Scaling properties of Polish rain series

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Scaling properties as well as multifractal nature of precipitation time series have not been studied for local Polish conditions until recently due to lack of long series of high-resolution data. The first Polish study of precipitation time series scaling phenomena was made on the base of pluviograph data from the Wroclaw University of Environmental and Life Sciences meteorological station located at the south-western part of the country. The 38 annual rainfall records from years 1962-2004 were converted into digital format and transformed into a standard format of 5-minute time series.

The scaling properties and multifractal character of this material were studied by means of several different techniques: power spectral density analysis, functional box-counting, probability distribution/multiple scaling and trace moment methods. The result proved the general scaling character of time series at the range of time scales ranging form 5 minutes up to at least 24 hours. At the same time some characteristic breaks at scaling behavior were recognized. It is believed that the breaks were artificial and arising from the pluviograph rain gauge measuring precision limitations. Especially strong limitations at the precision of low-intensity precipitations recording by pluviograph rain gauge were found to be the main reason for artificial break at energy spectra, as was reported by other authors before. The analysis of co-dimension and moments scaling functions showed the signs of the first-order multifractal phase transition. Such behavior is typical for dressed multifractal processes that are observed by spatial or temporal averaging on scales larger than the inner-scale of those processes. The fractal dimension of rainfall process support derived from codimension and moments scaling functions geometry analysis was found to be 0.45. The same fractal dimension estimated by means of the functional box-counting method was equal to 0.58. At the final part of the study implementation of double trace moment method allowed for estimation of local universal multifractal rainfall parameters (α=0.69; C_1=0.34; H=-0.01). The research proved the fractal character of rainfall process support and multifractal character of the rainfall intensity values variability among analyzed time series. It is believed that scaling of local Wroclaw's rainfalls for timescales at the range from 24 hours up to 5 minutes opens the door for future research concerning for example random cascades implementation for daily precipitation totals disaggregation for smaller time intervals. The results of such a random cascades functioning in a form of 5 minute artificial rainfall scenarios could be of great practical usability for needs of urban hydrology, and design and hydrodynamic modeling of storm water and combined sewage conveyance systems.