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A two-dimensional stochastic rainfall simulator

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Context
- The Precipitations are due to complex meteorological phenomena
- Precipitations can be described as intermittent processes.
- The spatial and temporal variability of this phenomenon is significant and covers large scales.

Goal
- adapt a one-dimensional time series model previously developed by the authors [Akour et al., 2015] to a two-dimensional rainfall generator.
- Simulate realistic radar rain maps.

Data
MeteoFrance meteorological RADAR:
location : Trappes near Paris
Spatial resolution : 1 km
Temporal resolution : 5 min
Area : 130 km x 130 km
Date : year 2012 ( 103 200 rain maps)

Model
1- Simulation of rain support using SIS method
Sequential Indicator simulation
Hypothesis :
- isotropic and stationary
- spherical model
Variogram parameters are estimated on observed rain maps (Figure 2) Obtained parameters.

Simulation parameters:
Range: \( a \) uniform [10, 100]
Still: \( \alpha = 0.17 \)
Nugget: \( c_0 = 0 \)
occurrence probability \( \mu \) uniform [0.15, 1]

2- Simulation of rain events using multifractal model FIF
FIF (Schereter and lovejoy, 1987) parameters: \( \alpha = 1.60 \), \( C_1 = 0.10 \) et \( H = 0.40 \)

3- Renormalization
Following relationship is used:
\[
RR = \frac{RR}{\text{Mean}(RR)}
\]
where \( RR_m \) are randomly drawn following alpha stable distribution
alpha stable distribution parameters are estimated on 330 346 observed rain events (Figure 3).
Obtained parameters: \( \alpha = 1.18; \beta = 1; \gamma = 0.03 \) s
\( \mu = 0.09 \) s \( + 0.65 \)
where s is the event surface

4- Transition processing
Following relationship:
\[
F(z) = \min(|z-y|)
\]
normalized and \( \epsilon \) [0,1]
\( z \in \{ x, l(x) = 1 \} \)
\( y \in \{ x, l(x) = 0 \} \)
\( l(x) \) Rain support

Reference
- generalization of the one-dimensional model (akrour and al. 2015) to a two-dimensional model.
- The simulated two-dimensional fields look realistic, they moreover have coherent statistical properties (cumulative rain rate distribution, power spectrum and structure function) with observed one.
- The proposed simulation processes is very general and can be adapted to any climatic area