Application of copulas and Huff curves in the generation of design storms

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The application of design storms can be very useful in many hydrological applications, such as the assessment of flood risks in specific catchments or the design of hydraulic structures. In this study, we propose a methodology to easily generate an ensemble of design storms by combining the concept of a copula-based bivariate secondary return period with the concept of a mass or Huff curve. The developed method is based on an analysis of storm events selected out of the 105-year 10-minute rainfall time series of Uccle (Belgium). Copulas allow for a flexible construction of the probability distribution of storm depth and storm duration and are used to simulate storms with a random duration and depth for any given secondary return period, which is the mean interarrival time of dangerous storms. These random storms are then superimposed to dimensionless random internal storm structures, which are generated by an algorithm based on the analysis of Huff curves. The practical usefulness of the proposed design storm generator on a catchment scale is validated with the use of a conceptual hydrologic model. An in-depth evaluation of the simulated discharges with respect to the ensemble of design storms is provided and results show interesting possibilities for future applications of the stochastic storm generator.