



COMPOUND EXTREMES ATTRIBUTION OF CLIMATE CHANGE: TOWARDS AN OPERATIONAL SERVICE

NEWSLETTER ISSUE No. 3 – SEPTEMBER 2025

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1. EDITORIAL

Dear Reader,

We are excited to share the third COMPASS Newsletter, designed to update you on the progress and results of our project activities, along with other significant developments in the field of extreme events and impact attribution. Our goal is to provide valuable insights to a broad audience, including the scientific, policy, and business communities, while encouraging your feedback and helping to build a strong COMPASS Community.

COMPASS “Compound extremes attribution of climate change: towards an operational service” is a collaborative project funded under the Horizon Europe Research and Innovation Programme. The project began in January 2024 and will run for 3 years. The COMPASS project aims to develop a harmonised, yet flexible, methodological framework for climate and impact attribution of various hazard types, which is a crucial initial step towards the deployment of a European Operational Service. COMPASS will innovate by going from the attribution of single-driver extremes to the attribution of more complex extremes (including compounding, sequential and cascading hazard events) and enabling a shift from a hazard-centred analysis to an impact-centred perspective. Main novelties include event-based hazard and impact modelling using a multi-scale approach, the use of weather type analysis for better understanding the physical drivers that give rise compound extremes, and the use of contextualized storylines to communicate attribution results. Our framework will be validated and applied to a set of Use Cases that cover historical extremes for various hazard types and impact context, as well as extreme events happening during the project.

In this newsletter, we highlight our recent achievements and outputs (section 2), provide updates on news and advancements within the weather and climate community (section 3), introduce you to the scientists working on the project (section 4), and extend an invitation to engage with and connect with the COMPASS team (section 5).

For more information about the project please visit our website WWW.COMPASS-CLIMATE.EU, and feel free to send us specific inquiries using the available [CONTACT FORM](#). A short [COMPASS VIDEO](#) is also now available.

2. INSIDE COMPASS: UPDATES ON OUR ACTIVITIES

During the past period, various activities have been implemented. Below we present brief summaries of the following COMPASS activities:

- [Report on integration of datasets and models](#)
- [COMPASS and WorldPop Advance Data Preparation for CMIP7 Forcing Datasets](#)
- [New Study Highlights How Adaptation Measures Have Reduced Europe's Flood Losses](#)
- [Report on understanding of weather types and large-scale climate drivers](#)
- [Dataset on weather types and largescale climate drivers](#)
- [Hazard and Impact Synthesis and Attribution for Phase I Use cases](#)
- [Annual Weather and Climate Conference 2025 – COMPASS presentation](#)
- [Living Planet Symposium 2025 – COMPASS poster presentation](#)

- **Report on integration of datasets and models**

The COMPASS project recently released a [“Report on integration of datasets and models”](#).

This report presents a modular and scalable workflow framework, developed within the COMPASS project, designed to support the impact attribution of climate-related compound events. This approach contributes to the overarching goals of climate resilience, knowledge-based adaptation strategies, and improved understanding of the human influence on extreme weather and climate events.

The workflow will be further demonstrated using the COMPASS Use Cases (UC), namely [UC5](#) (Poland – heatwaves and droughts), and conceptually extended to other use cases ([UC1–UC4](#)). This provides a foundation for generalising the approach while also acknowledging its current practical scope and limitations. The framework integrates publicly available datasets and open-source modelling tools into a unified, script-based environment for generating both factual and counterfactual climate scenarios.

