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Universal Multifractal description of a daily rainfall time series from Ebro River Watershed

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The Ebro River is very important in Spanish water policy. There are different water transfer projects to other regions. It's important to know the characteristics of rainfall in the watershed before developing models river flows. This help us to understand the relationships between rainfall and runoff and predict the results that produce the plans over the basin.

The objective of the present work is to validate the daily rainfall data generated by a regional climate model by using multifractal analysis. This will allow us to determine what extent there are singular variations in a region rainfall and so contribute to a better understanding of the variability of precipitation in the Ebro River watershed.

An important aspect of this study consists in the unusual fact of considering a complete river watershed, so that we examine 265 rain gauges in an area that contains around 85000 km^2. Daily rainfall was recorded over a period of almost 23 years (1980-2002). The west of the region the climate is oceanic. As we advance towards the east the climate becomes progressively Mediterranean.

We calculate the Lovejoy multifractal parameters:α, C_1 and H by DDT analysis technique based on multiscaling properties of the intermittent fluxes of daily rainfall. The mean values for the parameters are:

$$\alpha = 0.72\ (0.10) \qquad C_1 = 0.23\ (0.05) \qquad H = -0.14\ (0.05)$$

where the value in brackets is the standard deviation

We study the evolution about the Lovejoy Universal Parameters in this region, and we conclude that the multifractality increases as the climate is turning more Mediterranean. Nevertheless the Universal parameters values can be modified by the altitude and conditions of water retention in endorheic regions.

We can establish a power law between multifractality parameter C1 and mean rainfall for this region and we compare this result with another ones obtained by Labat, Tessier and Garcia-Marin.

We study the "fingerprint" a, b for time-series suggest by Kantelhardt and Koscienly. They are extracted from the extended multiplicative cascade model and must verify the relationship with the generalized Hurst exponent:

$$h(q) = \frac{1}{q} - \frac{\ln(a^q + b^q)}{q\ln(2)} + \frac{\ln(a+b)}{\ln(2)}$$

Clasical spectral analysis $S(f) = f^{-\beta}$of the all time series were calculated. In nearly all station there are two principal peaks: one at 6 months and one year. Only the rain gauges with high multifractality don't follow this pattern of behaviour. They have most peaks and they don' present a big peak at one year.

In resume for lower frequencies, $\beta \approx$0 is found. The break detected in the periodograms for approximately $f \approx$ 0.40. It corresponds with a period of 16 days like other studies (Labat et al. 2002, Tessier et al. 1996). They are essentially the "synoptic maximum" found when performing the analysis of the exponential function of the empirical moments scaling.

Finally we obtain a clustering for the rain gauges with the universal parameters and for extension we divided the Ebro River watershed in degree of multifractality, intermittency and persistency of multifractal model.