

Dear Editor,

Many thanks for your detailed response and constructive comments, as well as for pointing out this recent paper which we added to our references. We hope our answers below and the corresponding revision will bring the nuance the reviewer hoped for, and address all remaining concerns.

Best wishes,

A. Tuel and O. Martius

## Response to reviewer comments

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**Comment 1.1** *I thank the authors for their further set of replies. I am still not entirely convinced by some of the arguments that they put forward, and I somewhat struggle to grasp the relevance of the analysis. At the same time, the analysis itself is rigorous and appears scientifically robust. At this stage in the revision process I see no point in further delaying the publication of the study, and recommend acceptance subject to a final round of minor revisions.*

**Answer:** Thank you for your final comments and support for the publication of our study. We hope our answers below will address your remaining concerns.

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**Comment 1.2** *I find Fig. R1 valuable, as it provides readers with an indication of how closely one can expect the results in the present paper to relate to studies implementing the more commonly-used 3/5 day temperature extremes definition. Perhaps, in the caption to Fig. A1, the authors could specify that the definition is: "based on continuous exceedances of the daily 5th/95th temperature percentiles".*

**Answer:** Good suggestion, we reformulated as "3-day extreme periods are defined based on continuous exceedances of the daily 5<sup>th</sup>/95<sup>th</sup> temperature percentiles in each region."

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**Comment 1.3** *It would be useful to provide somewhere (in an Appendix table or in conjunction with the discussion of Fig. A1) an indication of how the sample sizes for your 3-week events relate to the 3/5-day events. This would help readers to make more sense of the statements made in the introduction (paragraph starting on l. 39) and of the ratios shown in the new Figure A1. Indeed, interpreting any overlap ratio between two sets of events is difficult without knowing whether the two sets contain a similar number of events or not.*

**Answer:** This is a very good point. We added this information in a supplementary table and made a reference to it in the caption of Figure A1, see Table 1 reproduced below.

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**Comment 1.4** *I still struggle with the authors' reply to my previous comment 1.b. It is true that persistent warm or cold spells lead to significant impacts, yet less clear that such impacts derive*

	<b>Cold</b>	<b>Warm</b>
<b>DJF</b>	11-22 (16)	9-23 (17)
	<b>1.4-4.4 (2.9)</b>	<b>1.2-3.4 (2.3)</b>
<b>JJA</b>	14-26 (19)	11-24 (17)
	<b>0.6-1.8 (1.0)</b>	<b>1.0 - 3.3 (1.9)</b>

Table 1: Number of identified persistent spells (black), and ratio of number of 3-day events to number of persistent spells (blue), for each season and type of spell (warm and cold). For each case, we indicate the range across clusters and in brackets the corresponding median.

*from their persistence and not from the shorter period of peak temperature anomalies within the longer period of unusual warmth/cold. In other words, high impacts during a prolonged warm/cold spell do not mean that the long duration was the cause of the impacts. Indeed, not all of the papers cited by the authors actually prove a link between duration and impacts, and some citations are used in a borderline misleading fashion. For example, White et al. (2022) start their paper with the following sentence: “An unprecedented heatwave occurred in the Pacific Northwest (PNW) from 25 June to 2 July 2021” (8 days – much closer to 5 days than to 3 weeks). I would recommend nuancing the framing in the introduction, clarifying that there is actually quite an incomplete knowledge on the relation between impacts and duration of warm/cold spells, and a limited literature explicitly connecting impacts to persistence.*

**Answer:** Thank you for the suggestions. We reformulated the second paragraph of the introduction by adding a couple more references (including von Buttlar et al. (2018) who make the link between heatwave duration – from days to months – and vegetation impacts) and by adding more nuance in the confidence we have about the relationship between spell duration and impacts:

*”The impacts of warm and cold spells are modulated not only by their magnitude, but also by their temporal persistence and their spatial extent. For instance, long summer or winter cold spells can be especially detrimental to vegetation (Chapman et al., 2020). von Buttlar et al. (2018) found that the duration of heat extremes was key in modulating the impacts on vegetation, with multi-week spells being more harmful than short-term events. Long summer warm spells can also lead to droughts or make droughts worse, notably in water-scarce regions (García-Herrera et al., 2010; Vogel et al., 2021). Finally, Polt et al. (2023) argued in the case of Germany that heatwaves were the most impact-relevant at time scales between 2 weeks and 2 months. While our knowledge of the relationship between the persistence of warm and cold spells and their impacts remains incomplete and further studies are needed to improve it, there is therefore some quantitative evidence that persistent warm spells can lead to much stronger35 impacts on human and natural systems.”*

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**Comment 1.5** A further detail is that the only definition Anel et al. (2017) ever mention is of “at least two consecutive days”. Then it is true that they present a number of case studies, but I could not find any explicit discussion of persistence, duration or whether persistence played a role for the impacts. I am therefore still puzzled as to where the authors conclude that the study explicitly evidences a non-linear impact scaling with duration.

**Answer:** You are correct; we removed this reference from the introduction.

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**Comment 1.6** *This may be a Latex compilation issue, but in the PDF I used on l. 10 I read “events ? co-localized”*

**Answer:** Probably a compilation issue as you suggested. We'll make sure this gets fixed in the final version.

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**Comment 1.7** *ll. 29-30 This statement may need to be updated, as complete climate data for the whole of 2022 is now available.*

**Answer:** Thanks. We changed l.27 to past tense, but the figures on ll. 29-30 are still valid.

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**Comment 1.8** *l. 62 persistence summer heatwaves. –> persistent summer heatwaves*

**Answer:** Thanks, corrected.