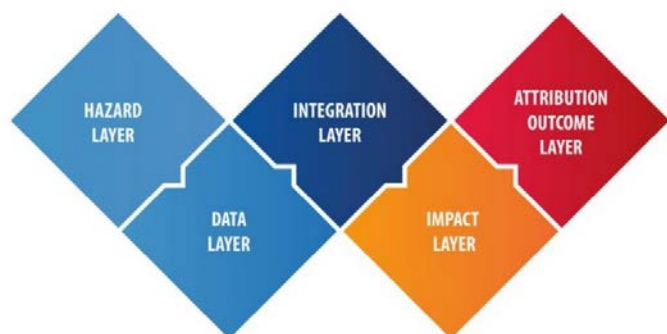
The proposed solution is not limited to a specific case study or hazard type. Instead, it offers a flexible foundation that can be adapted to diverse geographical contexts and climate risks, including but not limited to heatwaves, droughts, floods, tropical cyclones, and winter storms. It does so by leveraging:

- global climate datasets (e.g. ERA5, ERA5-Land),
- regional high-resolution observations (e.g. EMO-1),
- and impact and statistical models (e.g. ISIMIP3BASD, LISVAP, ATTRICI, CatBoost),

enabling consistent integration of hazard, exposure, and vulnerability data for comprehensive attribution assessments.

The framework supports both probabilistic (unconditioned) and storyline (conditioned) attribution approaches, making it suitable for a wide range of scientific and policy-relevant applications. Its open and modular design ensures reproducibility, transparency, and ease of use for researchers, decision-makers, and other stakeholders engaged in climate risk assessment.

The development of an automated event attribution workflow also revealed several key challenges. These include ensuring the robustness of attribution results across diverse data sources, managing the



Scalable workflow architecture for climate attribution, allowing hazard- and region-specific configuration based on open data and models.

computational demands of high-resolution modeling, and harmonizing heterogeneous datasets across use cases.

The developed approach contributes to the overarching goals of climate resilience, knowledge-based adaptation strategies, and improved understanding of the human influence on extreme weather and climate events.

To summarize, the developed COMPASS workflow for climate and impact attribution is:

- **Modular and open-source:** The workflow is composed of interoperable components that can be tailored to different hazards, regions, and impact models, using only open-source tools and datasets.
- **Globally applicable:** The workflow is demonstrated for heatwaves and droughts in Poland (UC5). However, the proposed workflow architecture is scalable to other hazards (e.g. floods, storms) and locations, including the full range of COMPASS use cases.
- **Supporting both factual and counterfactual scenarios:** Through integration with the ATTRICI model, the workflow enables comparative attribution to isolate the influence of climate change on extreme events.
- **Towards operational implementation and integration:** Scaling the workflow requires activities such as calibration, validation, incorporation of local data, and expert judgement on model configuration—steps that currently cannot be fully automated and different challenges are faced depending on the characteristics of the compound extreme. However, the workflow is already being implemented in an operational demonstrator for UC5 (heatwaves and droughts in Poland), supporting its future integration into regional climate services, adaptation assessments, and decision-support platforms.
- **Designed for co-development:** The workflow is built to evolve with stakeholder needs, the architecture encourages collaboration across research, policy, and practice communities.

More information can be found in the following COMPASS project Deliverable:

Terefenko, P. and Ślędzowski, J. (2025): [Report on integration of datasets and models](#). Horizon Europe project COMPASS. Deliverable D5.1. DOI: [10.5281/zenodo.15517565](https://doi.org/10.5281/zenodo.15517565)

▪ **COMPASS and WorldPop Advance Data Preparation for CMIP7 Forcing Datasets**

The COMPASS project, in collaboration with the [WorldPop project](#), has successfully developed and provided a new population dataset to support Earth system modeling for **CMIP7** (Coupled Model Intercomparison Project Phase 7). Based on the methodology outlined in [COMPASS Deliverable D3.1](#), this dataset has been accepted as **one of the 12 official CMIP7 ‘forcing’ datasets**, marking a significant contribution by COMPASS to the global climate modeling community.

The population data for the **historical period** is now publicly available via the [ESGF input4MIPs repository](#), and **future projections are in preparation**. Full documentation is maintained alongside other CMIP forcing datasets in the [input4MIPs CVs documentation](#).

The dataset will play a key role in simulations that feed into the **IPCC’s Seventh Assessment Report (AR7)**, helping to represent the influence of population distribution and growth on emissions, land use, and climate interactions.

