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A stochastic precipitation model conditioned on circulation patterns

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Global climate models (GCM) describe the climatic changes at large scales, both in space and time. However, most hydrological analyses are carried out at the catchment scale. Especially for flood modelling, precipitation data at a smaller scale are needed. Therefore, it is necessary to downscale the GCMs precipitation data to a lower scale for use in climate impact assessment in flood modelling.

One possible method of stochastic downscaling is to condition a precipitation model to atmospheric circulation patterns (CP). CPs can be defined using precipitation and pressure values. Both observation and GCM data can be used. Information about changes in the circulation patterns can be obtained from the GCMs data and therefore taken into account in the precipitation model through the conditioning. As the CP-definition needs large scale values, a reanalysis model can be employed instead of directly observed data. In this study, the NCEP/NCAR reanalysis model and the ECHAM5-GCM model are utilized. The CPs are obtained with an objective CP-classification using a fuzzy-rule-system.

The conditioning is carried out on an hourly precipitation model, which consists of two parts. First, the rainfall data is univariately produced with an alternating renewal model. This model describes wet spell durations, dry spell durations, and wet spell intensities using frequency distributions. The dependency between wet spell duration and intensity is regarded to by a copula function. The output of the model is a time series of rainfall events. Secondly, the spatial rainfall consistency is reproduced by subsequent application of a simulated annealing resampling of the univariately generated series of rainfall events. The objective function of this optimization considers special parameters which describe the dependencies between the modelled point values, thus reproducing the spatial rainfall relationship. Both steps are conditioned to the CPs.

The conditioning of the model to the circulation patterns of the North German Aller-Leine basin and some first results of the conditioned precipitation model are presented here.