

## **Comment on wcd-2022-45**

Anonymous Referee #1

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Referee comment on "European heatwaves in present and future climate simulations: a Lagrangian analysis" by Lisa Schielicke and Stephan Pfahl, Weather Clim. Dynam. Discuss., <https://doi.org/10.5194/wcd-2022-45-RC1>, 2022

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### **General comments:**

This manuscript/preprint is devoted to the analysis of European heatwaves under recent past (1991-2000) and future (2091-2100, RCP8.5) climatic conditions. A 3-D Lagrangean description (10-day backward trajectories) of the air mass stream flows underlying the occurrence of percentile-based heatwaves (Heat Wave Magnitude Index daily), with relative and time-dependent thresholds, in gridpoints within six target regions over Europe (following Zschenderlein et al., 2019) is carried out. A 35-member/initialization ensemble, generated by the Community Earth System Model (CESM1), is used for climate change impact assessments.

Overall, the topic of research is quite pertinent in the ongoing climate change context, with major and unprecedented heatwaves hitting many regions worldwide. Understanding their driving (dynamical and thermodynamical) mechanisms is of utmost relevance for the scientific community and society in general. The data and methods used are adequate for the study's purposes. State-of-the-art datasets are selected. A sufficient literature review is provided to the readers. The results are scientifically sounding and in agreement with previous research. The text is easy to follow, with enough explanation of the methodologies and findings. The figures are of good quality but too much. Therefore, I recommend the acceptance of this manuscript after some minor revisions that are outlined in the specific comments below.

### **Specific comments:**

- In the abstract: please state that you have used RCP8.5 in your climate change projections.
  
- Section 2.1: Although using a single general circulation model (GCM), i.e. CESM1, is understandable due to the lack of other similar data sources, this is indeed an important limitation of the study that should be stressed. Furthermore, the potential implications of using a single GCM in the results should also be more deeply discussed in Section 4. Only a short sentence is related to this point in the last paragraph of Section 4.
  
- Section 2.1: "Re-runs of the simulations have been performed for two 10-year time slices...". Please specify who did these new simulations and if they are available for upcoming studies.
  
- Section 2.3: The heatwave definition based on the 90th percentile of the daily maximum temperature within a 30-day running window is a reasonable choice. However, something should be mentioned regarding the possible implications of having a higher threshold (e.g., 95<sup>th</sup> percentile) or a different window length. A sensitivity analysis could be useful to clarify this issue and improve the robustness of the results.
  
- Section 2.3: The choice of having different thresholds for each time slice is plausible. Nonetheless, this choice deserves further explanation. In Section 1 this issue is already mentioned, but it would be useful to address this point here as well.

- Line 114: Please explain “annual maximum temperature”. Have you also applied the 30-day running window to the heatwave magnitudes? This is important to understand what you mean by “The latter criterion ( $M_d > 0$ ) also makes sure that heatwaves occur during the warmest time of the year, typically the summer months”. The heatwave definition deserves a better explanation for a reader not familiar with this concept.
  
- Equation 2: I would say “isobaric advection” rather than “advection”, as vertical advection corresponds to the adiabatic expansion/compression term.
  
- Figs 8-13: I suggest reversing the colour scale in the panels with the differences in parcel density (b-e), as reddish (bluish) colours are more commonly associated with positive (negative) anomalies.
  
- The number of figures is excessive. I suggest using supplementary material for some of them and shortening part of the text, namely sections concerning Figs 2-7. The authors may also choose to present the results only for some of the target regions, leaving the other figures as supplementary material.

#### **Technical corrections:**

Line 114: Delta  $y$  instead of Delta  $t$  in the 25<sup>th</sup> percentile.

Figure 2: no reference is made to the second box of HWhist.

Line 315: awkward sentence. Please revise.

Line 465: "presented her". Please correct.