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Influence of meteorological conditions on local space-time rainfall patterns

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Rainfall is generated by diverse and complex processes that produce rain fields with a large variability of patterns. One option to explore the diversity of rain fields over a given area is to define local rain types, i.e. groups of rain fields sharing similar patterns. This can be done by unsupervised classification (i.e. clustering) of the space-time statistical signature of rain as observed in radar images. The characterization of individual rain types, as well as the analysis of the occurrence of rain types throughout the year, are important to understand and quantify the impact of rain on the environment (e.g. on hydrology, sediment transport or plant growth).

Here we propose to study the influence of local meteorological parameters, namely pressure, temperature and humidity, on the occurrence of rain types over a 60 km x 60 km area situated in the Swiss Alps. To this end, we first explore the statistical relationships existing between the meteorological covariates and rain type occurrences. Then, we compare two methods to simulate rain type time series conditional to the meteorological variables, more precisely: a parametric approach based on a nonhomogeneous Markov model, and a non-parametric approach based on multiple-point statistics.

In the end, the proposed framework links the occurrence of rain types with meteorological covariates, and thereby allows to stochastically simulate ensembles of equiprobable rain type sequences conditioned to meteorological conditions. This paves the way to the simulation of rain type time series in the context of climate change, by first simulating the meteorological covariates using a climate model, and then stochastically generating rain types conditional to these covariates.