Additionally, Dr. Dominik Paprotny, Researcher at Potsdam Institute for Climate Impact Research (PIK) and member of COMPASS team, has been invited to join the [CMIP Climate Forcing Task Team](#), contributing to the strategic coordination of CMIP7 forcing inputs. This recognition highlights COMPASS’s leadership in promoting FAIR and policy-relevant data products within the international modeling landscape.

Related announcement: [CMIP International Project Office GitHub post](#)

▪ **New Study highlights how Adaptation Measures have reduced Europe’s Flood Losses**

A new study, supported by the **COMPASS project** and published in *Science Advances*, reveals that adaptation measures have significantly reduced flood-related economic losses and fatalities across Europe over the past 70 years.

Researchers from the Potsdam Institute for Climate Impact Research (PIK), together with European partners, analyzed seven decades of flood data and found that non-structural adaptation measures—such as early warning systems, emergency preparedness, and improved building regulations—have reduced economic losses by **63%** and fatalities by **52%** since 1950.

The study examined **1,729 flood events** across Europe between 1950 and 2020, assessing how changes in climate, socioeconomics, and adaptation influenced flood impacts. While absolute economic losses have almost doubled from €37 billion in the 1950s to €71 billion in the past decade, losses relative to GDP have dropped to one-third of 1950s levels. This indicates that adaptation efforts have partly offset the increased risk from climate change and urban expansion into floodplains.

However, the study warns that adaptation progress has slowed over the past two decades, and the limits of adaptation may soon be reached as climate change intensifies. “Flood protection and other adaptation measures have largely offset increasing flood risks across the continent since 1950,” says Dr. Dominik Paprotny, PIK researcher and lead author of the study. “But additional efforts are needed to prevent future increases in flood losses.”

The research underlines the importance of continuously monitoring adaptation progress and cutting greenhouse gas emissions to keep climate impacts within manageable limits.

Read the PIK press release: [70 years of data show adaptation reducing Europe’s flood losses](#)

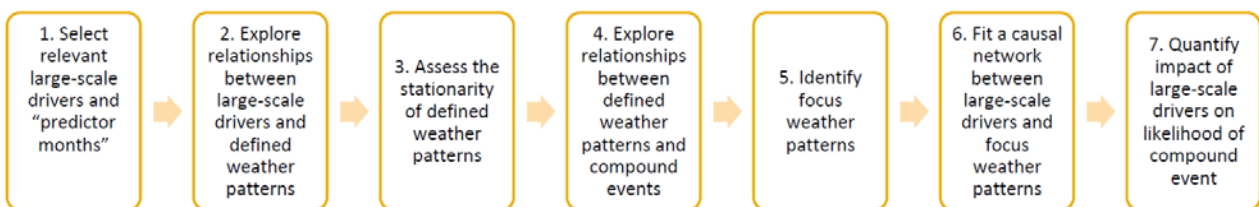
Also featured on: [UNDRR PreventionWeb](#)

Access the scientific article in Science Advances: [DOI: 10.1126/sciadv.adt7068](#)

▪ **Report on understanding of weather types and large-scale climate drivers**

The COMPASS project recently released a [“Report on understanding of weather types and large-scale climate drivers”](#).

This report presents a novel framework to identify, assess and understand large-scale drivers which give rise to compound extremes, utilising weather patterns to bridge the gap. Improving understanding of the large-scale drivers of compound events is crucial to operationalising the climate and impact attribution of these events. However, it is challenging to directly link large-scale drivers of climate variability to compound events. Weather patterns, a set of atmospheric circulation types over a defined geographical region on a given day, are an established method used to assess the conditions that give rise to weather extremes. A significant amount research on weather patterns exists that links meteorological hazard to their associated impacts. Here, we propose a framework to extend this research to understand the large-scale drivers of compound events and pave the way for future climate and impact attribution studies.



Schematic of the COMPASS framework, showing the steps required to understand and quantify the influence of large-scale drivers of a compound event.

