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# Spatial-Temporal modelling of extreme precipitation in Brandenburg-Berlin, Germany, of observations and regional climate models

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Precipitation is an important climatic variable and relevant to everyone's social life. Extreme precipitation, particularly, is one of the most frequent and widespread severe weather hazards that may lead to flooding and landslides. For example, in 2018, the central Europe has experienced one of the severest hazards which caused by extreme precipitation with damages of 200 million Euros and 69 deaths. The extreme precipitation event has widely affected many European countries, including Germany, Italy and Spain. Therefore, assessing the risk of extreme precipitation on a region plays a crucial role for hazards risk assessment. It is also an urgent demand for hydrology, agriculture and insurance.

A traditional approach of risk analysis is based on the estimation of high quantiles of extreme distribution on each observation, the so-called return-levels. For univarite extremes, the Generilaized extreme value (GEV) distribution is used to fit to the maximum value in a fixed block, and such quantiles 90%, 95%,98% are called 10,20,50 return levels. However, extreme events do not occur at one single point, but distribute continuously in space. As we expect, there will be a strong correlation between the maximum precipitation at relatively short distances, and it must be accurately included when the risk is assessed. For example, if we estimate the 20 year return-level extreme precipitation over three stations, the probability that all the three observations exceed their 20 year return level in the same year is 0.000125, which is severely underestimate and not the real case. In fact, a 20-year precipitation event intended to occur simultaneously at the closely neighbouring locations. So evaluating return level on each station individually is not enough to get the accurate risk analysis results. To solve this problem, a statistical model for extreme precipitation on a continuous space, accounting both the spatial and temporal variability is needed.

We provide a max-stable statistical model for maximum precipitation in summer and winter on a in Brandenburg and Berlin,Germany, accounting for both the spatial and temporal variability. We also aim to address the following questions: (i) How is the spatial dependence of extreme precipitation is like and how well does a max-stable statistical model represent the extreme precipitation, in both temporal and spatial field? (ii) Compared with regional climate model, which one is better, in the aspect of extreme modelling?

With the well-performed statistical model, we are able to estimate the risk that extremes occur simultaneously over multiple locations. We can even make predictions of extreme precipitation with the temporal covariant in the model.