

4.3 A NEW MULTIPLICATIVE RANDOM CASCADE MODEL FOR DOWNSCALING INTERMITTENT RAINFALL FIELDS

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Stochastic rainfall downscaling algorithms are statistical methods designed to artificially enhance the resolution of rainfall measurements. Many of them are built on the notion of multiplicative random cascades. They assume that the spatial organization of precipitation is the consequence of a process during which water is redistributed over smaller and smaller grid boxes. One of the most controversial aspect of such an approach is the way zero-rainfall values are produced during the cascade. Lots of efforts have gone into solving this issue but so far downscaled fields still exhibit rather unrealistic spatial structures and intermittency. To overcome these issues, I explore a new way of downscaling rainfall using a combination of random cascades and adaptive sampling. The cascade works by prescribing a maximum bucket capacity $b > 0$ to each grid box in the original domain. As long as the total volume of water in a grid box exceeds this maximum capacity, the box is split in two smaller sub-regions with equal amounts of water (i.e., half that of the parent grid box). However the areas over which these equal amounts of water get redistributed can be vastly different. The underlying probability distribution governing how redistribution takes place is modelled by a logit-normal distribution with zero mean and variable standard deviation. The cascade ends when the amount of water in all grid boxes is less than the maximum bucket capacity. The result is an irregular grid with grid boxes of various sizes and shapes depending on the local rainfall intensity. The latter is then re-sampled over a regular grid, which gives rise to intermittency without the need for any arbitrary thresholding. To help you understand how the technique works, I show two examples of downscaled radar rainfall fields over the Netherlands. The first represents a stratiform event with moderate intensities and the other is a strongly convective event with large amounts of intermittency. The fraction of zero-rainfall values and the variograms of the downscaled occurrence/intensity fields are used to assess the performance of the downscaling algorithm and outline some of the advantages and limitations of this new way of downscaling rainfall using adaptive grid box sizes.