Geophysical Research Abstracts, Vol. 9, 09837, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-09837

Stochastic synthesis of hourly precipitation using a univariate alternating renewal model with multivariate posterior resampling

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For derived flood frequency analysis based on hydrological modelling long continuous precipitation time series are needed. Often, the observed precipitation time series are too short, so stochastic precipitation synthesis is a good alternative. Here, a two step procedure is proposed to provide suitable space-time precipitation fields as input for future hydrological modelling. First, a univariate alternating renewal model is adapted to simulate hourly precipitation time series for several locations. In the second step a multivariate resampling procedure will be used to reproduce the spatial dependence structure and further characteristics which have been neglected in the first stage.

The model is developed for precipitation synthesis in the 3200 km^2 Bode river basin located in the Harz Mountains in Northern Germany. The alternating renewal model describes wet spell durations, dry spell durations, wet spell amounts and wet spell peaks using univariate frequency distributions. The dependence between wet spell amount, duration and peak is accounted for by a 3D Copula. For disaggregation of the wet spells into hourly intensities a special profile is used. Posterior resampling is carried out simultaneously on all synthetic time series using simulated annealing with an objective function considering spatial variograms and temporal saisonality characteristics.

The results demonstrate that univariate simulation of hourly precipitation is possible using a simple model with good performance. The main challenge is the simulation of the space-time structure while keeping the model as simple as possible. Research about this second step is still ongoing.