

**Second round of review of “Physical Processes Leading to Extreme day-to-day Temperatures Changes, Part 1: Present-day Climate” by Kalpana Hamal and Stephan Pfahl submitted to Weather and Climate Dynamics**

We would like to thank the reviewers again for their helpful comments. Our responses are printed in blue, whereas the reviewer's questions are in black.

**Comments of Reviewer 1 and Responses**

**A. Gereneral comments**

This is the second time I am reviewing the manuscript, and I believe it has substantially improved during the first round of review. In particular, I appreciate that the authors are now more precise in their use of terminology (e.g., “advection,” warming/cooling events), which significantly enhances the clarity of the text.

However, in response to some of my previous comments (regarding lines 159-161, twice line 214, Caption Figure 4 in the original manuscript), the authors stated that they had incorporated the suggested changes into the revised manuscript. Unfortunately, these changes do not appear in the current version. I assume this was an oversight, and I would like to encourage the authors to implement these revisions in the next version. I still have a few minor suggestions for improving the text, but overall, I feel the manuscript is close to being ready for publication.

1. L159-161: “Since the magnitude of  $\sigma$  changes can be expressed as a function of ..., Figures 1 and 2 show these related quantities.” Again, I think this sentence is not properly formulated. The Figures 1 and 2 do not show the other quantities because  $\sigma$  can be expressed as a function of them. It is rather that you decided to show them as they are part of the computation of  $\sigma$ .

**Response:** The sentence has been revised in the updated manuscript as: “According to equation 5, the magnitude of DTD changes can be expressed as a function of the standard deviation  $\sigma_T$ , and lag-1 autocorrelation  $r_{1,T}$  of daily mean temperature, which is shown in Figures 1c-f and S1e-l also show these related quantities for DJF and JJA.”

2. L214: I was wondering whether the word “distinct” is appropriate.

**Response:** The sentence has been revised in the updated manuscript as: “Over the 3d leading up to this preceding day, these cold air masses (mean temperature of  $-21.5^\circ\text{C}$  at -3d) experience a gradual temperature increase (of  $5.7^\circ\text{C}$ ), with significant adiabatic warming ( $8.3^\circ\text{C}$  in the mean) due to a strong 100hPa mean descent (Figures 5e-f)”.

3. L214: What is meant by “limited” diabatic cooling?

**Response:** The sentence has been revised in the updated manuscript as: “Some diabatic cooling, likely due to longwave radiation, is indicated by a reduction in  $\theta$  (by  $-2.6^\circ\text{C}$  in the mean), constraining the temperature increase (Figure 5g)”.

4. Caption Figure 4 in the original manuscript, (Caption Figure 4: You write “selected grid point” but what is shown is a “grid box”)

**Response:** We have replaced “grid point” by “grid box”.

**B. Minor comments**

1. L61: The sentence “In contrast, tropical regions typically exhibit weaker temperature advection” suggests a comparison, but earlier in the text, you have not explicitly mentioned that other regions exhibit stronger temperature advection. Consider rephrasing to make the comparison clearer and more logically connected.

**Response:** Thank you for the helpful suggestion. We have revised the sentence to make the comparison more explicit and logically connected.

In contrast, tropical regions generally experience much weaker temperature advection compared to the extratropics, and extreme temperature events there are more strongly influenced by local processes such as precipitation, radiation, cloud cover, and surface fluxes (Gough, 2008; Matuszko et al., 2004; Sun and Mahrt,

1995; Dirmeyer et al., 2022). Nevertheless, an accelerated warming of extreme temperatures across tropical land has been observed recently (Byrne, 2021).

2. L61: I feel that the use of “However” at this point may not be appropriate.

**Response:** The word "However" is no longer in line 61.

3. L112: “The approximation in equation (4) is based on ...” instead of “... is associated with”?

**Response:** We have changed this to "is based on".

4. L124: I suggest removing the word “previous” from the phrase “previous studies on extreme temperatures,” as it may imply that your study also focuses on extreme temperatures, which it does not.

