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Exploring the capability of Copulas to model precipitation in a high temporal resolution

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The design, planning 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 and the locations in which they are recorded are limited. 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 and for locations without observations. A stochastic model is applied for this purpose which involves an alternating renewal process describing a system consisting of events which can be in one of two possible states: wet or dry. Events are characterized by variables describing durations, amounts and peak intensities which are simulated stochastically.
The generation of rainfall time series using this type of models is straight forward for single sites and the potential of using copulas to model the join behavior of some variables is analyzed. An extension of the model to spatio-temporal simulations is as well presented by using vine-copulas combined with a hybrid model. Finally copulas are as well considered for the estimation of the model parameters in regions without observations based on site descriptors.
Rainfall series registered in several stations located in different regions in Germany are used to develop and validate the proposed methodologies. The available data consists of registers with high temporal resolution (5 minutes) records and the lengths range from 6 to 20 years. The site descriptors include non-climatic and climatic information available for the whole country.
Given that the model is stochastic the validation is performed on the basis of ensembles of many long synthetic time series which are compared with observed ones. Results from the single site application shows that properly modeling the join behavior of amount and duration is essential for reproducing the observed properties, especially the extreme events. Copulas can properly reproduce this join behavior; however caution must be taken during the selection of the copula. Vine copulas are an appropriate tool for simulating events in several stations, due to their ability to reproduce different dependence structures. The proposed method is a satisfactory extension of the model for multiple sites simulations. Regionalization of the model is evaluated by cross-validation. Results indicate that the modeling of all events in regions without observations is difficult, whereas extreme events are better reproduced. The regionalization technique shows to be very robust. Advantages and limitations of the different copula based proposed techniques are presented and discussed.