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Understanding rainfall extreme values in Tuscany (Italy)

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The changes in extreme events, that may accompany climate change, are of particular concern not only for scientists but also for a large part of public opinion as they hold the most potential for negative social and environmental impacts. An important part of climate science is related to the modifications inherent the hydrologic cycle. Among all the components of hydrologic cycle, rainfall is considered a highly valuable climatologic variable. Rainfall characterization has in fact important repercussions, among others, on flood risk mitigation and drought assessment, on water resources availability and management as well as on climate change scenarios definition. The analysis of rainfall extreme values and the study of their spatial distribution are carried out in many environmental studies with the aim to identify protection systems and to define mitigation interventions against the negative implications of their changes. For such specific issues ad hoc investigations tools are required.

The study area is the Tuscany Region, in Central Italy. The dataset is composed by the time series of annual rainfall maxima of different durations (i.e. 1 day, 1, 3, 6, 12, and 24 hours) of about 700 recording rain gauges, spatially distributed over an area of about 23.000 km2. The record period covers mainly the second half of 20th century.

We use here a hierarchical modeling approach to investigate a collection of spatially referenced time series of rainfall extreme values. We assume that the observations follow a generalized extreme value (GEV) distribution whose locations are spatially and temporally dependent where the dependence is captured using a geoadditive model. Geoadditive models analyze the spatial distribution of the studied variable while accounting for the explicit consideration of linear and nonlinear relations with relevant explanatory variables, as well as the spatial correlation described by a standard spatial autocorrelation function. Under the additivity assumption they can handle the covariate effects by combining the ideas of additive models and kriging, both represented as linear mixed model. This approach, based on the generalized mixed model/splines paradigm, has achieved a valuable success during the last decade as useful tool with which to study the spatial distribution of climate variables as well as in other contexts. The preliminary results of the analysis are described and discussed here.