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High resolution spatial analysis of short-term rainfall time structure variability

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Hydrological responses to a given precipitation total can substantially vary due to naturally large variability in spatial and temporal distribution of precipitation intensities. Therefore, water management requires not only design precipitation totals but also design storm hyetographs which represent typical course of precipitation episodes. Individual sites are usually characterized by site-specific return levels and only one synthetic hyetograph. Despite the classical approach, the presented study recognizes six such hyetographs and performs their frequency analysis with high spatial resolution. Input dataset consists of radar-derived precipitation series with the time resolution of 10 minutes in warmer-half years 2002-2011, adjusted by daily measurements from rain gauges in the Czech Republic.

Reference episodes are picked out as six-hour running maxima in selected 1 by 1 km radar pixels and partitioned into six clusters with respect to three indexes quantifying the concentration of precipitation in time steps from six to one hour. For each cluster, the episodes are disaggregated with respect to precipitation intensity into main 30-minute sections and adjacent side sections. The synthetic hyetograph is then constructed by averaging characteristics of these sections. The final set of six hyetographs distinguishes not only simple shapes of precipitation intensity course (i.e. long-lasting steady rains and short torrential rains) but also episodes comprising two well-marked precipitation maxima separated by a short break.

Next, the frequency analysis of precipitation totals is carried out in each radar pixel. Generalized extreme value distribution is applied as the parametric model for annual maxima of totals and its parameters are estimated by the L-moment algorithm and the region-of-influence method. In addition, the knowledge of cluster-related distribution functions of extremes enables to evaluate the probability of occurrence of the considered six types of episodes for a given return level. The first results indicate the significant dependence of the percentage of heavy longer lasting rains on topography. Outcomes may improve design hydrographs of small streams where runoff is basically influenced by the rainfall time structure.