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Generating spatial precipitation ensembles: impact of temporal correlation structure

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Precipitation is the most dominant input term determining the hydrological response at the catchment scale. For both scientific and applied hydrological studies one is interested to have a sound spatial estimate of precipitation and its uncertainty. Sound spatially distributed rainfall fields including a proper spatial error structure can be obtained by conditional simulation, which unlike kriging interpolation does not only provide the best local estimate, but generates realizations which match the sample statistics and can also be conditional on the neighbouring estimates. Both interpolations and conditional simulations have their origin in the spatial domain and do not primarily take into account the temporal evolution of the spatial field. Nevertheless, the large temporal variability of precipitation is important to be considered together with its spatial variability within the whole ensemble. This can be achieved using spatial conditional simulations which are made conditional on previous simulations back in time.

Synthetic and real world experiments are carried out within the hilly region of Belgian Ardennes. 27 hourly rain gauges are available within the simulation domain with an area of 10 000 km^2. Precipitation fields were simulated on a grid with 10 x 10 km^2 raster resolution. The analysis tested the uncertainty in the simulated fields based on 1) the number of previous simulation hours, on which the new simulation is conditioned, 2) the advection speed of the rainfall event, 3) the size of the catchment considered and 4) the rain gauge density within the catchment. The results show that for typical advection speeds of >20 km/h no uncertainty in terms of across ensemble spread (expressed using coefficient of variation) is added to simulated precipitation fields by conditioning it on more than one or two previous simulations. Moreover, by halving the observation network, i.e. using 14 rain gauges, the uncertainty in simulations increases only slightly.