ONE Planet Doctoral Training Partnership

Natural Environment Research Council

Project title: Compounding extreme rainfall and heatwaves: how important are large scale dynamics in generating extreme floods?

Ref: OP2474

Keywords: Flash drought, heatwaves, extreme rainfall, flash floods, compund extremes

One Planet Research Theme:

Climate & Climate Change ☒ | Earth System Processes ☒ | Anthropocene ☐ | Environmental Informatics ☐

Lead Supervisor:

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Key Research Gaps and Questions:

- What are the key connections between atmospheric blocking, flash drought and extreme rainfall in the mid-latitudes? How will these processes change in a warming climate?

- What are the ingredients/drivers of these events and can we better forecast them?

- How is hydrological response to intense rainfall changed following flash droughts?

Against a backdrop of increasing hydroclimatic variability with global warming, flash drought (sudden intense onset drought) conditions associated with heatwaves are projected to become more common in summer months alongside increases in short-duration intense rainfall events that commonly cause flash-flooding. There is a clear connection between heatwaves and termination by extreme short-duration rainfall in observations in the mid- to high-latitudes (Sauter et al. 2023; DOI: 10.1016/j.wace.2023.100563). Recent extreme events in the summers of 2021-2022-2023 have also shown clear connections between blocking and extreme rainfall from cut-off lows (e.g. Storm Daniel in 2023; Germany floods in 2021). Recent developments in convection-permitting climate models (e.g. Kendon et al. 2014; doi:10.1038/nclimate2258) enable the investigation of how these processes will change into the future – this quantification is highly important for understanding impacts of these connected extremes under future warming.

This project will investigate the changing frequencies and intensities of flash drought/heatwaves and their links to extreme rainfall using object-based datasets developed from reanalysis data to identify the ingredients for better forecasts of these compound extremes, then examine climate model simulations to establish how these events and their impacts on flash flooding etc, might change in a warming climate.

The project is collaborative with the UK Met Office Hadley Centre and the National Center for Atmospheric Research in Boulder, Colorado and will use reanalysis data, high-resolution observations and the latest climate model projections. There is the opportunity to use a suite of hydrological and hydrodynamic models to explore case studies of impacts.

Skills which would be developed as part of the training for this project could include: Analysis and use of climate model data; programming, rainfall-runoff modelling, hydrodynamic modelling.

Prerequisites: A numerate degree such as engineering, maths/stats, physical geography, science, etc. Desirable skills, working with large data sets, understanding of climate models, GIS proficiency including writing scripts, statistics.

For more information, please contact Prof Hayley Fowler (hayley.fowler@ncl.ac.uk).

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