

Downscaling of Radar-Rainfall Fields Using Multiplicative Random Cascades

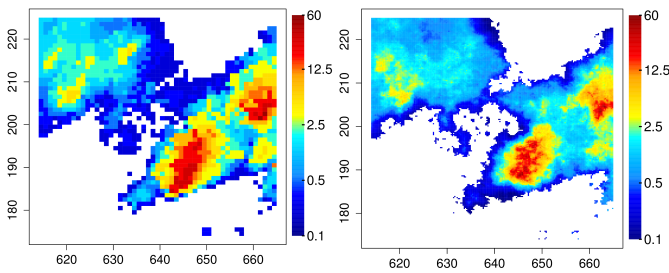


Fig 1: Example of original and downscaled rainfall field

Motivation:

Modern hydrological models require high-resolution rainfall inputs. Radar and satellite often do not satisfy these requirements. Downscaling is a technique by which the resolution of an original image is increased. Many different methods have been proposed to do this. Among the most popular ones are random multiplicative cascades.

Multiplicative random cascades:

A random cascade is an iterative process during which an original signal is successively redistributed over smaller and smaller grids cells based on random weights drawn from a given probability distribution. A well-known problem of traditional multiplicative cascades is that they struggle to reproduce the intermittency of rainfall (i.e., the dry regions).

A new approach to downscaling rainfall:

In 2016, Schleiss and Smith proposed a new mathematical representation of rainfall based on the notion of “inter-amount times”. The approach is equivalent to adaptive sampling (see below). Its main advantage is its ability to deal with intermittency, making it promising for rainfall downscaling.

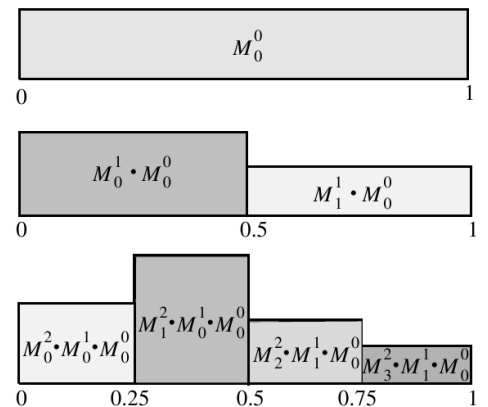


Fig 2: Illustration of a multiplicative cascade

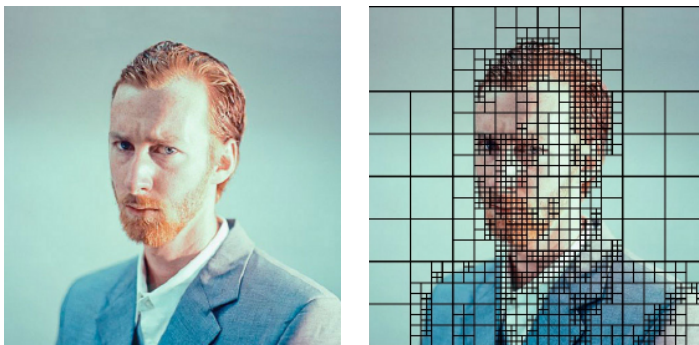


Fig 3: In adaptive sampling, the resolution of pixels is adapted to the local variability.

A new type of multiplicative cascade:

The goal of the proposed thesis will be to implement a new downscaling technique based on the notion of inter-amount times. The new method will be applied to real radar-rainfall fields collected over the Netherlands. Its accuracy will be compared to that of classical multiplicative random cascades to assess the benefits and limitations of each approach.

Objectives:

- (1) Analyze the scaling properties of rainfall fields using the classical and adaptive sampling framework.
- (2) Train a downscaling algorithm based on the notion of adaptive sampling.
- (3) Perform synthetic experiments to compare the performance of the two downscaling methods as a function of spatial correlation structure and intermittency.

Keywords: downscaling, random cascades, statistical methods