Intensity–dependence of interarrival times and run lengths in multifractal rainfall

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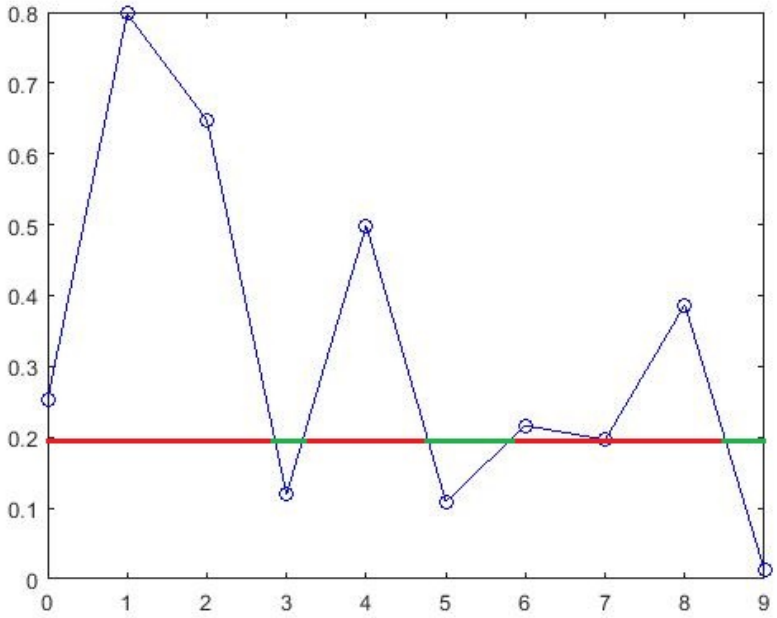
Interarrivals vs. run lengths

Given a process characterized by an intensity over time, for any given threshold, interarrivals and run lengths are complementary magnitudes (a fact that is often forgotten...):



Common use in Hydrometeorology

In the zero-threshold limit, the thresholding of rainfall intensities distinguishes between "rain" and "no–rain" situations, i.e., inter-arrivals are times between rainfall events, whereas run lengths are the durations of those events as such.

In the limit of high thresholds, one obtains intensity–duration–frequency curves, by considering the conditional probability ("frequency", under the assumption of multiannual temporal ergodicity of the process), for which an intensity threshold is consistently exceeded, giving rise to a run length for a duration measured at the considered time scale.

Multi-/monofractal models

Mass scaling of atmospheric precipitation has been successfully characterized by various multifractal frameworks in the studies dedicated to this subject. Asymptotic properties make multiplicative models using log–α–stably–distributed kernels (of which log–normals are a special case for $\alpha = 2$) a particularly attractive alternative, which may or may not be combined with a monofractal β–model.

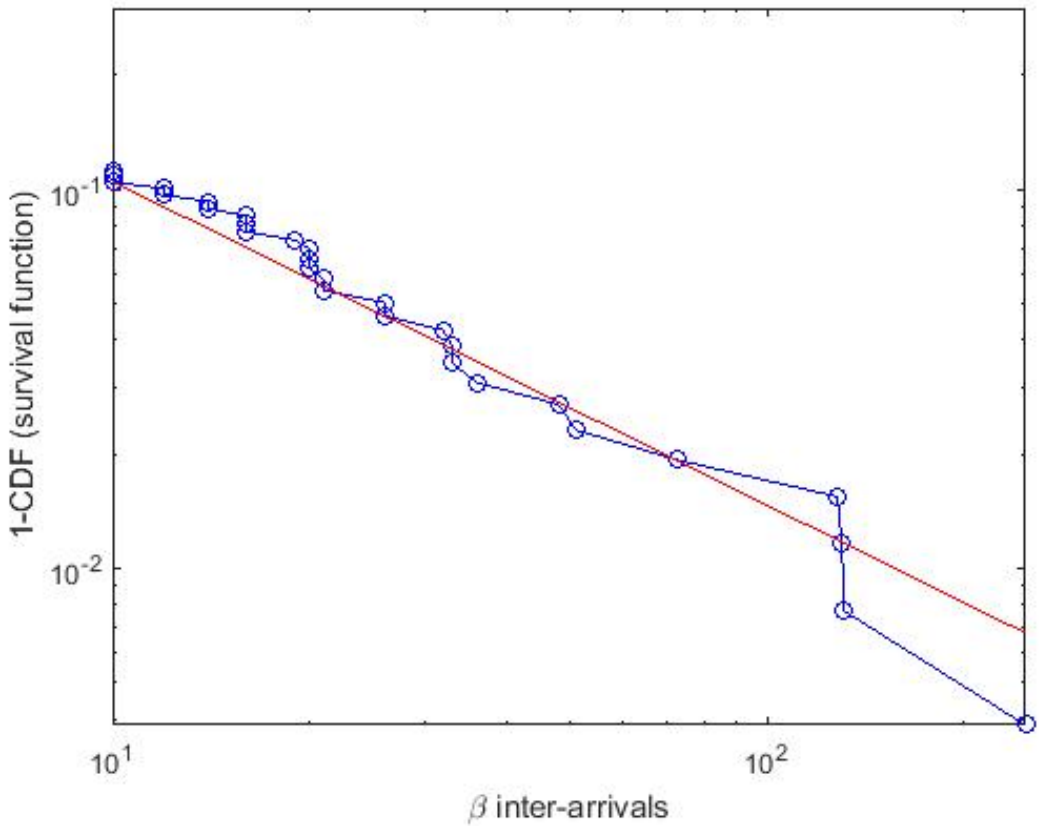
Such models give rise to particular distributions of interarrivals and run lengths, as shown by Langousis et al. [*Hydrofractals* 2013].

