Geophysical Research Abstracts
Vol. 16, EGU2014-10974, 2014
EGU General Assembly 2014


# Stochastic modelling of spatially and temporally consistent daily precipitation time-series over complex topography

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There is a growing demand for high-resolution precipitation time-series at the local scale that are both consistent in time and in space. This is of high relevance for climate impact models that are sensitive to averaged rainfall amount over a specific region and over a multi-day period (e.g. for modeling river runoff regimes). In this regard, weather generators (WGs) calibrated at multiple sites, are an appealing technique that allow the simulation of synthetic series of unlimited length taking into account the spatio-temporal correlation structure. To date, only a few multi-site WGs have been documented in the literature and those that exist have rarely been tested for a topography as complex as the Alps. It is the aim of this study to fill this gap.

Here, we present results from multi-site precipitation simulations with a generator that has been inspired by Wilks (1998). In essence, it is a Richardson-type WG that additionally takes into account the spatial correlation structure between all the station pairs. A first-order two-state Markov process is chosen to simulate daily precipitation occurrences, while precipitation amounts are re-sampled from a mixture model of two exponential distributions fitted at individual stations. Our multi-site WG is tested and evaluated here at the example of the hydrological catchment “Thur” in the Swiss Alps for the time-period 1961-2011 and on a monthly basis. In the catchment eight meteorological stations (from MeteoSwiss) are considered at which artificial time-series with the respective spatio-temporal dependence structure are simulated. The eight measurement sites are evenly distributed over the catchment, representing the complex topographical and associated precipitation characteristics.

The study reveals first that our stochastic model is able to generate time-series that well represent the annual cycle of the precipitation statistics, such as mean wet day frequency and intensity as well as accumulated precipitation amounts. Second for our topographically complex catchment area “Thur”, the analysis clearly indicates an added value of our WG in simulating area-averaged precipitation sums in comparison to multiple WGs calibrated at single-sites only. Yet, the WG is conditioned on long-term means only, which is why the stochastic variability is too small to also reproduce observed year-to-year variability of monthly precipitation sums. Regarding temporal dependencies, we found that the frequencies of shorter spell lengths are better reproduced than those of longer spell lengths. Consequently, some deficiencies in reproducing precipitation sums over multiple wet days have been detected, too. In the presentation, we will further show under which conditions a multi-site WG is superior over several single-site WGs using different configurations of selected stations.