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A rainfall simulator based on multifractal generator

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Abstract: The Precipitations are due to complex meteorological phenomenon's and unlike other geophysical constituents such as water vapour concentration they present a relaxation behaviour leading to an alternation of dry and wet periods. Thus, precipitations can be described as intermittent process. The spatial and temporal variability of this phenomenon is significant and covers large scales. This high variability can cause extreme events which are difficult to observe properly because of their suddenness and their localized character. For all these reasons, the precipitations are therefore difficult to model.
This study aims to adapt a one-dimensional time series model previously developed by the authors [Akrour et al., 2013, 2014] to a two-dimensional rainfall generator. The original time series model can be divided into 3 major steps : rain support generation, intra event rain rates generation using multifractal and finally calibration process. We use the same kind of methodology in the present study. Based on dataset obtained from meteorological radar of Météo France with a spatial resolution of 1 km x 1 km we present the used approach : Firstly, the extraction of rain support (rain/no rain area) allowing the retrieval of the rain support structure function (variogram) and fractal properties. This leads us to use either the rain support modelisation proposed by ScleissXXX [ref] or directly real rain support extracted from radar rain maps. Then, the generation (over rain areas) of rain rates is made thanks to a 2D multifractal Fractionnally Integrated Flux (FIF) model [ref]. This second stage is followed by a calibration/forcing step (forcing average rain rate per events) added in order to provide rain rate coherent with observed rain-rate distribution. The forcing process is based on a relation identified from the average rain rate of observed events and their surfaces.
The presentation will first explain the different steps presented above, then some results illustrating the simulator's capabilities will be provided. They show that the simulated two-dimensional fields have coherent statistical properties in term of cumulative rain rate distribution but also in term of power spectrum and structure function with the observed ones at different spatial scales (1, 4, 16 km2) involving that scale features are well represented by the model.

Keywords: precipitation, multifractal modeling, variogram, structure function, scale invariance, rain intermittency

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