**Response:** We have removed "previous" from the sentence.

5. L125: It is not clear to me why the near-surface layer must be assumed to be well-mixed. Could you clarify this point?

**Response:** Thank you for the comment. The near-surface layer is assumed to be well-mixed to justify using multiple trajectory initialization heights to represent the same air mass. Under typical daytime conditions, surface heating generates turbulence that mixes temperature and moisture within this layer, but this turbulence is not explicitly resolved by the ERA5 wind fields that are used for the trajectory calculations.

6. L127-129: Think about just omitting the fact that you actually computed 10 day trajectories, although in the end you only needed 3 day trajectories.

**Response:** Yes, we ultimately used only 3-day trajectories for the primary trajectory decomposition analysis. However, in the density plots, we included the color shading from the 5-day trajectories and the contours from the 3-day and 1-day trajectories to provide a comparative reference for the spatial distribution of air parcel origins. Therefore, we believe it is relevant to mention the computation of 10-day trajectories as well.

7. L136: Where does the “these” refer to?

**Response:** In the previous sentence, we mentioned the different locations selected for the study. The term “these” refers to those locations where the Lagrangian temperature decomposition will be performed.

8. L137: I would try to be consistent with the heading of this subsection, so I suggest instead of “Lagrangian temperature variation decomposition” “Lagrangian temperature variability decomposition”.

**Response:** We have implemented the suggested change.

9. L186: “... while in the tropics,  $\sigma_{DTDT}$  is lower associated with lower  $\sigma_T$ , despite lower  $r_{1,T}$ .” I have difficulty understanding this sentence. Think about rephrasing.

**Response:** Thank you for the suggestion. We have rephrased the sentence as follows: “At the same time, in the tropics,  $\sigma_{DTDT}$  is smaller because the standard deviation of daily temperature  $\sigma_T$  is low, even though  $r_{1,T}$  is also lower”.

10. L541-544: “... but advection plays a smaller role, in particular for temperature extremes and heat waves in larger parts of the mid-latitudes”. I appreciate that you tried to add a more nuanced discussion here. However, I still feel that it is not correct what is stated here, since the literature is not clear about whether advection really plays a smaller role for warm extremes than for cold extremes. Maybe just apply a more cautious formulation, e.g. “... where advection is sometimes thought to play a smaller role, in particular for temperature extremes and heat waves in larger parts of the mid-latitudes”?

**Response:** We have made the formulation more cautious: “Comparing these processes associated with extreme DTDT changes with the mechanisms leading to usual temperature extremes (heat and cold waves) indicates similarities in the winter season, when temperature extremes are also strongly affected by advection

in many mid-latitude regions (Bieli et al., 2015; Nygård et al., 2023; Röthlisberger and Papritz, 2023b; Kautz et al., 2022), but larger differences in summer, when extreme DTD events are still primarily driven by advection, whereas advection is, according to several studies, thought to play a smaller role, in particular for temperature extremes and heat waves in larger parts of the mid-latitudes (Zschenderlein et al., 2019; White et al., 2023, Röthlisberger and Papritz, 2023a)”.

11. L576: Where does the “this” refer to?

**Response:** In the revised manuscript, we have replaced the sentence as “This equation contains an approximation, as the trajectories are initialized only once a day (while  $\delta_T$  refers to daily average temperatures) and from different heights above the surface, assuming (and sampling) a well-mixed near-surface layer.”

