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How the spatial structure of extreme rainfall observed by meteo-radars can impact the estimation of the return period of extra-ordinary events?

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This work analyses the spatial structure of some extra-ordinary extreme rainfall events (EEEs) in Liguria (NW of Italy). The EEEs affecting the region are often caused by Mediterranean Back-building MCS events which are usually characterized by a very small spatial extent. EEEs produce the annual maximums of precipitation for short durations, commonly used for the probabilistic analysis of rainfall and flood hazard.

The characteristic spatial scale of the EEE analyzed, represented by the cross-sectional dimension of the peak structures, compared with the average rain gauge density shows that the former is often less than or of the same order as the latter.

Rain gauge data are used to obtain statistics of extreme rainfall, usually expressed by rainfall depth-duration-frequency (DDF) curves. This statistical approach relies on the assumption that the maxima observed by the raingauges are matching with the local maxima of the actual event. The lower is the average rain gauge density compared to the characteristic spatial scale of EEEs, the less valid is the aforementioned hypothesis.

The spatial analysis of some recent EEEs in the region underlines that the mismatch between the characteristic spatial scale of the rainfall field and the average rain gauge density can be extremely significant.

This impacts the probability of observing the actual peak rainfall and can lead to an overestimation of the return period associated with the most intense events, which are of interest for the design of hydraulic structures and risk planning.

The dramatic underestimation of the rainfall depth at very high return periods due to the application of traditional statistical methods has been already highlighted as a criticality in the literature, focusing on daily rainfall. This work presents a first attempt to set up a framework to quantify the underestimation of the precipitation peak (or the overestimation of the return period) at sub daily scale as a function of the ratio between the raingauge density and the transversal dimension of the precipitation events.