dataset (and not only the largest values). Here, we adapt this mixture and extend it to the joint modeling of two random variables. The performance and flexibility of this new model are illustrated on simulated and real precipitation data.