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Interactive comment on "Weather extremes over Europe under 1.5 °C and 2.0 °C global warming from HAPPI regional climate ensemble simulations" *by* Kevin Sieck et al.

Anonymous Referee #1

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Review comments on Weather extremes over Europe under 1.5°C and 2.0°C global warming from HAPPI regional climate ensemble simulations by Sieck et al. (esd-2020-4)

This paper presents simulations from the HAPPI project, one large and one semi-large global climate model ensemble downscaled by one regional climate model. The results are used to study the climate at +1.5°C and +2°C global warming. This will occur rather soon, which means that climate change is small compared to natural variability. When that is the case there is a clear benefit of using large ensembles since that enables better statistical analyses. This paper could be a good contribution to the

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Discussion paper

"large ensemble field", especially since it is a RCM ensemble, which is not usually the case. Unfortunately the paper gives a slipshod impression. I wish that the authors would have proofread and language checked once more before submitting. All the questions I get about definitions, methods and analyses stands sometimes in the way for my evaluation of the scientific content. I think the paper needs a lot of improvement before being published.

* General comments

I think Laura Suarez-Gutierrez raises some valid points about how the results presented here relates to previous studies and the impact of the prescribed SSTs (which the authors themselves describe as "unrealistic"). I trust the authors to properly respond to that, so I wont go into that more here.

Is this paper a presentation of a data set or a presentation of results? The title suggests results, but the abstract starts "This paper presents a novel data set" and the Discussion "A unique data set has been presented". It's of course fine to do both, but a data description paper would require a lot more information about models, time periods, scenarios etc. I'm not sure that I agree that a data set is properly "presented" here.

Describe the model experiments in more detail. Why did you use 10 year periods? And why 20 years for the pre-industrial period? How are the specific warmings levels (SWLs) for +1.5 and +2 defined and calculated? You say that you use both RCP2.6 and RCP4.5. Do you mix them in the SWLs? What is the ratio RCP2.6/RCP4.5? I guess that this is described in some HAPPI paper, but it's worth to spend a few lines on that also here.

10 year periods are short in a climatological sense, how is the choice of 10 year periods motivated? One could, of course, argue that with enough ensemble members natural variability will be sampled anyway; however, 10 years with 100 members equals 1000 simulated years which corresponds to 33 members simulating 30 years. 10 years

times 25 members equals 30 years and 8.3 members. A 9 or 35 member ensemble does not sound as impressive as a 25 or 100 member ensemble. Don't make to bold statements about the size of the ensemble. Furthermore, you don't explicitly say how many members the RCM model consists of. You say that the GCM ensembles have 25 and 100 members respectively, but you don't actually say that you downscale all of them. Not as far as I can see at least. Overall I think section 2.1 could be rewritten in a clearer way first presenting the HAPPI project and the GCMs then the RCM and the GCM-RCM combinations, time periods, etc. As it is now it's a bit of a mixture where the reader has to go back and forth to get it all.

Why did you choose these particular indices? And why do you do use different statistical methods to analyse them? The choice of methods and the ways to present the results seem a bit arbitrary.

A suggestion for improving section 2.2: Remove the bullet points with indices. It's a bit strange when the indices are listed together with some kind of motivation or definition, but in a different way for each index. Instead just list the names of the indices. Then, have a sub-heading for each index under which you properly explain the definitions and motivations behind each index.

To what degree would you say that you are showing the value of large ensembles? You mention a smaller sub-ensemble, but I can't see it in the analyses. Sure, you compare the NorESM and ECHAM6 forced ensembles, but how can you know that all differences between the ensembles are due to the ensemble size and not the models themselves?

Think about how you want to name the SWLs. "1.5°C period", "temperature target 1.5°C simulation" (bulky), "2.0°C increase in GMT" or something else. It's a bit annoying when different names are used at different places in the text.

* Specific comments

L20: This sentence (especially the first line) is incomprehensible to me. Think about what you want to say, then write it in two, or even three, sentences. Long sentences with few commas has no intrinsic value.

L26-28: One could add to this that even though it's relevant to work with SWLs the choice of RCP can have an impact on the simulated SWL climate (e.g. Bärring & Strandberg, 2018). This should be interesting to you since I suppose that you mix RCPs in you index calculations.