This report presents a demonstration of the COMPASS framework for a case study of the 2013/2014 UK winter storms, a discussion of the findings and recommendations for future work. In addition, we have conducted research which begins to explore whether weather patterns remain consistent over long time periods to be reliably used in climate attribution studies. It aims to clarify what is meant by non-stationarity and identify the main challenges and uncertainties in assessing it.

Key findings – case study demonstration:

- There are statistically significant associations between a set of large-scale drivers of winter North Atlantic atmospheric circulation and a previously defined, well-used set of daily weather patterns for circulation over the UK (Neal et al., 2016).
- A review of the literature shows that weather patterns 29 (cyclonic south–south-westerly with a deep low centre of pressure west of Ireland) and 30 (cyclonic west-north-westerly with deep low pressure southeast of Iceland) from Neal et al. (2016) are linked to the 2013/2014 winter storms in the UK.
- Whilst the performance of the large-scale drivers in predicting the frequency of weather patterns 29 and 30 in January and February through an initial causal network is poor, a number of areas for further research and improvements have been identified.

Key findings – assessing the stationarity of weather patterns:

- We use a machine learning clustering algorithm to create historical weather patterns for the UK based on mean sea level pressure data. These patterns are compared across different time windows to a set of reference patterns to assess how they differ. Our findings suggest that some of the spatial patterns of generated clusters show changes across time windows over the last 40 years. However, it is currently not possible to determine whether these changes reflect real shifts, natural variability, or limitations of the method itself.
- This research highlights the complexity and uncertainty involved in assessing weather pattern stationarity and suggests that using weather patterns as constraints – and the assumption of stationarity – in climate attribution should be done with caution and warrants further research.

The report is available on the COMPASS research repository Zenodo at the following DOI: [10.5281/zenodo.17077013](https://doi.org/10.5281/zenodo.17077013).

More information can be found in the following COMPASS project Deliverable:

Rushby, I., Etheridge, D., Perks, R., Bernie, D., Munday, G., Cotterill, D. (2025): [Report on understanding of weather types and large-scale climate drivers](#). Horizon Europe project COMPASS. Deliverable D2.2.

▪ **Dataset on weather types and largescale climate drivers**

The COMPASS project recently released a [“Dataset on weather types and largescale climate drivers”](#).

This dataset facilitates the analysis of relationships between UK weather types and large-scale drivers relevant to winter North Atlantic circulation. This dataset is closely linked to the [“Report on understanding of weather types and largescale climate drivers”](#) which aims to extend the weather type approach to consider compound events for specific geographies and develop a framework to understand associated drivers.

The dataset (currently v1.0) is available on the COMPASS research repository Zenodo at the following DOI: [10.5281/zenodo.16984885](https://doi.org/10.5281/zenodo.16984885).

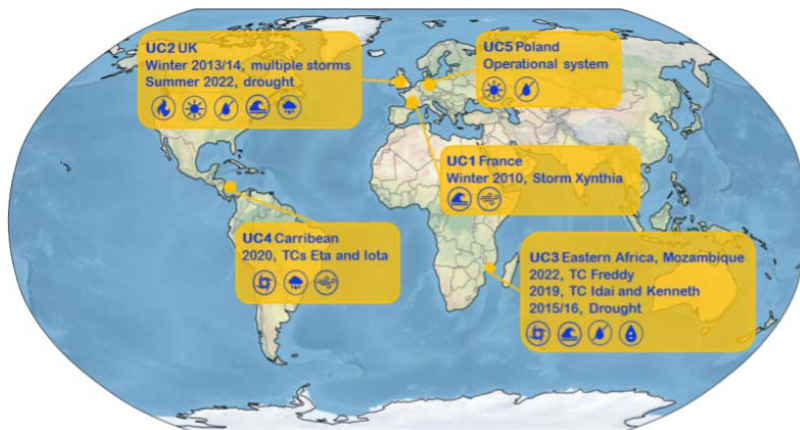
More information can be found in the following COMPASS project Deliverable:

Rushby, I. (2025): [Dataset on weather types and largescale climate drivers](#). Horizon Europe project COMPASS. Deliverable D2.3.

