Attempting to physically explain space-time correlation of extremes

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Spatial and temporal clustering of hydro-meteorological extreme events is scientific evidence. Moreover, the statistical parameters characterizing their local frequencies of occurrence show clear spatial patterns. Thus, in order to robustly assess the hydro-meteorological hazard, statistical models need to be able to take into account spatial and temporal dependencies. Statistical models considering long term correlation for quantifying and qualifying temporal and spatial dependencies are available, such as multifractal approach. Furthermore, the development of regional frequency analysis techniques allows estimating the frequency of occurrence of extreme events taking into account spatial patterns on the extreme quantiles behaviour. However, in order to understand the origin of spatio-temporal clustering, an attempt to find physical explanation should be done. Here, some statistical evidences of spatio-temporal correlation and spatial patterns of extreme behaviour are given on a large database of more than 400 rainfall and discharge series in France. In particular, the spatial distribution of multifractal and Generalized Pareto distribution parameters shows evident correlation patterns in the behaviour of frequency of occurrence of extremes. It is then shown that the identification of atmospheric circulation pattern (weather types) can physically explain the temporal clustering of extreme rainfall events (seasonality) and the spatial pattern of the frequency of occurrence. Moreover, coupling this information with the hydrological modelization of a watershed (as in the Schadex approach) an explanation of spatio-temporal distribution of extreme discharge can also be provided. We finally show that a hydro-meteorological approach (as the Schadex approach) can explain and take into account space and time dependencies of hydro-meteorological extreme events.