Simulation of rain time series with zero rainfall and actual statistical distribution in a Universal Multifractal framework

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Abstract

Rainfall is the consequence of many complex physical processes that result in particular features (extreme variability, inhomogeneity, extreme values, and succession of wet and dry periods). It induces the complexity behind rain observation, making it a complex topic.
Simulation tools can be very helpful to generate synthetic rain fields able to represent the "true" rain features at small spatial or temporal scale. These rain fields can be the starting point of many studies like the test of the performances of a particular embedded observation device, beam filling effects, design of new systems, rain intercomparaison methods ... More generally the building of simulation tools can be seen as a crucial to improve remote sensing.

Due to its strong links with turbulence, precipitations have scale invariance properties leading to power law energy spectrum. Universal multifractal model (UMM) Schertzer and Lovejoy [1987] can be used to simulate geophysical fields with scaling properties. It is well suited for various geophysical fields where turbulence is involved. In the case of rain, the problem is more complicated because rain spectrum is composed of several scaling regimes mainly due to the alternation of dry and rainy periods (rain support). Indeed the UMM model does not allow generating zero values and thus to represent dry periods. It follows that the use of the standalone UMM model generates synthetic data do not exhibit all the statistical properties of an actual rainfall time series.

This study propose a calibration method of synthetic rain with multifractal properties, in order to generate rainfall time series with same multifractal properties, but also the same statistical distribution, than actual measurement. The starting point is a rainfall rate time series obtained with a disdrometer with a 15 seconds time resolution recorded for two years (2008 –2010) in Palaiseau, France.

The first part of the poster will focus on the properties on the observed data in term of energy spectrum, fractal analysis of the support and in term of multifractal analysis of the rainy periods. UMM parameters are estimated. The rainy and dry durations are analyzed and parameters of gev / Poisson distributions are estimated.

In a second part the 1D (time series) simulator is presented. Several properties of rainfall time series that are relevant to different use of rainfall data, like the development of

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methods for comparing observations at different spatial and temporal scale, were used to determine statistically the degree of agreement between the synthetic series and observed rainfall.
Finally, in the last part the extension to the simulation of 2D rain maps is discussed, we detail the stages required to step up to the 2D simulation and some examples of synthetic maps are presented.