



Four PhD positions on the attribution of extreme climate events

General overview

Europe and other mid- and high-latitude regions in the world have experienced a number of unprecedented extreme climatic events in the past years, in particular heatwaves and droughts, as well as catastrophic floods like those that occurred in Belgium in the summer of 2021. *Attribution* is the research area at the crossover of climate science and statistics that aims at evaluating the relative contributions of different causal factors to the occurrence of extreme events. It serves in particular to pinpoint the possible role of anthropogenic climate change in these extremes.

We are seeking **four talented PhD candidates** to join us in the effort to **better constrain the probabilities of occurrence of past and future extreme events and to arrive at robust attribution statements that do not understate nor overstate the future risks society will face**. The different positions, described in further detail below, are centered around different types of climate events (*floods* over Europe, *heatwaves* and compound *drought-heat* events over Europe, and *sea ice extent reduction* in the Antarctic), each leading to distinct methodological challenges.

This interdisciplinary project involves multiple research institutes: the Namur Institute for Complex Systems ([naXys](#)) at UNamur, the Earth and Climate Center (part of [ELI](#), the Earth and Life Institute) at UCLouvain, and the institute of Statistics, Biostatistics and Actuarial Sciences (part of [LIDAM](#), the Louvain Institute of Data Analysis and Modeling in economics and statistics) at UCLouvain.

The PhD grants are financed through the *Action de Recherche Concertée (ARC)* called **EXALT - EXtreme weather Attribution at mid- and high-Latitudes using advanced statistical Techniques**, under the supervision of profs. Francesco Ragone, François Massonnet and Johan Segers from UCLouvain and Anna Kiriliouk from UNamur. For more information, please see the project website:

<https://exalt-project.github.io/>.

Position 1: attribution of European floods

Main affiliation	UNamur
Secondary affiliation	UCLouvain
Keywords	Attribution, Extreme-value theory, Floods, Non-stationarity

The PhD candidate will investigate flexible and physically realistic non-stationary extreme-value models for attribution of heavy precipitation and floods over different regions of Europe. In particular, the candidate will identify physical covariates that take into account the regional response to climate change in both thermodynamical and dynamical properties.

Different models with different covariates are expected to be selected for different regions of Europe. A first broad-scale differentiation will be made in terms of Central-Northern Europe versus Southern

Europe and the Mediterranean area, justified by the expected response of the atmospheric circulation to climate change. After a general analysis, the candidate will zoom in on regions that recently experienced unprecedented floods (Belgium, Northern Italy and Southern France), and use the developed models to arrive at an attribution statement.

Position 2: attribution of European heatwaves

Main affiliation UCLouvain
Keywords Attribution, Clustering, Extreme-value theory, Heatwaves, Tail dependence

The PhD candidate will focus on the attribution of European heatwaves using multivariate techniques that take into account spatio-temporal dependence and compounding mechanisms between high temperature and soil dryness.

In particular, the candidate will develop (bivariate) spatial extreme-value models for different classes of heatwave events in Europe, with the aim of better identifying typical regional heatwave patterns within Europe and analysing concurrent drought-heat events. Finally, the candidate will detect and attribute changes in the properties of heatwaves in response to increased CO₂ emissions, provide robust estimates of return periods for recently observed events (such as the 2023 Cerberus heatwave), and quantify the increase of the risk of heatwave events in future scenarios.

Position 3: attribution of European droughts

Main affiliation UCLouvain
Keywords Attribution, Droughts, Extreme-value theory, Non-stationarity, Rare event algorithm

The PhD candidate will focus on the attribution of European droughts using multivariate techniques that take into account spatio-temporal dependence and compounding mechanisms between high temperature and soil dryness.

In particular, the candidate will analyse the multi-year temporal compounding aspect, the relation with surface temperature anomalies at seasonal and inter-annual scales, and the relation to the low frequency variability of the atmosphere. In addition, large datasets of extreme multi-year droughts will be generated with rare event algorithms applied to numerical climate models of different complexity. Finally, non-stationary extreme value models will be developed to quantify future changes in the probability of occurrence of prolonged extreme droughts and to arrive at solid attribution statements for recent events.

Position 4: attribution of low Antarctic sea ice

Main affiliation UCLouvain
Secondary affiliation UNamur
Keywords Attribution, Extreme-value theory, Non-stationary, Sea ice extent, Tail dependence

The PhD candidate will use multivariate techniques to obtain better insight in the nature of Antarctic extreme sea ice states and to arrive at a robust and precise attribution statement of recent record lows.

Regional aspects are key to understand Antarctic sea ice dynamics. The Southern Ocean is comprised of several sub-basins. The seasonal development of sea ice, as well as its inter-annual variability, are dictated by processes that are basin-specific. The PhD candidate will characterise the tail dependence between the sea ice extent in these five sub-basins and select appropriate multivariate extreme-value models. Next, he/she will make an observation-based attribution statement, which will be complemented by a storyline approach based on the use of a climate model.

Practical information and expected profile

We offer:

- full-time four-year PhD grants, starting from October 1st, 2024, or later
- a net salary of around 2400 euros/month (including social insurance and transportation to / from work)
- an international and multidisciplinary working environment
- travel opportunities for attending scientific conferences and doing research visits
- access to a high-performance scientific computing environment
- opportunities to gather experience in teaching and consultancy

The values underlying the staff policy at UCLouvain are described [here](#).

Expected profile: you are holding a master degree (120 ECTS) in statistics, mathematics, physics, climatology, earth sciences, engineering, or a similar domain. Your skills and interests include

- statistical modelling
- programming skills in, for instance, R and/or Python
- fluency in English, spoken and written
- autonomy, a sense of initiative and proactivity
- experience with extreme-value theory and/or the analysis of climate data is a plus

How to apply: please mail your CV, motivation letter, names and contact details of at least two reference persons, and a list of your master courses and grades to Anna Kiriliouk (anna.kiriliouk@unamur.be) with subject "EXALT PhD application" at your earliest convenience. You can apply to a specific position, or to all of them at once.