PROJECT TITLE: Climate change's impact on extreme European rainfall

DTP Research Theme(s): Changing Planet
Lead Institution: University of Bristol
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Project keywords: climate change; extreme weather; drought; flooding; climate modelling

Somerset Levels floods in 2014

2022 UK drought

Project Background

Climate change will have major effects on the risks of extreme rainfall in Europe, which is a primary cause of flooding and drought, two of the biggest dangers we face. Events like the flooding in the UK in 2014 and the 2022 European drought are expected to become more likely. However, it is still uncertain how large future changes in extreme events like these will be, making it difficult to apply our knowledge to adaptation and disaster risk reduction. This is because extreme events are rare, so we cannot obtain large samples of observed extremes to learn about them, and typical climate modelling experiments also do not sample enough of them. There are also large fundamental uncertainties about how driving weather patterns will change – for example, how far the jet stream location will shift in future. Better understanding of the risks of these extreme weather events are highly important for work such as the UK government Climate Change Risk Assessments. This project will help to fill this gap.

Project Aims and Methods

The goal of this project is to deliver new understanding of changes in these climatic extremes using state-of-the-art climate simulation datasets. These include multi-thousand-year simulations (e.g. from www.climateprediction.net) that sample large enough numbers of extreme weather events to allow them to be systematically studied. We will use these to understand how climate change will affect the risks of extreme European rainfall. One key science question that will be tackled is understanding how changes in these weather extremes are linked to changes in the behaviour of atmospheric features like the jet stream, and how risks vary across different scenarios for how these large-scale patterns will change. This will allow us to show the most severe plausible scenarios for how the risks of extreme rainfall will change as the world warms, which is crucial so that planners can be prepared for all possible eventualities. If the student is interested, there will also be opportunity to use new machine learning methods developed in our group to predict very high-resolution rainfall – a first for combining these with large climate simulation datasets to study extremes at high-resolution. And there will also be an opportunity to use UK hydrological models, which convert rainfall data to river flows, to derive corresponding flooding and drought risks. Under the supervisors' guidance, the student will be encouraged to develop the research direction to best reflect their interests and strengths.

Candidate requirements

Candidates should be interested in understanding how climate change will affect extreme extratropical weather. They should have strong quantitative skills (e.g. from studying a physical science, mathematics or a related subject) and be interested in developing skills in computer programming in order to run models and carry out numerical analysis on large datasets. Prior experience with a relevant programming language like Python or Matlab and using Unix-like systems would be an advantage, but is not a requirement.

We welcome and encourage student applications from under-represented groups. We value a diverse research environment.

Project partners

This project benefits from a **CASE partnership with the Met Office**. Dr James Pope in their Applied Science & Scientific Consultancy division will co-supervise and provide expertise on directing the research to answer the most important questions about climate change impacts. There will be opportunity for the student to do work placements at the Met Office to broaden their network and perspectives and to present their research.

Training

The student will gain highly valuable experience from working in a multi-disciplinary team of internationally-recognised researchers. Our expertise includes using very large climate simulation datasets to model the impact of climate change on extreme weather (Dr Watson and Prof Mitchell), how rainfall extremes cause flooding and drought (Dr Coxon) and applying climate change research to address needs of decision makers and solve societal problems (Dr Pope and Prof Stainforth). The student will receive training provided by the DTP, including a Research and Training and Support Grant (RTSG) of £15,000 and a £3,250 training budget. They will be encouraged to present the results of the research internationally at conferences.

Background reading and references

- Recent papers using new multi-thousand-year climate simulations that we co-developed to study extreme rainfall:
  - Bevacqua et al., 2021 . "Larger spatial footprint of wintertime total precipitation extremes in a warmer climate". *Geophysical Research Letters*, 48, e2020GL091990. https://doi.org/10.1029/2020GL091990
  - Leach et al., 2022. "Generating samples of extreme winters to support climate adaptation". *Weather and Climate Extremes*, 36, 100419. https://doi.org/10.1016/j.wace.2022.100419
- On the importance of future changes in atmospheric circulation for climatic risks:
  - Shepherd, 2014, "Atmospheric circulation as a source of uncertainty in climate change projections". *Nature Geosci.*, 7, 703–708. https://doi.org/10.1038/ngeo2253
- A workshop paper on application of state-of-the-art machine learning methods to predict high-resolution UK rainfall from our group:
  - Addison et al., 2022. "Machine learning emulation of a local-scale UK climate model". *NeurIPS 2022 Workshop: Tackling Climate Change with Machine Learning*. https://www.climatechange.ai/papers/neurips2022/21

Useful links

School URL: http://www.bristol.ac.uk/geography/courses/postgraduate/

Bristol NERC GW4+ DTP Prospectus:
http://www.bristol.ac.uk/study/postgraduate/2024/sci/phd-great-western-four-doctoral-training-partnership-nerc/

How to apply to the University of Bristol:
http://www.bristol.ac.uk/study/postgraduate/apply/
Please note: If you wish to apply for more than one project please contact the Bristol NERC GW4+ DTP Administrator to find out the process for doing this.

The application deadline is Tuesday 9 January 2024 at 2359 GMT. Interviews will take place from 26 February to 8 March 2024.

For more information about the NERC GW4+ Doctoral Training Partnership please visit
https://www.nercgw4plus.ac.uk.

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