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Identification of meteo-hydrological extreme events at the regional scale: the Northwestern Italy case study

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Extreme value theory (EVT) is commonly applied in hydrology to study extreme events. The univariate approach has been widely used in literature on this topic, but this limits the analysis to single sites. A more recent approach considers multivariate techniques applied to larger datasets, to detect the spatial structure of these events. However, how to properly define events and which variables should be considered for their identification and characterization in a regional domain is still a matter of debate. Moreover, recent studies have pointed out the increasing need of establishing connections between the different processes entering the hydrological cycle at larger spatial scales, especially in the context of global climate change. This work presents a non-parametric method for extracting the largest hydrological events occurring over the Northwestern Italy in the last decades and correlates them to spatially averaged extreme climate indices (ETCCDI). In particular, the extraction of extreme hydrological events started from the calculation of the empirical non-exceedance probability of the daily runoff values, at each station of the stream gauge network, and of a corresponding empirical return time. Then, a daily regional return time was determined by averaging the return time values over all stations for each day, with a sliding time window and site-related weights. Finally, the local maxima of the regional return time were extracted by intersecting the signal with a filter of the return time itself and the largest annual event was considered for each year. The spatial dependence of these events was analysed by extracting the local maximum discharge values at each station, corresponding to the occurrence of the maximum regional return times. A correlation with regional values of the ETCCDI indices was also performed to get some insights on the meteorological extremes playing a role in the formation of floods. Results show a rank of the extracted events for the study area and some considerations on their relative impact in terms of damage are provided. This gives an indication of the long-term variability of extreme events at the regional scale.