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Abstract

Remotely sensed weather radar images and in situ rain gauge measurements are complementary sources of information to reconstruct rain fields precisely and exhaustively. Conventionally, radar images are acknowledged to provide a proper characterization of rainfall space-time variations, while rain gauge measurements are viewed as more accurate, but spatially sparse. Although appealing to obtain reliable and spatially dense rainfall reconstructions, the coupling of radar images with rain gauge measurements remains challenging. This is mainly because the supports of these two types of observations are very different: a radar pixel covers around 1km^2 and is acquired instantaneously, while a rain gauge collects rain water over area <1m^2 and integrates measurements over periods ranging from minutes to hours. Within the geostatistical framework, the usual procedure for merging radar and rain gauge data is by kriging with external drift (and sometimes co-kriging), considering rain gauge measurements as the primary variable and radar observations as a covariate.

We propose here to adopt a different perspective for the case where high resolution rain field reconstructions are desired over areas of small extent (a few square kilometers), as is often the case in urban hydrology. In the proposed approach, a dense network of rain gauges is used to infer the local space-time structure of rainfall, while radar images provide coarse (because spatially averaged) but exhaustive rainfall measurements. These two sources of data are merged using a stochastic rainfall model that accounts for most of the space-time features of local rain fields, in particular rain intermittency and rainstorm advection - diffusion. Model parameters are first inferred from the rain gauge observations only. Next, stochastic simulations are carried out to generate an ensemble of high resolution (100m in space, 1min in time) synthetic rain fields conditioned to the available observations (i.e. radar and rain gauge data). In practice, a Gibbs sampler is used to honor both spatially averaged radar observations and punctual rain gauge measurements. The resulting ensemble of rain field realizations can then be used as input for urban hydrological modeling.