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Local modelling of spatial rainfall patterns and their dynamics

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The characterization of rainfall spatial and temporal variability is a longstanding challenge. Since the physical processes responsible for rainfall generation are still only partially understood, stochastic methods have been widely used to characterize and model rainfall. These models have continuously evolved in the last decades to fit instrumental improvements in resolution and accuracy. Data and models at the 1km x 1km x 5min resolution are nowadays available for applications where the local features of the rain field are important.

Here we propose to study the structure of the rain at a finer resolution, i.e. 100m x 100m x 30sec in order to investigate rainfall variability within a single pixel of current models. The focus is on characterizing and reproducing rainfall patterns and their dynamics at the scale of interest. Relevant data are collected by new high resolution drop counting rain gauges (measurement precision: 0.01mm rain height, integration time: 30sec) set up in a dense local network (area coverage: 1km2 number of gauges: 8, gauge spacing: 50-800m).

Starting from these data, the spatial and temporal correlation structures of the rain field are analyzed using geostatistical tools. Results show that despite a strong variability, the rain field presents a degree of spatial and temporal coherence at the extremely small scales considered here. After data analysis, a stochastic rainfall model based on a meta-Gaussian random field is proposed to characterize and reproduce the observed small-scale rainfall patterns, i.e. the advection and morphing properties of rain cells over time, the intermittency and the skewed distribution of rainfall, and the decrease of the rain rate near the rain cell boundaries. Finally the performance of the model is tested (1) in terms of reproduction of space-time statistics in non-conditional simulations, and (2) in terms of prediction of rain rate time series at ungauged locations using conditional simulations.