Parametrization of the models

There are at least two fundamental aspects of interarrivals vs. run lengths that such rainfall models should be able to consistently reproduce, and which therefore should be usable for their parametrization: (1) the behavior of extremes ("distributional tails"); and (2) the behavior as a function of scale.

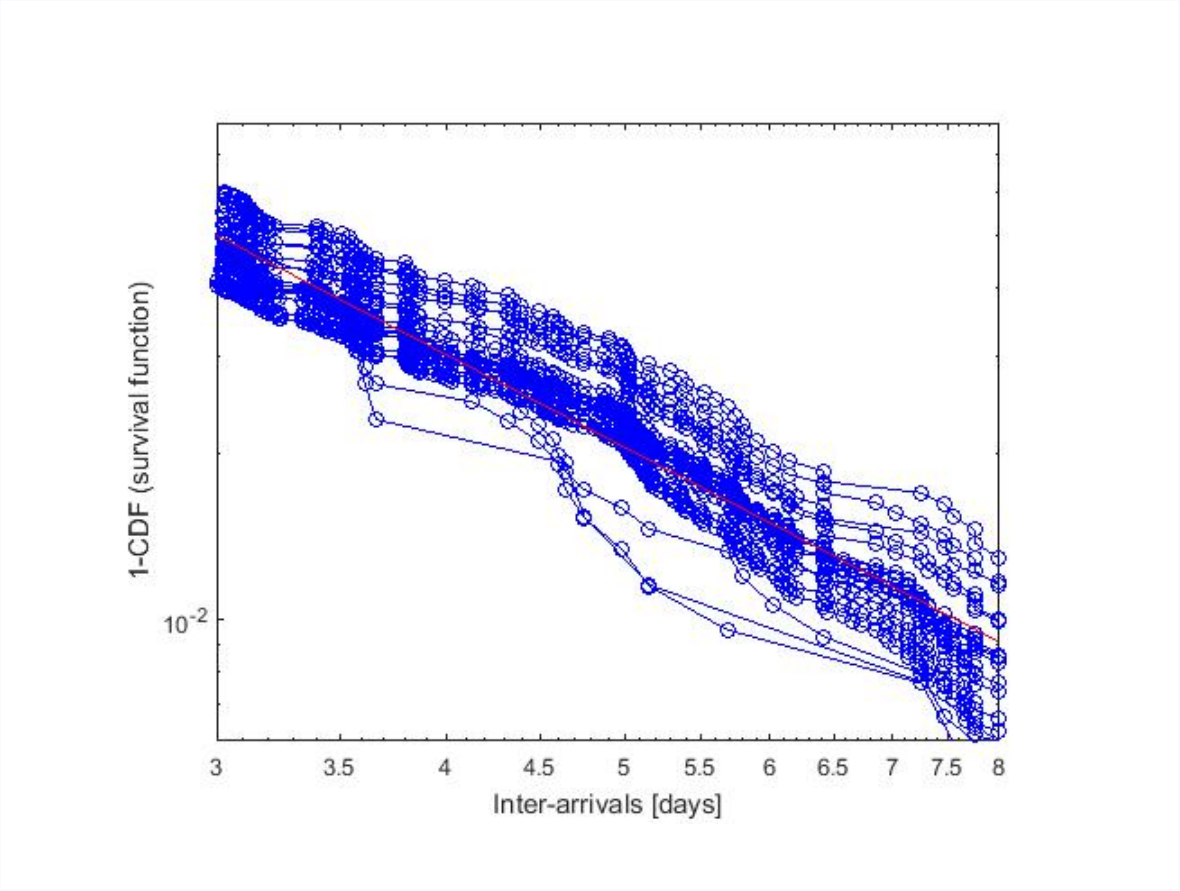
The aforementioned zero-threshold limit, when applied to β–log–α-stable multifractal multifractal models, results obviously in a monofractal β–model, whose interarrivals exhibit a power-law asymptotic distribution, when we take the limit in the formulae derived in 2013.

β–model realization interarrival CDF



18–year ensemble of interarrival CDFs from Florence

15 out of the 18 years show remarkable parallelism, with a power–law "tail" of exponent (log–log slope) of -1.737.



Thank you!