L30: "5 to 15 models available". I had a quick look at ESGF and found ca 70 members from 30 models from 13 model families. I don't think it's fair to describe the CMIP5 archive in such a diminutive way.

L58: How where the +1.5 +2 SWLs calculated, please explain.

L59: Why is the pre-industrial period 20 years when the other periods are 10 years?

L61: "greenhouse gas forcing is constructed from RCP2.6 and RCP4.5" What do you mean by "constructed"? Don't you just use the forcing data from the RCPs?

L61: "RCP2.6 and RCP4.5" Do you use both and mix them in the SWLs? How many of the 100 (25) members are from RCP2.6 and RCP4.5 respectively?

L69: The use of "per period" is a bit confusing. Isn't it enough to just state the number of models?

L73: "For each GCM member" Are these all of the 125 members?

L74: "These time scales" What times scales?

L75: "RCMs" → "RCM's"

L94: "recommend" → recommended

L97: (or L105-109) Please explain a bit more about apparent temperature. Why is it apparent? Why doesn't it always occur?

L109: “Relative change” I guess you look at the change in all indices, I don’t get why you specify this explicitly here.

L 103: “and NorESM has” → “and the NorESM driven have”

L115-116: This sentence is incomprehensible to me. Think about what you want to say, then write that in two, or even three, sentences. Long sentences with few commas has no intrinsic value.

L116: Remove “As such”, this is not the correct use of that term.

L118: “exceedance probability” Isn’t rainfall events rather associated with either a probability or a threshold. Maybe I just don’t understand what you mean.

L118: “ rainfall intensity for the 50-year return” Do you mean rainfall intensity with a 50-year return period?

L119: “Such information” What kind of information?

L121: “between 100 and 100 years” I guess that at least on of the “100” should be another number.

L122: What is your definition of CDD? Is it the longest period of consecutive dry days, or something else? Is it the longest period over the whole 10-year period or is the annual average for all 10 years? What is the threshold for a dry day (1 mm?)?

L122: Why do you analyse CDD for the Prudence regions and not in a map as with the other indices? Or, why don’t you do the thorough analysis that you do for CDD for the other indices?

L130: “historical” Is this pre-industrial (1861-1880) or current (2006-2015)?

L131-132: “differences of the /.../ percentiles were computed by subtracting the ensemble mean” Isn’t the difference in any percentile calculated by computing the difference between the percentile for one period with the same percentile for another period? I

think this sentence could be made more understandable.

L132: “areas” What kind of areas? Isn’t it done per grid point?

L135: How is the “percentile confidence range” defined?

L138: Why do you choose the Mann-Whitney-U-test?

L140: “precipitation intensity of the 50-year period” I think you mean “precipitation intensity with a 50-year return time”.

L141: “historical” Is this pre-industrial (1861-1880) or current (2006-2015)?

L141: “NOResm” → “NorESM”

L141: Why do you explicitly mention the model names here? I expect you to do analyse both ensembles for all indices. It’s implicit that you do.

L150: “mean temperature” Please add a “(not shown)” here.

L152: “and more in the median around the Mediterranean” Please consider rephrasing to something more understandable.

L154: “no change in the distribution of ATG28” Based on figs 2 & 3 I don’t agree. For +2 in central Europe the 5th percentile doesn’t seem to change much, while the 95th percentile increases with around 6°C. Isn’t that a change in the shape of the distribution?

L154:”spatial resolution allows”. It’s of course better than the GCMs, but is it really true? Isn’t the motivation for EUR-011 that EUR-044 doesn’t resolve complex topography?

L156”Mediterranean” → “around the Mediterranean” or “Mediterranean region”

Figs 2 & 3. Please consider the following: Add percentile names in a new top row. Add SWL names in a new left column. Add units by the colour bars. Add letters a-f in the caption. Add ensemble sizes in the caption And it seem like white colours are replaced by grey.

L169: “the four REMO ensemble experiments” This is a bit ambiguous. How many REMO ensembles are there, 1, 2, 4, 6? Depends on the definition. Consider erasing “four”.

L172: “more coherent” More coherent than what? Not with “larger areas”.

L172: “more significant” How is significance calculated, and how is it shown in fig 4?

L173: “difference in ensemble size” Between what?

L176:”the interior of the simulation” What is the “interior of the simulation” if not everything apart from the boundaries? This seems to be an unnecessary complicated way to describe where the largest changes are. Also consider changing “simulation” to “domain”.

