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Published in:
Geophysical Research Abstracts

Publication date:
2012

Document Version
Publisher's PDF, also known as Version of record

Geophysical Research Abstracts
Vol. 14, EGU2012-4092, 2012
EGU General Assembly 2012

Variations of extreme rainfall events in space and time

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In the ongoing climate change discussion, methods for identification of variability governed by climate change are important tools. The magnitude of variables that can describe this variability should be compared with magnitudes of variables describing variability in a stationary setting. This study focuses on variations of extreme rainfall events, observed at 70 different locations in Denmark over a period of 31 years. The aim is to identify and compare variables, both spatially and temporally, which can explain different parts of the variability in this data set. Assuming that the number of extremes at each location is generated by a point process, we develop a spatio-temporal model based on Poisson regression. The starting point of the analysis is two marginal models formulated for number of events 1) averaged over all years of observations 2) averaged over all measurement sites. The first resembles a classical regional extreme value model, which includes the spatial correlation between the observations and a weighing based on the number of active observation days at each site. The latter resembles a Generalized Least Squares regression, with a weighing based on the number of active measurement sites each year.

To explain the observed variability we consider the mean annual precipitation at a given location as a spatial regression variable. As temporal variables we consider both local variables, like the average Danish summer temperature in a given year, and large-scale variables like the variety of well-known teleconnections in the Northern Hemisphere. The analyses are performed for rainfall of 10 min and 24 hour duration, to represent different rainfall characteristics relevant to urban hydrology. We find that the mean annual precipitation explains a significant amount of the spatial variation, whereas annual variations are related to changes in the average Danish summer precipitation, the average Danish summer temperature and the East Atlantic pattern. The spatio-temporal Poisson regression model was found to be a helpful tool when comparing the internal importance of these variables. Still there are challenges when we explicitly model the number of extreme events at a given year, at a given location. It was found that the goodness of the model highly depends on assumptions in the generalized linear model, notably the link function between the continuous regression model and the observed count process and that the count process follows a Poisson distribution.