We would like to thank the reviewers for their constructive and valuable comments on our manuscript. We are committed to addressing the concerns in a revised version, and provide our more detailed responses below:

RC2: 'Comment on egusphere-2026-2697', Anonymous Referee #2, 07 Sep 2026

This manuscript synthesizes findings from the first phase of the ClimXtreme programme, drawing on 21 special-issue articles and 33 additional publications. It addresses heatwaves and droughts, heavy precipitation and floods, and extratropical cyclones and windstorms, linking physical processes, statistical methods, attribution, and socioeconomic impacts. The manuscript provides a useful overview of a substantial collaborative research effort. However, its contribution beyond a descriptive summary of individual publications needs strengthening. In particular, the geographical scope, interpretation of causal necessity and sufficiency, and evidential basis for the mediator–moderator framework require clarification.
Major comments

1.The geographical scope of the title exceeds that of much of the evidence presented.

The title suggests a synthesis of European atmospheric extremes, whereas many of the detailed examples concern Germany and Central Europe, particularly the 2018 hot–dry conditions, the 2017 Berlin precipitation event, and the July 2021 flooding. Although some reviewed studies have a broader European domain, the manuscript does not consistently distinguish continental findings from regional results.

As this point has also been mentioned by Reviewer 1, we will put an extra effort to clarify the geographic scope and the related results and suggest changing the title of the manuscript as suggested in the response to Reviewer 1 to

Past and future meteorological extreme events impacting central Europe – the ClimXtreme program's structure and results

2. Connect the conclusions more directly to the questions posed in the Introduction.

Section 1.1 asks whether past climate change has increased extreme events and how future climate change may affect them. However, the Conclusions focus mainly on methods and conceptual frameworks. Please return explicitly to these two questions and summarise what the reviewed studies establish for each hazard, including where an answer remains uncertain.

Thank you for this advice! We will rewrite and complement the respective text in the conclusions to provide an arc between the initial and the final part of the manuscript. The initial questions as they are stated in the current version of the manuscript at the beginning signal a preset perspective of socio-economic stakeholder and the more general public providing a certain guideline to ClimXtreme. The questions thus define an ideal setting of the research in ClimXtreme. As a result of the work they cannot be answered in their actual stake-holder / general public inspired width but must be interpreted in view of the actual ClimXtreme results. The questions themselves already imply causal relationship between climate change as a driver of meteorological extremes, for

example, but research in ClimXtreme did show that this causality needs to be addressed and clarified. Therefore, the text around the questions at the beginning of the manuscript will be reformulated including the remarks about the implied but yet unproven causality. The remarks by Rev.2 on this aspect (see AC2, *"1. The two overarching research questions should be formulated more neutrally")* provide a guidance. Then this points will be picked up in the conclusion and answers can be formulated to the initial questions in view of the causality results by the ClimXtreme research.

3. Use a more consistent structure for the hazard-specific sections.

The heatwave and drought section introduces indices before discussing an event, the precipitation section gives considerable attention to methods and case studies, and the windstorm section follows a different organisation. A common sequence would make comparison easier: the main research question, principal findings, an illustrative example, and remaining limitations.

Again thank for this specific hint. We will streamline each hazard-specific section according to the reviewer's suggestion *„A common sequence would make comparison easier: (1) the main research question, (2) principal findings together with an illustrative example, and (3) the emerging and remaining limitations.„*

4. Meteorological hazards, actual impacts, and compound events should be distinguished more clearly.

Although Section 2.3 acknowledges the importance of exposure and vulnerability, the subsequent discussions of insurance losses, forest damage, and agricultural yield reductions do not consistently explain how these factors influence the interpretation of impacts. For example, higher losses associated with compound wind–precipitation events do not, by themselves, demonstrate a synergistic effect beyond the effects of the individual hazards. Such differences could also reflect variations in wind speed, affected area, or asset exposure. The authors should clarify whether and how the underlying studies controlled for these factors.

The relationship of the different factors to loss will be mentioned within the revised section 2. The respective parts of the text of the subsequent sections will be revised accordingly.

5. Introduce the recurring conceptual terms more clearly.

Terms such as "mediator," "moderator," "necessity," and "sufficiency" recur throughout the manuscript and occupy a prominent place in the conclusions. Their practical relevance may nevertheless be difficult to follow for readers outside attribution research. Please introduce them with one simple example and explain how they help interpret the studies reviewed. A conceptual figure could provide a useful reference and reduce repeated explanations.

To present these contributions of the manuscript more concise, the discussion parts regarding "necessity and sufficiency" will be removed altogether across the whole manuscript. With respect to the mediator / moderator approach a conceptual figure will be added and discussed by introducing a simple example on European heat waves in the relevant sections. With respect to the relevance of

the mentioned terms, a new ClimXtreme paper by Buschow et al (2026) is available which we will refer to in the revised version. It introduces more mathematical details jointly with a toy model using the moderator / mediator concept as an interpretation help for a real world (the European heat waves in the summers of 2006 and 2007) event attribution. Indeed, the terms mediator / moderator form an essential part of the conclusions, they are part of the wider „causality“ research in statistics, machine learning etc. But they are almost never mentioned in the extreme event attribution questions of climate change.

Minor comments

1. The two overarching research questions should be formulated more neutrally.

The questions appear to presuppose a causal relationship in which climate change modifies extreme weather events. However, extreme events arise from complex dynamical and thermodynamic processes and occur within an evolving climatic background. Unless the manuscript explicitly defines and tests the relevant causal relationships, it would be more appropriate to formulate the questions in terms of how the statistical characteristics of extreme events have evolved in the context of the observed changing climate and how they are projected to evolve under different future climate scenarios. For example, the authors could ask: "What changes in the frequency, intensity, duration, and spatial extent of extreme weather events have been observed in the context of a changing climate?" and "How are these characteristics projected to evolve under different future climate scenarios?" Such wording avoids presupposing causality and more accurately reflects the descriptive and projection-based evidence synthesized in the manuscript.

This aspect will be discussed in the revisions in the context of the reviewer's major comments 2 and 5 (see AC1, "*2. Connect the conclusions more directly to the questions posed in the Introduction.*"). We agree with the reviewer's observation that there is no simple answer to the initially mentioned question (which are asked by stakeholders and the more general public). Based on the ClimXtreme research results, limitations of the ability to provide answers to these questions become clear. This is a key aspect of the ClimXtreme outcomes arising, for example, from the different ratings of individual events within the climatological records, which show up e.g. when considering the different indices for an event.

The other minor points 2 and 3 will be all changed/corrected accordingly

2. Table 1 should provide more complete definitions of the indices.

The table provides only the index names and references, while key information such as definitions, units, thresholds, temporal scales, and reference periods is missing. This is particularly important because indices such as SPEI, HWMId, UTCI, and the compound-event indices can be calculated using different accumulation periods or thresholds, which may affect the interpretation and comparability of the reported results. Please add concise definitions and the relevant methodological settings for each index. The authors should also use "Standardized Precipitation Evapotranspiration Index" consistently as the full name of SPEI.

3. The statistical basis of return periods and event rankings should be specified.

In Section 3.2, statements concerning the 100-year return level, the event ranked as the fourth most extreme, and its classification as one of the five most severe events of the past 70 years should specify whether the estimates refer to individual stations or spatially aggregated regions, as well as the precipitation accumulation period and extremeness index used. Rankings derived from different spatial or temporal scales, event definitions, or indices should not be presented as directly comparable.

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