Interactive comment on "Regional scaling of annual mean precipitation and water availability with global temperature change" *by* Peter Greve et al.

Anonymous Referee #3

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The authors investigate regional changes in precipitation (P) and water availability (expressed in terms of precipitation minus evaporation, P-E) as a function of global temperature changes in a sub-set of the CMIP5 simulations. They further decompose the uncertainties by sources related to climate variability, scenario, and model choice. They find robust changes towards wetting in northern high-latitude regions, and tendencies towards drying in subtropical regions, however associated with larger uncertainties. In particular, they also discuss changes related to political global warming limits of 1.5K and 2K.

This study is a worthwhile contribution to the literature, addressing the relevant topic

of regional impact-relevant responses related to different amounts of global warming. The manuscript is mostly well written, but some clarification is needed at a few places. I also have a few more major questions related to the methodology, but think that it should be possible to clarify these with some revisions.

Major comments:

(1) The authors use resampling to estimate the effects of internal climate variability. They mention that this leads to similar results as using different realisations of one model but do not show results. As estimation of different uncertainty sources, including variability, is one of the main goals of this paper, I think the authors should provide evidence that their approach by just resampling results from one run does actually lead to comparable results to analysing different runs. This seems important as usually effects of variability are estimated from a number of runs started from different climate states with respect to internal variability.

(2) The authors document some larger differences in the response between different scenarios, and seem to discuss these differences in the context of different strength of the GHG forcing. However, also the aerosol concentrations differ between the different RCP scenarios, and I wonder to which extent these scenario differences of P and P-E changes could be attributed to differences in aerosols?

Specific and technical comments:

- Abstract, line 3: I'd remove "large" as I don't think 14 model simulations is a "large" sub set of the total number of runs available in CMIP5

- Abstract, line 6: (Please also check throughout the text!) I suggest avoiding "dependency" when discussing the relationship of regional climate with global mean temperature. Better just say "linear relationship" here.

- page 1, line 21: suggest adding "public and political debate"

- page 2, line 14: I wonder if the assumption of a linear relationship is justified when

investigating changes at individual grid cells from individual ensemble members. Especially P and P-E can be rather noisy variables, strongly affected by low-frequency variability, so it might help to justify the robustness of the approach if the authors provided some tests whether linearity is a reasonable assumption in this context.

- page 2, line 20: This sentence is ambiguous, it seems like "this work" and "this analysis" refer to different studies, but it is not really clear what refers to what.

- page 3, line 1: insert "global" warming-degree targets

- page 3, line 23: many readers may not be aware what exactly the "prerequisites provided in Fischer et al." are – for better readability please briefly summarise

- page 3, line 25: the historical runs include the year 2005, therefore if starting in 1980 this should be "26 years" and "from 2006 onwards".

- page 3, line 26: remove duplicate word "in"

- page 3, line 26/27: Sippel et al (https://doi.org/10.5194/hess-21-441-2017) discuss that assessing changes relative to a short reference period may lead to bias in the out-of-reference period. As the authors chose here to use only 20 years as baseline, I am wondering whether their quantifications of changes would be affected by such biases?

- page 3, line 27: Sentence not clear, does "majority of models" suggest that some models are treated different than others?

- page 4, line 1: What kind of least squares fit did you use, e.g. ordinary or orthogonal (i.e. minimising squared differences only in y-direction or in both x and y-directions)? I think there may also be some error in the T values, so orthogonal least squares might be most appropriate?

- page 4, line 24: Please check, is it 10th and 90th quantile, or 25th and 75th quantile as written on Figure 2?

- page 4, line 25: Very confusing use of parentheses. If I follow your logic that the text in

parentheses indicates some opposite results/statements then this sentence seems to suggest negative values always relate to (P-E) – which of cause is nonsense. Please also see this text by A. Robock (https://eos.org/opinions/parentheses-are-are-not-for-references-and-clarification-saving-space), and consider rewriting this sentence in a more readable (and clearer!) way.

- page 5, line 5: based on only 14 models, the 90-100

- Page 5, line 21: Figure 4 shows the scaling relationships as regression lines, it does not explicitly show the "coefficients" as claimed in this sentence.

- page 5, line 26: replace "/" by "or"

- page 6, line 1: remove "much"

- page 6, line 3: replace "within" with "in", and "parts" with "individual grid cells"

- page 6, line 4: replace "within" with "in"

- page 6, line 7: consider adding the clarification "(very) likely decrease [across all scenarios]".

- page 6, line 21: replace "many" with "some"

- page 6, line 25: The structure of the Results section seems somewhat confusing. Section 3.2 is named "sources of uncertainty" – but didn't already section 3.1 discuss one specific source of uncertainty? Please consider restructuring Section 3 more logically, or at least use more suitable sub-section names, e.g. "3.2 Comparing different sources of uncertainty".

- page 7, line 26: add "with stronger global warming" (or similar) at the end of the sentence after "P-E".

- page 9, line 1: This sentence is a literal repetition of page 7, line 30-32. Please consider rephrasing one of these instances. Otherwise this is a very nice conclusion.

- Figure 2: It looks like ocean areas and Antarctica were removed. This is not explicitly mentioned in the text – are these regions removed due to P-E<0 here (page 3, line 27) ? As mentioned above, please also check for consistency whether it is 10th/90th percentile (or if you wish to express in quantiles: 0.1 and 0.9), or 25th/75th

- Figure 3/4: The text and labelling of the T-P scaling plots surrounding the map is impossible to read and should be larger. To save space you may consider to axis labels only on one plot (assuming it is equal for all), and then minimise the white space.

- Figure 10 caption: replace "all SREX regions" with "each SREX region" – I assume this is what you actually wanted to say (having an average for each region rather than one average over all)?