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Evaluation of a conditional simulation approach to quantify the uncertainty in spatial rainfall

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Rainfall is one of the most important inputs of hydrologic models. Lumped models use the areal rainfall as input (i.e. the rainfall spatially averaged within the catchment boundaries), while distributed models use the whole rainfall field. In both cases, understanding and quantifying the spatial variability of rainfall is required to improve the calibration and prediction of hydrologic models.

Unfortunately, spatial rainfall is not measured directly. Instead, it is generally estimated based on: (i) (sparse) measurements from the raingauge network; (ii) (imprecise) indirect radar estimates; or (iii) a combination of them. Such estimates are affected by significant uncertainties that need to be quantified.

This poster focuses on the estimation of spatial rainfall based on raingauge measurements, and aims at assessing the reliability of a geostatistical approach to quantify the uncertainty in spatial rainfall. This approach is based on a spatio-temporal rainfall generator (TBM) used in conditional simulation (CS) mode: the generated rainfall fields match the observed values at the raingauge locations, but differ elsewhere. In other words, the rainfall generator simulates multiple realizations of the rainfall in between raingauges, therefore quantifying the uncertainty associated with the incomplete spatial coverage of the raingauge network.

A case study is used to illustrate the application of the TBM rainfall generator and to assess the reliability of its conditional simulations. It is based on hourly data from 64 raingauges over the period 2000-2008, located within or near the Ardèche catchment at Sauze (South-Eastern France, 2240 km^2). 25 raingauges are used to calibrate the TBM rainfall generator, which includes: (i) a clustering procedure to define a restricted number of homogeneous “rainfall types”; (ii) the estimation of the geostatistical properties of rainfall within each type (spatial and temporal variograms, local distribution). The conditional simulation of 100 replicates (using the 25 calibration raigauges as conditioning values) is then performed. Those 100 CS replicates are finally evaluated against 39 validation raingauges, which were use neither for calibration nor for conditioning. Overall, this validation exercise highlights an acceptable reliability of the CS replicates. However, the reliability differs significantly for different rainfall types: in general, CS replicates are far more reliable for heavy autumnal rainfall types than for types corresponding to small and scattered rainfall events. These results suggest several avenues to improve the geostatistical model behind TBM.