L179: It should be easy enough to at least roughly test the effect of SST. Just plot it and see how unrealistic it is. Also check the timing of RX5day, is it in winter or in summer? I guess the SST bias works differently in different seasons. In winter it’s probably too warm, in summer too cold. I suggest that you do some kind of check.

Figure 4. Consider the following: Add SWL names in a new top row. Add model names in a new left column. Add letters a-d to the panels. Add units to the colour bars. Explain grey shading in caption.

L190: “To account for” What do you mean with this¿It doesn’t seem to be the correct use of the term “to account for”.

L190: “the relative change in daily rainfall intensity is presented in Figure 5”. No, it’s not. Figure 5 shows the change in the intensity with a 50 year return time.

L191: “In the both the” → “In both the”

L193: “precipitation intensity of the 50-year period” I think you mean “precipitation intensity with a 50-year return time”.

L190-195: It's seems like you're struggling with how to describe the precipitation intensity of events with a 50 year return time. Why don't you just define RI50yr properly and a bit lengthy, and then just stick to RI50yr? That would save you some trouble in writing, and should avoid some confusion for the reader.

Fig 5: Who do you suddenly show results for a different domain? Excluding parts of northern Europe and including parts of northern Africa where you don't have data. For consistency, show the same domain in all plots. This domain should preferably be the same as the model domain, unless you have a good motivation for excluding certain areas. Also, consider the following: Add SWL names in a new left column. Add letters a-d in the caption. Replace "Percent" with "%" in the legend. This is perhaps a matter of taste, but common practice is "%" I think.

L204: This sentence should start: "Both the 1.5°C and 2.0°C distributions ..."

L205: "historical" Is this pre-industrial (1861-1880) or current (2006-2015)?

L205: I think you can remove "respectively". It doesn't add anything.

L207-208: "whereas the /.../ distributions" This goes without saying. Consider removing for brevity.

Table 1: Why are the p-values suddenly the most important part of the analysis of an index? And why is CDD analysed for the Prudence regions? Please explain.

L215: "longer period of dry days" Be careful how you interpret changes in CDD. You don't define CDD so I can't be sure if you make the correct interpretation. If your CDD is averaged over your 10- year period it could be correct. If your CDD is the longest dry period over the 10-year period it only tells you that the longest dry period will be longer. That doesn't necessarily mean that dry periods on average will be longer.

L217: ". . . indistinguishable in the simulations /.../ (Table 1)." I don't understand the this sentence. Please rewrite.

L218: “more frequent” This is not correct. CDD is the length of the longest dry period (at least this is the common definition). If you want to know if dry periods will be more frequent you should study the number of dry periods.

L221: “1.5°C vs. 2.0°C” I think yo mean “1.5°C instead of 2.0°C”

L222: “adaption” Do you mean “adaptation”?

L221-222: I have a few problems with this, somewhat ambiguous, sentence. First, it is not the +1.5°C or +2°C targets that will have an impact on society, it is the climate change. Second, that the climate will be different in the +1.5°C world compared to the +2°C world is obvious. I guess you mean that the change in CDD is not linear so that the extra 0.5°C will have a large impact. Third, why do you point out changes in CDD in region 7 as a particular motivation for adaptation and mitigation? In my view this whole paper is a motivation for adaptation and mitigation as it shows how climate change may change in the future. Consider rewriting.

L225-226: It’s a poor motivation to exclude regions just because the U-test gives different results. Especially since the results differ also in region 3. Strictly speaking the results differ for all regions since you get different p-values (Table 1). With the possible exception of IP at +2.0 where both ensembles get 0.000.

Fig 6: It’s very odd to measure the number of days in the unit weeks. Add to the caption something like: “for the ECHAM (top row) and NorESM (bottom row) driven ensembles”.

L235: “10 x 100 years” I would prefer “100 x 10 years” since it is 100 10-year simulations.

L250: “smaller sub-ensemble driven by ECHAM6” I don’t see this sub-ensemble anywhere in the text. Should it be added to the analysis?

* References

Bärring, L., & Strandberg, G. (2018). Does the projected pathway to global warming targets matter? Environmental Research Letters, 13(2), 024029. https://doi.org/10.1088/1748-9326/aa9f72

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