2025 Helmholtz – OCPC – Programme

for the involvement of postdocs in bilateral collaboration projects

PART A

Title of the project:

Advancing attribution of weather impacts to human-induced climate change: Intercomparison and development of novel methods

Helmholtz Centre and/or institute:

Helmholtz Centre for Environmental Research - UFZ

Project leader:

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Department: (at the Helmholtz centre or Institute)

Department of Compound Environmental Risks (CER)

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Description of the project:

Our climate is changing rapidly, with many impacts already visible and more expected. Extreme events often drive the most noticeable consequences, making it crucial to understand changes in their intensity and frequency. Attribution science quantifies the role of human-induced climate change in such extreme events and their impacts, thus improving process understanding, raising awareness on climate impacts, and informing climate risk management. While attribution methods are well established, their link to real-world impacts remains weak. Most studies focus on temperature and precipitation extremes, whereas impact-relevant variables include river discharge, human mortality, and crop yields. Quantifying climate change's role on those impacts is challenging and requires the modelling of impacts beyond weather variables.

Recent efforts in attribution science have aimed to move in this direction. A key requirement is the creation of counterfactual weather conditions—scenarios representing a world without human-induced climate change. By comparing simulations of impact models, such as hydrological or energy models, under observed (factual) and counterfactual weather conditions for a given high-impact event, it is possible to quantify the climate change effect on the event magnitude. However,

methods for creating counterfactuals are still in their early stages, with multiple approaches available. Key questions remain: How do different methods compare? What are their strengths and limitations? Which are best suited for specific events? Can combining approaches improve attribution? Addressing these questions is essential for advancing impact-based attribution science. This project will address these questions using data from observations, reanalyses, and climate model simulations. As a testbed for comparing attribution results across different counterfactual approaches, the candidate will rely on simulations from different impact models (hydrology, crops, energy).

The PostDoc will take these main steps. (1) **Compare available methods**, including analogue-based counterfactual approaches, detrending methods based on observations (e.g., ATTRICI), and detrending methods that use climate change signals derived from different types of climate model simulations. By comparing these counterfactual approaches across selected high-impact events—particularly floods and droughts, driven by precipitation over short and long time scales, respectively—the project will assess their applicability across different variables and time scales. (2) **Synthesize key advantages and limitations** of these methods and distill recommendations for users of counterfactual data. This synthesis will provide insights into the suitability of different approaches for various attribution studies. (3) **Develop new methodologies** by integrating the strengths of different approaches. For example, while advanced detrending methods exist, they are typically applied only to observations, posing the risk of confounding human-induced climate change effects with internal climate variability. By combining these approaches with climate model simulations, it is possible to leverage the advantages of different methods while reducing their individual limitations.

Overall, this project will support attribution efforts within the scientific community by developing and publishing novel factual and counterfactual datasets, including newly designed approaches, along with recommendations for their use in studying different types of high-impact events. Additionally, applying these methods to various events will simultaneously yield attribution statements for recent high-impact events. These outcomes will provide a valuable contribution to enhancing attribution studies and advancing the operational attribution of complex, high-impact weather and climate events.

Description of existing or sought Chinese collaboration partner institute (max. half page)**:**

We have an established collaboration with Beijing Normal University, working on compound events and climate change attribution. A lose collaboration exists also with the Chinese Academy of Meteorological Sciences in Beijing, which also conducts excellent work on extreme event attribution and which we would be interested in deepening.

Required qualification of the postdoc:

- PhD in Climate Science, Hydrology, Environmental Sciences, or similar
- Experience with large data analysis, attribution of extreme events
- Language requirement: fluent in English (spoken and written)