▪ **Hazard and Impact Synthesis and Attribution for Phase I Use cases**

The COMPASS project recently released a report on [“Hazard and Impact Synthesis and Attribution for Phase I use case”](#).

This document provides an in-depth summary of the implementation, strengths, and challenges of the first phase of [COMPASS Use Cases \(UCs\)](#). The overarching goal of COMPASS is to develop a harmonized and flexible methodological framework for attributing climate and impact to complex extreme events, including compound, sequential, and cascading hazards such as storm surge and river flooding, or sequences of tropical cyclones. The UCs served as critical test beds for evaluating this framework, encompassing a diverse range of event types and geographical contexts. Two primary attribution analysis methods, probabilistic (risk-based) and storyline-based, were implemented, each offering distinct advantages in analysis and communicating results to stakeholders. This report details the observed hazards, impacts, modeling frameworks, and attribution results for each UC, concluding with a synthesis of key findings and avenues for future advancement through the phase to UCs.



Use Cases of the COMPASS project.

In many of the use cases, climate change emerged as a significant driver of the observed and recorded impacts of the compounding hazards. At the same time, non-climate drivers including population and economic growth, the covid-19 pandemic, and chronic insecurity and poverty emerged as critical factors, highlighting the need to consider the wider complexity of extreme events and the holistic policy responses required to reduce the impacts of future extremes.

The UCs have demonstrated the value of a harmonized but flexible methodological framework, allowing implementation to adapt to local contexts and data availability, but still benefiting from considerable shared code, model components, and datasets. This success clearly suggests that the goal of operational attribution modeling is achievable. Moving forward several opportunities have emerged related to the further refinement and development of the COMPASS methodological framework including improved bias correction of climate datasets, improved inclusion of mitigation measures such as flood defenses in the relevant models, improved inclusion of quantitative vulnerability indicators, and further integration of quantitative and qualitative attribution approaches. With the initial methodological framework well established, an increased focus on stakeholder engagement and policy relevance is now possible.

The report is also available on Zenodo: [10.5281/zenodo.17099072](https://zenodo.org/record/17099072)

More information can be found in the following COMPASS project Deliverable:

Jack, C., Vogel, M., de Boer, T., Gale, S., Paprotny, D., Muis, S., Goulart, H., Wilson, E., Munday, G., Cotterill, D. (2025): [Hazard and Impact Synthesis and Attribution for Phase I use case](#). Horizon Europe project COMPASS. Deliverable D4.1.

▪ Annual Weather and Climate Conference 2025 – COMPASS presentation

The RMetS [Annual Weather and Climate Conference](#) scheduled for 2 – 4 July 2025 at the Manchester Metropolitan University (UK), provided a platform for scientists and operational meteorologists working in academia, public and private sectors to present their work to the weather and climate community, with dedicated sessions to showcase early career researchers and early career professionals, alongside RMetS Award winners and keynote speakers.

Isabel Rushby, Applied Climate Scientist at Met Office and member of COMPASS team co-chaired a workshop on “Compound Extremes and Cascading Impacts and Risks”, which was held on the 3rd July. This workshop brought together over 50 cross-disciplinary scientists, academics and practitioners discussing the challenges and potential solutions to complex climate and hydrological hazards and risk. Breakout groups discussed topics including:

- What are the key challenges, knowledge gaps and barriers in understanding and quantifying compound extremes?
- What are the latest approaches being used to assess and manage compound extremes and cascading impacts?
- How can we improve their use in practice and develop adaptive solutions?

Attendees identified a number of challenges, highlighting the challenges in quantitatively linking hazards to impacts, and the importance of collaboration between weather/climate experts and other sectors, as well as across sector collaboration.

An overview of the COMPASS project was given near the beginning of the workshop, introducing the project to a wide audience. This covered the goals of the project and the partners involved.

▪ Living Planet Symposium 2025 – COMPASS poster presentation

Held every three years, ESA's Living Planet Symposia are among the world's premier events on Earth observation. With the climate crisis intensifying, the [Living Planet Symposium 2025 \(LPS25\)](#) emphasised transitioning from 'observation to climate action and sustainability for Earth'.

