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Temporal synthesis of long continuous precipitation series for urban hydrological applications with a special focus on the extreme values

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The design and operation of urban drainage systems require long and continuous rain series in a high temporal resolution. Unfortunately, available observations with such resolutions are usually short. Nevertheless a precipitation model could be used to tackle this shortcoming by generating long time series which are not constrained by the length of the observed data. Therefore it is the aim to present a stochastic point precipitation model to generate long synthetic series of rainfall in a short time increment of 5 minutes and to evaluate its capability to reproduce long term rainfall properties as well as extreme value statistics.
The model is based on an alternating renewal framework. Events are characterized by variables describing durations, amounts and peak intensities. The potential of using copulas to model the join behavior of some of these variables is analyzed.
A group of 24 stations located in the north of Germany are used for this purpose. Rainfall events are identified for each station and frequency analysis is performed on the different variables describing events characteristics. Properly modeling the join behavior of amount and duration of rainfall events was found to be essential for reproducing the observed properties, especially for the extreme events. Copulas are found to be an advantageous tool in terms of properly reproducing this join behavior; however caution must be taken during the selection of the proper copula. The fact of including the seasonality within the model was as well found to be crucial.
The model was directly validated by generating long synthetic time series and comparing them with observed ones. Indirect evaluations were as well performed by setting up a fictional urban hydrological system to test the capability of the rainfall model regarding flooding and overflow characteristics. The proposed model has a good overall performance in terms of reproducing the seasonal behavior and main characteristics of the rainfall events including the extreme events. The model is easy to understand and to transfer to other regions.