2018-00495 - [PostDoc2018-LEMON] Simulation of spatio-temporal fields of rainfall integrating extremes events to assess the impacts of floods

Level of qualifications required: PhD or equivalent
Function: Post-Doctoral Research Visit

About the research centre or Inria department

The Inria Sophia Antipolis - Méditerranée center counts 37 research teams and 9 support departments. The center's staff (about 600 people including 400 Inria employees) is composed of scientists of different nationalities (250 foreigners of 50 nationalities), engineers, technicians and administrators. 1/3 of the staff are civil servants, the others are contractual. The majority of the research teams at the center are located in Sophia Antipolis and Nice in the Alpes-Maritimes. Six teams are based in Montpellier and a team is hosted by the computer science department of the University of Bologna in Italy. The Center is a member of the University and Institution Community (ComUE) “Université Côte d’Azur (UCA).

Context

LEMON is a Montpellier-based research team in applied mathematics working on the design, analysis and application of deterministic and stochastic models for processes that occur in the coastal region. This area can be seen as the natural interface between various environments: sea, sandy bottom, urban coastal areas, river deltas, lagoons, etc. Our objective is to build and improve models to simulate those systems and to couple them (together or with external data) in order to produce a global forecasting system that better accounts for the variety of natural phenomena. The candidate will be affected to the Lemon team. The recruited person will also work in collaboration with University of Montpellier, IRD and INRA. The collaboration with these other partners has first been formalized thanks to the Cerise project funded by LEFE/INSU (http://cerise.msem.univ-montp2.fr/). Its strength is to bring together scientists with both theoretical and more applied statistical research interests. Therefore, our aim is twofold: on the one hand, the development of stochastic methods for the realistic simulation of spatio-temporal processes integrating extreme events, and on the other hand, tailoring the stochastic generators to the needs of hydrological models.

Assignment

The principal goal for this postdoc project is to develop a stochastic precipitation generator that is capable of producing precipitation fields that include extreme rainfall but also dry and ordinary (i.e., non extreme) wet periods in order to feed spatialised hydrological models to assess the impacts of floods.

The study area is the French Mediterranean basin known for its intense rainfall events called «Cevenol episodes», which have recently received increased attention.

A first task will consist in studying and utilizing the data to understand and model the space-time structure of hydrological extremes, such as those observed in this area.

Indeed, such knowledge is essential for constructing stochastic methods for the realistic simulation of spatio-temporal fields of rainfall integrating extremes events.

To solve this problem, two major issues must be tackled. The first one is the development of stochastic methods for the simulation of extreme spatio-temporal processes of realistic rainfall. This requires the construction and estimation of large-scale spatio-temporal extreme generator models, where we combine suitably designed resampling schemes with appropriate modeling assumptions motivated by extreme value theory to deal with the high dimensionality of data. This first step is essential but absolutely not sufficient to achieve the intended purpose. Indeed, if we want to feed simulations to deterministic models such as rain-flow models, we must tackle the second issue, that is, be able to integrate these extreme event simulations into realistic simulations of complete rainfall chronicles including non extreme rainfall. Far from being straightforward, this combination of extreme and non-extreme scenarios represents a true challenge to ultimately develop the generator which will be used with hydrologists as input to their numerical models.

Main activities

The postdoc will:

- work on precipitation reanalysis data available at an hourly time-step and 1km spatial resolution, obtained by combining radar reflectivity with rain gauge observations. This data...
The large size of this high resolution data set presents an additional challenge for the statistical modeling of spatio-temporal extremes. In particular, the postdoc will explore and model the space-time structure of such hydrological data.

- learn and re-use the methods and algorithms which have already been developed by the team.
- propose new methods and algorithms in order to simulate extreme precipitation with respect to two important aspects: i) adapting well-studied spatial modeling techniques for extreme events based on asymptotically justified models for threshold exceedances to the space-time setup and ii) capturing the strength of potentially decreasing extremal dependence when moving towards higher values, which requires developing models that allow for so-called asymptotic independence.
- integrate these extreme simulations into a more general stochastic precipitation generator of complete long-term space-time precipitation scenarios with realistic transitions between dry, common wet and rare extreme episodes. Existing spatial precipitation stochastic generators are generally based on a Gaussian spatial process which are not adapted to generate extreme rainfall, but periods with high values in their simulations could be suitably replaced with our improved simulations of realistic extreme events.
- review and extend existing computer code from the team, integrate the newly developed methods, and encapsulate the key components of the code in an R package for public use
- feed hydrological numerical models with such simulations and participate in the interpretation of the results

**Skills**

The candidate should have a PhD in statistics and solid skills in probability; knowledge of extreme value theory with a focus on spatial extremes and/or space-time modeling is desirable. Additionally, she/he should have a proven interest in environmental sciences and should be capable to exchange with hydrologists. Programming experience in R is required, paired with at least basic knowledge in the statistical treatment of high-dimensional datasets.

**Benefits package**

- Subsidised catering service
- Partially-reimbursed public transport
- Social security
- Paid leave
- Flexible working hours
- Sports facilities

**Remuneration**

Gross Salary: 2650 brutto per month