

***Interactive comment on* “The substructure of extremely hot summers in the Northern Hemisphere” by Matthias Röthlisberger et al.**

Anonymous Referee #1

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General comments

This manuscript investigates Northern Hemisphere extreme hot summer seasons from a statistical point of view. The topic is relevant, because hot summers have societal impact and are going to become more frequent due to anthropogenic climate change. The paper focuses on the entire 3-month summer season rather than addressing individual heat waves (which have been studied before quite extensively). The method involves a novel statistical analysis based on ranking the 92 days of a summer season according to their anomaly with respect to the corresponding climatology.

The results indicate that hot summers in different areas on the Northern Hemisphere may have different substructure: in some regions a summer season tends to be hot because the hottest tercile is anomalously hot, while in other regions the summer sea-

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son tends to be hot because the coldest tercile is anomalously hot. In addition, it is shown that the Community Earth System Model (CESM) is able to broadly represent such regional differences. The regional differences are made plausible by studying a few cases/locations. I think these are interesting results. In addition, the paper is very well written. I have a few specific comments below which may help to produce a final version.

My only general comment is the following. I found that the statistical method is well described and sounds very interesting, and while reading I was eagerly awaiting the discussion of possible physical causes. But then (reading that section) I was somewhat disappointed. For instance, the shift in the onset of the Indian monsoon obviously explains the behavior found in the statistical analysis; actually, the explanation is so obvious that in retrospect the statistical analysis almost appears as an artifact. Let me grossly exaggerate to make my point clear: if you have a very simple phenomenon and apply a rather complex or strange analysis to it, you are likely to find a complex or strange result, but the complexity or strangeness of the result in this case would be mostly a feature of the analysis and not a feature of nature. Having said this, I still believe that the analysis is worth doing, and you do it very well.

Specific comments

Line 68: Can you give here an example, too?! You could, for instance, mention Nevada (USA) and say that this will be discussed later.

Line 96: Do you really "illustrate physical causes"? I feel that you, rather, aim to "uncover the underlying physical causes for the different summer substructures".

Beginning of section 2.3: At this point I thought your analysis implies some spatial averaging, e.g., a summer season in Switzerland. Only later it becomes clear that this analysis is done grid-point wise. It would help me if you can say this rather early in the text.

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Line 134: You could add that $D = 92 =$ the number of days in the summer season.

Line 238: "most regions"? 46% of the NH land area is less than half of the land area, so in what sense is this "most regions"? Did I get something wrong here? The same remark applies to the summary section (line 448).

Line 273: I wonder to what extent this "result" is more or less trivial: To the extent that a particular tercile of the distribution is much more variable than the other two, does this not imply by necessity that an anomalous season must be due to this tercile being anomalous? If this is so (i.e., more or less trivial), you should say this; if I am wrong and this is not trivial, it would help (me, but possibly other readers as well) to explain why it is not trivial. This remark applies equally to the conclusion section (line 407) and the abstract (line 26).

Line 284: "closely"— really? There is quite some resemblance, but I would not call it "close".

Line 364: Is this really a "breaking" trough? In my eyes this is a large (nonlinear) trough, but not quite breaking (yet).

Line 405: Can you speculate why in some areas there is no good correspondence between CESM and ERA-Interim?

Technical corrections

Line 302: Should it not read VF_{cold} and VF_{hot} ?!

Line 588: Is "Earth's Futur." the title of the journal?

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