Response to reviewers

We are pleased to see that the reviewers value the content of our study. We appreciate their feedback and suggestions. Below, we provide a detailed, point-by-point response to the comments from the reviewers.

Our responses to reviewer comments are organized by category. Each response is labeled with a code in the specified range. The response categories are given below.

Reviewer Comments	Author Responses
CC1	A1-A2
RC1	B1-B26
RC2	C1-C30
CC2	D1-D5

CC2:

Dear authors
The theme of this article is extremely interesting and important to me.

D1: We are happy to see that our work is recognized and of interest.

However, I am not acquainted with the data you use, nor with the techniques you use. So, my comments below may be completely irrelevant.
However, maybe I misunderstood, but I anticipated that you i) would show where hot extremes could occur under increasing global warming (in terms of temperatures, K, and region, that is, a Figure 2, but with colors showing extreme temperatures. Second, ii) I anticipated the map you show in Figure 2 of the possible causes for the hot extremes, but I assumed that you would have included the effects of ocean temperature variability. Ocean variability seems to have played a dominant role for global warming until about 1950, that is, the cold phase in ocean variability could compensate for increases in CO2, e.g., Wu et al. (2019).

D2: Thank you for pointing out these interesting aspects.
i) While mapping extreme temperatures under increasing global warming would indeed be interesting, our study is focused on the global distribution of drivers of hot extremes rather than on the spatial distribution of the extreme temperatures themselves. Our analysis examines the drivers independently of the temperature values associated with each hot extreme event. However, we do categorize the relevance of different drivers by region, as shown in Figure 3, which aligns with a similar intent to understand the spatial variation of hot extreme drivers.
ii) Ocean variability is indeed an important aspect of hot extremes. However, as we mentioned in our response A1, we only consider land surface and atmospheric drivers of hot extremes. Incorporating ocean variability indices in future analyses could provide valuable insights into how large-scale oceanic patterns influence continental temperature extremes. We will acknowledge this fact in our introduction.

Also, maybe I am too numerical, but for me an equation like
T = a1 geopotential (unit) + a2 wind (m.s-1) +..
with variables centered and normalized to unit standard deviation to avoid any effect of the units. Since I am not sure the variables are "strongly not related" line 189, maybe a Principal component analysis, PCA, would be appropriate (I don't know).

D3: Thank you for the suggestions. We will calculate a cross-correlation matrix to quantify the correlations of the variables. See response B2 for details on the planned approach.

You use the term "Dominant driver" , "… while net radiation is the dominant driver in a slightly larger area.." but I am not sure how you come to that conclusion, except that it covers a larger portion of a study area.

D4: In our study, we use the term 'dominant driver' to describe drivers that are found to have the strongest influence across the largest area of the study region. This is based on the spatial extent where each driver is most relevant, rather than on a direct quantitative comparison of their intensities or magnitudes. As a result, when we describe net radiation as a 'dominant driver,' we mean that the area it covers as the most influential driver is larger for 7-day hot extremes compared to 1-day hot extremes.

"We find that long-term mean temperature and radiation are the most relevant predictor variables for both 1-day and 7-day hot extremes " , and I am not sure what "Most relevant" means. I would have anticipated some numerical values here.
If my comments do not give any meaning t you, please just skip them.

D5: We used SHAP (Shapley Additive Explanations) values to provide insight into the contribution of each predictor, in other words to determine the relevance of these features. The mean absolute SHAP values were calculated, and we found that long-term mean temperature and radiation are the most relevant predictor variables for both 1-day and 7-day hot extremes. The numerical values of the SHAP values are given in Figure A2. A detailed explanation of how we calculate the relevance (SHAP values) and the updated text is given in our response C18.

Best Knut L. Seip

Wu, T. W., Hu, A. X., Gao, F., Zhang, J., & Meehl, G. A. (2019). New insights into natural variability and anthropogenic forcing of global/regional climate evolution. Npj Climate and Atmospheric Science, 2. https://doi.org/UNSP 18
10.1038/s41612-019-0075-7