Project Title: Climate Drivers of Future Extreme UK Flood Risk

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Primary Supervisor: Dr Peter Watson
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Summary

Climate change will have major effects on the risks of extreme flooding in the UK. However, the magnitude and spatial patterns of the changes are still highly uncertain, challenging our ability to adapt and reduce disaster risks. A key part of this knowledge gap is the role of changing weather patterns in flood risk. This PhD project aims to address this by understanding the links between key weather drivers (e.g. the jet stream, storm frequencies) and surface and river flooding and illuminating how changes in these drivers affect future risk, enabling better quality projections.

We will use the latest atmospheric and hydrological science to both better constrain future risks and investigate the full range of plausible futures, including shedding light on potential severe outcomes e.g. the impact on future flood risk if multiple weather drivers are at the high end of projections. Understanding the links between atmospheric drivers and flood risk will also greatly clarify the reasons why flood risk is changing. We will focus on intensities of extreme events that are relevant for flood defence planning, up to and including those that occur only once every ~100–1000 years, applying the team's expertise in studying extreme weather and flooding.

Methods

We will combine state-of-the-art methods from both hydrology and climate science that have been pioneered by the team. We will examine how changes in major weather patterns affect flood risk in existing UK national risk projections (Bates et al., 2023). Having identified the main driving weather patterns, we will use the latest atmospheric science to develop a range of possible scenarios for how these drivers could change in future and consequent changes in extreme rainfall events, using the large samples of possible futures contained in multi-model climate simulations and recently developed large-ensemble simulation datasets (e.g. Leach et al., 2022). We will apply novel machine learning methods to generate high-resolution rainfall corresponding to these simulations (Addison et al., 2024) and state-of-the-art flood risk modelling to generate corresponding flood events (Bates et al., 2023). This will show changes in flood risk and give a clear understanding of the reasons behind them. This will include studying combinations of drivers that are plausible but are perhaps not seen in climate model simulations, to show the full range of possibilities (e.g. a particularly large jet stream shift combining with an especially high increase in atmospheric water capacity), which is very important for informing robust resilience strategies.

Background reading and references

- On present state-of-the-art UK flood risk modelling by our group:

Bates et al., 2023, “A climate-conditioned catastrophe risk model for UK flooding”, NHESS, 23, 891–908, https://nhess.copernicus.org/articles/23/891/2023/

- On new multi-thousand-year climate simulations that we co-developed to study extreme rainfall and temperatures:

  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

- A presentation on application of state-of-the-art machine learning methods to predict high-resolution UK rainfall from our group:

  Addison et al., 2023. “Downscaling with a machine learning-based emulator of a local-scale UK climate model”. *EGU General Assembly 2023*. https://doi.org/10.5194/egusphere-egu23-14253

How to Apply

The deadline for this position is 8th January 2025. The studentship will begin in September 2025. Please apply to the “Geography- PhD” here https://www.bristol.ac.uk/study/postgraduate/apply/