Response to Reviewer 2

Brief communication: Contextualizing the September 2024 extreme precipitation in Austria within the climatological record

Responses to reviewer comments coloured in blue.

Novelty comment

This brief communication revisits the exceptional September 2024 Storm Boris precipitation event, focusing on Austria and providing a statistical characterization of the observed precipitation extremes. The manuscript is generally well written, the methodology is sound and clearly described, and the results are presented in a clear and convincing manner. The study provides a comprehensive assessment of the rarity of the event from an extreme-value perspective.

We thank the reviewer for the positive assessment and useful comments. We respond point-by-point below, including suggestions for improving the manuscript.

Nevertheless, I believe the manuscript would benefit from a clearer discussion of its scientific novelty. Several studies have already analysed Storm Boris from different perspectives (event attribution, dynamical mechanisms, hydrological impacts, etc.), many of which are already cited by the authors. Therefore, the manuscript should better articulate what additional scientific insight this contribution provides beyond the existing literature and why this statistical analysis deserves publication as a standalone contribution.

After clarifying the novelty of the study and addressing the comments below, I consider the manuscript suitable for publication in NHESS.

While several studies have investigated Storm 'Boris' from dynamical, attribution, and hydrological perspectives, our contribution focuses on a complementary aspect: a rigorous statistical characterization of the event within a regional extreme-value framework.

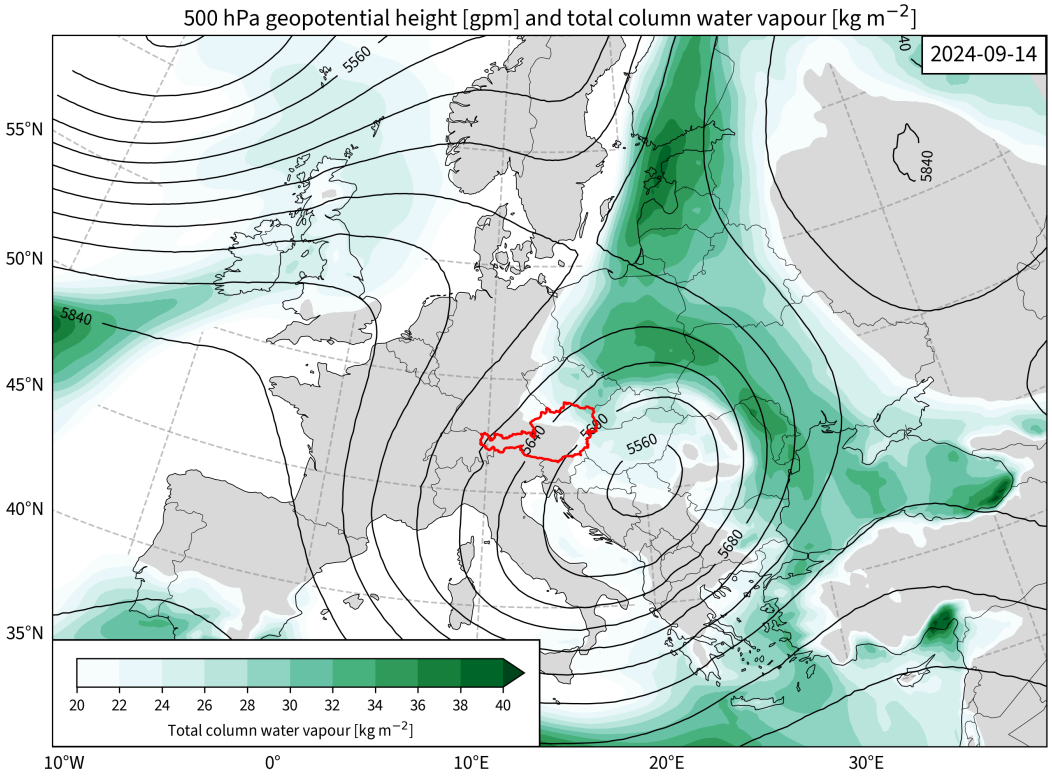
In particular, existing rapid assessments of the event rarity are commonly based on single-station, frequentist approaches using relatively short observational records, which are associated with substantial uncertainties when extrapolating beyond the observed range. To address this challenge, we apply a spatial Bayesian hierarchical peak-over-threshold approach that combines information across stations and allows for robust estimation of the regional extreme-value distribution. This framework enables the inclusion of short-record stations while stabilizing parameter estimates through spatial pooling.

Beyond quantifying the rarity of Storm Boris, our analysis identifies a coherent regional heavy-tailed precipitation regime across the pre-Alpine region, providing a statistically robust baseline for interpreting this exceptional event. We will revise the Introduction and Conclusions to better highlight these aspects and clarify why this statistical perspective provides a distinct and complementary contribution to the existing literature on Storm Boris.

General comments

Given the strong emphasis on the exceptional nature of this event, I think the manuscript would benefit from including a synoptic figure illustrating the atmospheric configuration responsible for the event. Although the circulation has been described elsewhere, such a figure would considerably improve the physical interpretation of the statistical results and help readers unfamiliar with the event understand why precipitation was so persistent and spatially organized.

Thank you for this suggestion. We agree that illustrating the large-scale atmospheric conditions provides important context for the event. To accommodate this addition while respecting the NHESS limit of three figures/tables for Brief Communications, we will integrate following visualization (depicting the circulation and atmospheric water content), as a new panel / subfigure within Figure 1.



The discussion on the estimated return periods could be strengthened. The authors correctly acknowledge the substantial uncertainty associated with extrapolating return periods far beyond the observational record. However, this issue has received considerable attention in the recent literature, particularly following recent record-breaking climate extremes. I encourage the authors to discuss their findings in the context of these recent studies. For example, see Zeder et al. (2023); `https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2023GL104090`

Thank you bringing this relevant literature to our attention. Our analysis directly aligns with perspectives highlighted by Zeder et al. (2023) in multiple aspects. Specifically, our station pooling approach helps mitigate the limitations of short observational records by expanding the effective sample size, while our Bayesian modeling framework offers a more robust representation of uncertainty than classical single-station GEV estimation. We will update the discussion to contextualize our findings within this broader literature. Specifically, we will address the aforementioned challenges of estimating return periods for unprecedented events and handling potential biases, incorporating references to Zeder at al. (2023) as well as Miralles et al. (2023) and Barlow et al. (2020), regarding different biases discussed in the manuscript.

Minor comment

L85: please support this statement with an appropriate reference, particularly because no circulation analysis is presented in this study.

We will add the corresponding reference (Seibert et al., 2007) and weaken the statement slightly toward a suggestion, instead of an indication. This should clarify that while no direct circulation analyses was done, the statement is based on precipitation climatology characteristics between Alpine and pre-Alpine areas. We propose to change the sentence to: *"This suggests strong synoptic, convective, or a mix of both forcings as a main driver of these high precipitation intensities, given that effects from orographic lifting alone are weaker in pre-Alpine areas (Seibert et al., 2007)."*