### C. Technical corrections

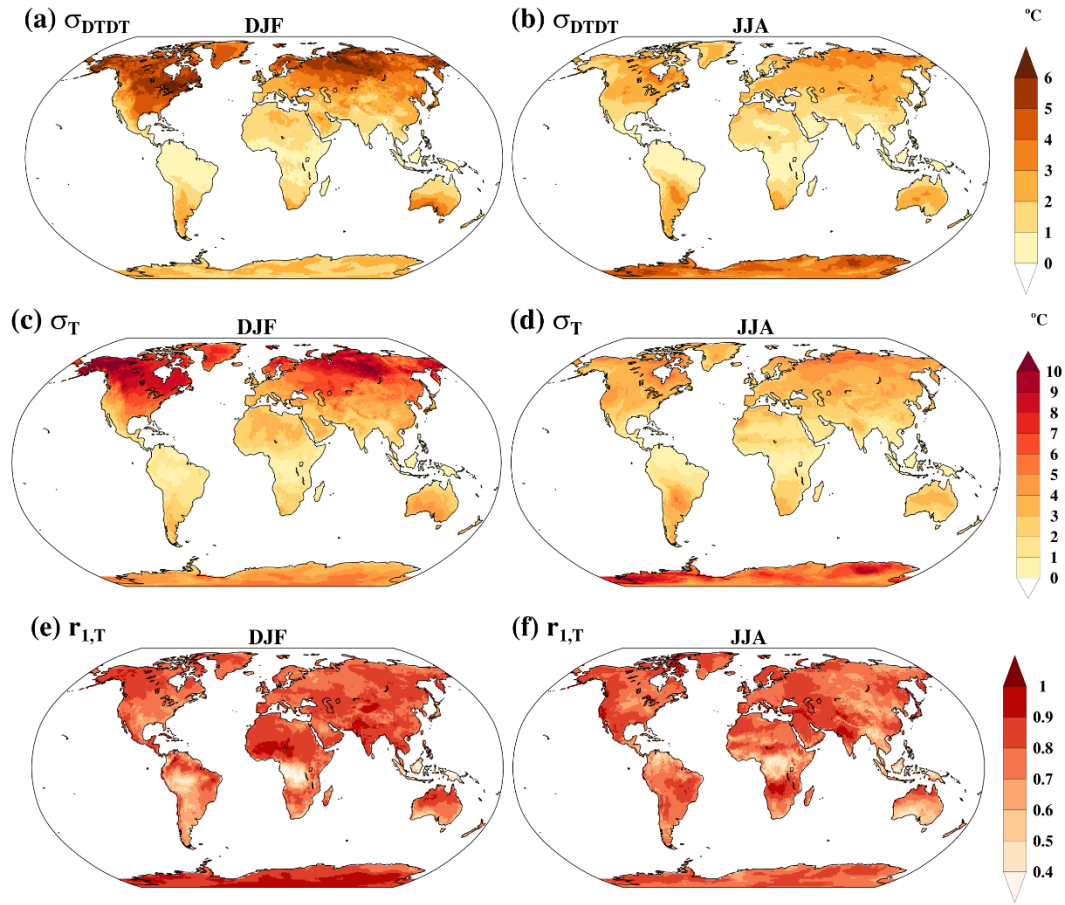
1. L147: Cross the “was”?

**Response:** We have removed the term was.

## Comments of Reviewer 2 and Responses

I thank the authors for taking into account my and the other reviewer's comments. I think these comments have been satisfactorily answered and I recommend the paper for publication. I would still add a final complain about Figure 1 where the authors argued against my suggestion to use a non-divergent color maps: I am afraid I must insist on this suggestion because I think it can strongly distorts the understanding of the figure by the readers. I left the final choice to the editor.

**Response:** Thank you for your valuable suggestion. We have updated Figure 1 to use a non-divergent color map as recommended to improve clarity and avoid potential misinterpretation (see Figure 1 below). We appreciate your helpful feedback.



**Figure 1.** (a, b) Standard deviation of DTD variations ( $\sigma_{DTDT}$ , °C), (c, d) standard deviation of daily mean temperature ( $\sigma_T$ , °C), and (e, f) lag-1 autocorrelation of daily mean temperature ( $r_{1,T}$ ) in December-February (DJF, 1st column) and June-August (JJA, 2nd column) derived from the ERA5 dataset.