5.15 Multifractal IDF and non-conservation of the rain rate

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A classical purpose-oriented way of representing the probability distributions of the maximum rainfall amount at various time scales is the Intensity-Duration-Frequency curves (IDF). The empirical estimate of the probability law is based on rank analysis of the empirical rainfall quantiles. Then a regression analysis is performed to deduce a parametric equation relating the quantiles and durations. Numerous parametric statistical models could be cited as rather standard IDF models. Whereas these parametric models yield similar values near the centre of the distribution (because they were fitted on low order statistics), the extreme rainfall quantiles often differ significantly. This happens because the rainfall data often display long-range dependencies, non-stationarity and clustering of the extremes, and therefore violates these classical theoretical conditions. Thus, there remains a strong practical interest in searching for methods that could incorporate physical principles in the statistical analysis and to derive physically meaningful asymptotic behavior of the IDF curves, for return periods much longer than the length of available historical records. Searching for such a method, during the last decade there have been numerous applications of scaling theories to IDF curve extrapolations. The majority of available theoretical results concerning the scaling of the IDF curves has been obtained either with the 'simple scaling' formalism or with the multiplicative cascade formalism. While the first formalism oversimplifies a multifractal nature of rainfall, the second one assumes the strict equivalence between the duration (of a sliding window for moving average) and the scale of data observation (corresponding to disjoint windows). In a general manner, the scaling behavior of IDF curves strongly depends on how the durations are defined. An additional complexity arises from the fact that zero-rainfall generally introduces a scaling brake between small and large time scales of the rainfall process. A robust procedure to define from empirical data the corresponding conservative flux (that could be directly modeled by a multiplicative process) was recently developed within the framework of a near-wall atmospheric turbulence. This leads to non-ambiguous estimates of the universal multifractal parameters, also extending the scaling range of the empirical data. This procedure was tested on numerous rainfall data. The results demonstrate that the rainfall process should not be considered neither a passive scalar nor a conservative flux. We propose to discusses the real scaling nature of the rainfall, the transforms associated to scaling and changing durations, which yield the multifractal IDF curves.