Hydrol. Earth Syst. Sci. Discuss., 8, C4077–C4080, 2011
www.hydrol-earth-syst-sci-discuss.net/8/C4077/2011/

Hydrology and Earth System Sciences Discussions

Interactive comment on "Multiplicative cascade models for fine spatial downscaling of rainfall: parameterization with rain gauge data" *by* D. E. Rupp et al.

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Received and published: 19 September 2011

General comments

This study introduces a new method to estimate the parameters of a multiplicative random cascade (MRC) model (devised for the spatial disaggregation of rainfall fields) when the rainfall observations are collected by a sparse network of gauges. In this context, the approach based on the moment-scale diagrams is deemed to be no suitable, as the gauge density is low relative to the desirable grid cell density. Therefore, the Authors exploit the properties of the α-stable distributions to derive a set of analytical

expressions that allows estimating the model parameters, resorting to the ratio between the rainfall values at the two limit scales of the cascade without using the intermediate scales. The proposed method is applied to calibrate eight versions of a beta-logstable model, in which the scale parameter of the distribution of the weight generator is assumed to be constant or varying with the scale and/or the large scale rainfall, whereas the intermittency parameter depends on the large scale rainfall. These models and the estimation method are tested on a rainfall data set recorded by 25 gauges located around Warsaw, Poland (the data are aggregated at 15-min temporal resolution). The performance is assessed by comparing the cumulative distribution functions, and the semi-variograms of the observed and simulated rainfall values. The approach seems to be very interesting, hypotheses and possible weaknesses are clearly stated, and, in general, the paper is clear and well organized. In my opinion, the paper is suitable for publication in HESS after some minor changes. Some technical comments are provided in the next sections. Please, note that some of my remarks should be considered as a contribution to the open discussion rather than requests of changes.

Specific comments

Page 7276 (10-11): The Authors state "We believe this is an artifact of the discrete nature of the cascade procedure that was applied". It could be interesting to try the continuous in scale universal multifractal (UM) model, in which the parameter α can be obtained by using the method discussed in the study under review, H can be set up equal to 0 (or a suitable value taken from the literature), and C_1 may be seen as a tuning parameter. The model can be more parsimonious than a scale dependent approach and allows avoiding the simulation of the rainfall values at intermediate scales, when they are not required.

Pages 7278 (15-20): As mentioned by the Authors, the model is based on the assumption of stationarity; however, the seasonality is a type of cyclic nonstationarity. For instance, convective or stratiform events can characterize some seasons, resulting in different degrees of spatial intermittency (rain/no rain) and spatial dependence. Merging together all data can influence to some extent the calibration/simulation, and the resulting covariograms. Thus, it may be worth describing briefly the seasonality of the Warsaw climate.

In the context of time series disaggregation, Lombardo et al. (2011; http://itia.ntua.gr/en/docinfo/1132/) have recently proved that the set of weights provided by the dyadic generation process is not stationary, as the autocorrelation of the weight series depends on the position of the simulated weights along the time series. I think that this result can be also applied to the spatial case, and can affect to some extent the spatial correlation. On the other hand, the simulation procedure of the UM model does not suffer this problem, as it is based on transformations in the spectral domain.

It could be interesting to show how the simulations reproduce the properties embedded in the model structure by introducing, for instance, the counterpart of Figures 3 and 4 for the simulated data.

Technical corrections

Page 7262 (11): The number...needs.
Page 7262 (19): probability density function.
Page 7264 (9): The number...needs.
Page 7264 (12): spatial variability.
Page 7265 (9): more damped.
Page 7265 (15): The model is introduced in terms of rainfall per unit area (“rainfall rate”). However, throughout the paper the Authors use the terms “rainfall amount” and “rainfall depth”. Perhaps, referring to R_0 as “rainfall rate”may be more correct, as Eq.

(1) yields rainfall per unit area.
Page 7265 (18): Δ_n is given by $L_0^2 b^{-n}$.
Page 7265 (21): Fig. 2.
Page 7265 (24): Perhaps, “various types” can be better.
Page 7266 (12-13): $0 < \alpha \leq 2$, $-1 \leq \beta \leq 1$.
Page 7270: Perhaps, using $SI\sigma$ should be more consistent with $RI\sigma$ and $RD\sigma$, as the scale dependence refers to σ.
Page 7271 (13): all eight models.
Page 7272 (4): In four of the models.
Page 7274 (22): Eq. (17).
Page 7287 (4, caption): $\alpha_Z = 2$.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 7261, 2011.