Geophysical Research Abstracts
Vol. 15, EGU2013-11847, 2013
EGU General Assembly 2013

Variability in the microcanonical cascades parameters among gauges of urban precipitation monitoring network

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In the fall of 2008, Municipal Water Supply and Sewerage Company (MWSSC) in Warsaw began operating the first large precipitation monitoring network dedicated to urban hydrology in Poland. The process of establishing the network as well as the preliminary phase of its operation, raised a number of questions concerning optimal gauge location and density and revealed the urgent need for new data processing techniques. When considering the full-field precipitation as input to hydrodynamic models of stormwater and combined sewage systems, standard processing techniques developed previously for single gauges and concentrating mainly on the analysis of maximum rainfall rates and intensity-duration-frequency (IDF) curves development were found inadequate.
We used a multifractal rainfall modeling framework based on microcanonical multiplicative random cascades to analyze properties of Warsaw precipitation. We calculated breakdown coefficients (BDC) for the hierarchy of timescales from λ=1 (5-min) up to λ=128 (1280-min) for all 25 gauges in the network. At small timescales histograms of BDCs were strongly deformed due to the recording precision of rainfall amounts. A randomization procedure statistically removed the artifacts due to precision errors in the original series. At large timescales BDC values were sparse due to relatively short period of observations (2008-2011). An algorithm with a moving window was proposed to increase the number of BDC values at large timescales and to smooth their histograms.
The resulting empirical BDC histograms were modeled by a theoretical "2N-B" distribution, which combined 2 separate normal (N) distributions and one beta (B) distribution. A clear evolution of BDC histograms from a 2N-B distribution for small timescales to a N-B distributions for intermediate timescales and finally to a single beta distributions for large timescales was observed for all gauges. Cluster analysis revealed close patterns of BDC distributions among almost all gauges and timescales with exception of two gauges located at the city limits (one gauge was located on the Okęcie airport).
We evaluated the performance of the microcanonical cascades at disaggregating 1280-min (quasi daily precipitation totals) into 5-min rainfall data for selected gauges. Synthetic time series were analyzed with respect to their intermittency and variability of rainfall intensities and compared to observational series. We showed that microcanonical cascades models could be used in practice for generating synthetic rainfall time series suitable as input to urban hydrology models in Warsaw.