The event provided a forum to present and discuss the latest scientific findings and applications based on satellite data, and to review the contribution that data and technologies have made and could further make in addressing environmental and societal challenges. The symposium showcased innovative products, services, missions and initiatives, with the overarching goal of demonstrating how science, society, policy-making, businesses and the economy can all benefit from observations made from space.

During the five-day event, diverse communities united by a common interest in exploiting Earth observation data gathered together, creating a unique opportunity to meet and network with space enthusiasts from a wide range of sectors.

COMPASS project was presented with an e-poster at the DG DEFIS stand, at the screen dedicated to HaDEA Earth Observation-related projects. The poster is available [here](#).

3. NEWS FROM THE WATER AND CLIMATE COMMUNITY

EC OPEN CALL ON “THE ATTRIBUTION TO CLIMATE CHANGE, AND IMPROVED FORECASTING OF EXTREME AND SLOW-ONSET CLIMATE- AND WEATHER-RELATED EVENTS AND THEIR IMPACTS”

The European Commission has an open call on [“The attribution to climate change, and improved forecasting of extreme and slow-onset climate- and weather-related events and their impacts”](#) [HORIZON-CL5-2025-06-D1-04].

Project results are expected to contribute to all of the following expected outcomes:

- Advanced understanding of the causality between anthropogenic climate change and the frequency and intensity of climate and weather extremes (including temperature extremes, heavy precipitation and pluvial floods, river floods, droughts, storms, as well as compound events), and their risks and impacts, including cascading impacts, on human systems and ecosystems;
- Improved methodologies and tools of attribution of extreme climate- and weather-related events, and their impacts, to anthropogenic climate change;
- Enhancement of existing or creation of new pilot global databases of extreme events, impacts and their attribution;
- Advanced knowledge of how attribution science and forecasting can be operationalised for a range of policy purposes, including informing and improving preparedness, civil protection and humanitarian planning for future extreme and slow-onset events, post-disaster reconstruction, resilience and adaptation plans.

For more information, visit the [EU Funding & Tenders Portal](#).

4. MEET THE COMPASS TEAM

The COMPASS project has a vibrant and multidisciplinary team of scientists and researchers. Let us take this opportunity to introduce to you some of our team members...

Jakub Śledziowski is a scientist at the University of Szczecin and a member of the COMPASS project under the Horizon Europe program, where he contributes to the development of a project framework for analyzing and integrating multi-hazard data. He recently completed his PhD in environmental sciences, which focused on the analysis of climate data and the impact of storms on the southern Baltic coast, combining UAV-LiDAR surveys, remote sensing, and reanalysis data.

His main research interest is the impact of extreme weather events - in particular storms and complex hazards - on coastal morphology and vulnerability. As part of the COMPASS project, he is working on developing a framework linking extreme climate events with socio-economic impacts, enabling threshold detection, regional risk assessment, and the development of demonstrators for future forecasts.



Jakub has been involved in several national and European research initiatives, focusing mainly on coastal monitoring, climate data processing, and the integration of various observational and model datasets. His extensive knowledge of software design and development, and his ability to analyze extreme climate events using advanced statistical methods and machine learning, are invaluable in creating innovative tools that combine climate science with practical applications in risk assessment and climate change analysis.

5. GET INVOLVED IN THE COMPASS COMMUNITY



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THE PROJECT AT A GLANCE

Title: COMPOUND EXTREMES ATTRIBUTION OF CLIMATE CHANGE: TOWARDS AN OPERATIONAL SERVICE (COMPASS)

Instrument: HORIZON-CL4-2023-SPACE-01, EUROPEAN HEALTH AND DIGITAL EXECUTIVE AGENCY (HADEA)

Total Cost: 2,293,611 €

EC Contribution: 2,293,611 €

Duration: 36 MONTHS

Start Date: January 1st, 2023

Consortium: 6 partners from 5 countries

Project Coordinator: Stichting Deltares

Project Web Site: www.compass-climate.eu

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