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Comparison of a deterministic model, a stochastic multifractal model and radar rainfall data

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Two primary approaches to model rainfall are the stochastic approaches, which aim at mimicking the rain phenomenology, and the deterministic approaches. The latter mainly rely on geophysical fluid dynamics equations, in particular the Navier-Stokes equations. Solving these equations require simplifying assumptions such as parameterization and scale truncations. In the present case, we used Meso-NH model, which is a meteorological non-hydrostatic mesoscale model developed by Meteo-France/CNRM and Laboratoire d'Aérologie (Toulouse, France).
Multiplicative cascade models, which are physically based models involving huge ratios of scales and intensities, allow to bridge the gap between the two previously mentioned methods. In this study, we considered a multifractal space-time cascade model, whose space-time anisotropy is defined with the help of a unique scaling exponent. We worked in the framework of universal multifractals in which the scaling variability and the extremes of the rain are quantified with the help of three parameters.
The rainfall outputs of the Meso-NH model and the radar data were analyzed in the framework of the stochastic model. We selected a case study corresponding to a heavy rainfall event in the south of France. Both data sets exhibit a similar qualitative multifractal behavior in accordance with the framework of a unified space-time scaling model. Quantitatively, the estimates of the multifractal parameters suggest that the deterministic model under-represent the natural variability of the rainfall field.