Spatial and temporal extremes in hydrology

Advisor
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Research topic
Engineering design of hydraulic structures is related to precipitation and is frequently based on extreme value statistics. The statistical investigation of extremes is usually conducted for single locations. For precipitation this approach is not appropriate as critical water volumes require heavy precipitation over an area and with a certain duration. This changes the traditional univariate extreme value investigations to a multivariate case. Both temporal and spatial dependence structures of rainfall fields are of central importance. Intensity duration frequency curves (IDF) and area reduction factors (ARF) are the traditional tools used by engineers. Their development is based on a few simplifying assumptions, which under circumstances may be inappropriate. A careful study of rainfall fields observed at close locations and a parallel investigation of radar fields can describe the particular properties of extreme precipitation events in space and time. These properties are likely to be related to general climatic conditions and can thus be used to provide guidelines for changes of extreme hydrological events under climate change.

Methods to be used
The doctoral student will first have to do a literature review to provide an overview of existing methods and of geostatistical approaches for the description of spatial random fields. Spatial copulas will be used to describe dependence structures of observed point precipitation. Spectral methods will be used to investigate the spatial structure of radar images corresponding to extreme events.

Research goals
The overall goal of this work is the development of a stochastic simulation model of extreme precipitation fields.
A corresponding numerical scheme for the numerical simulation and a computer code are the final products of the research. This generator should provide input to hydrological models used for design.

Research environment
The doctoral student will find a strongly interdisciplinary working group. The main research topic of the group is in stochastic hydrology and uncertainty quantification for hydrological models. The applicant will have contact to other PhD students working on various topics including climate change, stochastic rainfall modelling or optimal use of radar data for precipitation estimation.

Prerequisites
Background and experience in probability and statistics is preferred. In order to cope with the large amount of data (radar images) good knowledge of a programming language (preferably Python or FORTRAN) is required.

Contact for questions
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