

Interactive comment on “Variations of global and continental water balance components as impacted by climate forcing uncertainty and human water use” by H. Müller Schmied et al.

Anonymous Referee #2

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In this manuscript, the authors assessed the variations of global and continental water balance components as impacted by climate forcing uncertainty and human water use. In addition to that, the authors evaluated the impact of climate forcing uncertainty and the effect of temporal aggregations on the different water components at local, regional, and global scales.

The paper addresses relevant scientific questions within the scope of HESS. Although it is not the first paper that evaluates the impacts of human interventions versus hydro-meteorological changes on hydrological parameters, the research angle chosen as well as the approach could be of added value to the research domain of water resources research.

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Overall, the paper reaches some interesting conclusions- especially regarding the uncertainty of meteorological forcing data-sets and with respect to the dominant factors of change- backed-up with figures and numbers (results) and substantiated with some existing research (discussion). I would therefore support the manuscript for publication but with substantial revisions taking into account the following general and technical comments/suggestions:

General comments:

1. Locally redundant text, especially when it comes to the introductory parts and descriptions of data in different sections:
 - a. The introduction of section 2 (Data and Methods) shows much overlap with the last paragraphs of section 1 (Introduction).
 - b. Page 6, line:2-26: Move the list of modifications to the appendix.
 - c. Page 16, line:7-9: Here the authors refer to Müller Schmied et al (2015) for a comparison of AET, Q, WCa, and total water storage to the five climate forcings. Since the different climate forcings are already described in this paper, the authors can shorten all text with reference to these climate forcings (section 2.3).
 - d. De results and discussion section show a lot of overlap. In its current form, the discussion section is basically a repetition of/part of the results section but with some possible explanations for the observations given. Please avoid any unnecessary repetition and try to substantiate/discuss the found results with previous research where possible.
 - e. The authors use their research questions as titles for the discussion section, please choose shorter title names.
2. The results presented in the results section do not follow an intuitive order. Section 3.1 (temporal aggregations) is not a very logical section to start with. Given the order GCM(-impact)-GHM(-impact)-outputs I would start with the GCM uncertainty discus-

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sion (3.1 - make a separate section for this topic), then continue with the human impacts section (3.2), and finally end with the impact of aggregation section (3.3). Results for the global and continental scales could be discussed in sub-sections. Change the order of the research questions and the discussion accordingly.

3. In the discussing the impact of climate forcing uncertainty clearly distinguish between the modeling spread in forcing data (P, T, LWD) and the modelling spread in WaterGAP output (Q, AET, WCa) and elaborate a bit more on the discussion whether the initial spread in forcing data increases/decreases when feeding it into WaterGAP.

Specific/Technical comments:

4. Page 3, line: 13-16: “The international .. data-sparse regions”: Would leave this sentence out. Does not add much to the introduction

5. Page 7, line: 5-6: “The initial .. well-being”: Incomplete sentence

6. Page 7, line: 24: Please specify (or with reference) why you applied this minimum and maximum catchment area size

7. Page 12, line: 13-14: I would say that -despite A being negative- change in P might still be a significant driver to the change in Q (although not the largest/dominant driver of change). E.g. without a positive change in P, Q might have been even lower than already observed due to human activity.

8. Page 12, line: 21-24: Isn't it technically possible that there is (+/-) change from natural to human whilst there is a change in the other direction when comparing period 1 with period 2? Again, although anthropogenic factors would in that case not be the major driving factor, the influence can still be significant.

9. Page 12, equations: I think it would be good to provide the reader with a map (appendix) that shows the results of the consistency indicators individually. From figures 3 & 4 I cannot deduct for the red/green areas which share of this land area is red/green simply due a negative result for the inconsistency indicator of the other parameter.

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10. Page 13, line: 7-8: I had to read this a few times before understanding. With the 0.5 you basically take the mean of the ratio between Q and Precip over period 1 and period 2. Would be more clear if you show something with the SUM/AVERAGE symbol in the equation. Moreover, the line afterwards "assuming that the runoff coefficient remains constant over the two time-periods" is a bit strange in this context: the runoff coefficient is namely estimated using data from the two time-periods.

11. Page 13, line: 7-8: Wouldn't it –w.r.t. to comment 3- be more logical to estimate the $lvar_{prec,n}$ with the use of the runoff coefficients ($C_{qp,n}$) under both natural and human conditions in time period 1 and 2 only, rather than combining it again with Q and P?

12. Page 13, line: 7-8: I would say that it is especially this runoff coefficient that is changing due to human interventions. Wouldn't in that sense the change in runoff coefficient be responsible for the share of Q that is impacted by changes in P under a human impacts run?

13. Page 13, line: 15: Would be good to show a figurative example (with numbers) to show how/whether different P and Q scales end up to fall within the same range in $lvar_{ant}/lvar_{prec}$.

14. Page 15, line: 22: "1971-2000": The values in the table refer to long-term means Please mention in text.

15. Page 16, line: 7-9: "Müller Schmied .. Table 2": Is this correct? It seems to me that the numbers are swapped. Moreover, could you think of an explanation why the homogeneous forcing performs worse than all forcings (although prob. no significant difference)?

16. Page 16, line: 22: "10.5%": Where does this number come from?

17. Page 17, line: 7: "of": should be "in"

18. Page 17, line: 8-14: This piece of text is a bit fuzzy. Starts with anthropogenic water use, then on to Q, finally back to WCa again. Please reformulate.

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19. Page 17, line: 15: “different .. AET”: Can you relate AET also with differences in T or Radiation? And how could this possibly influence your irrigation water demand estimates?

20. Page 18, line: 8: “leads” should be “lead”

21. Page 18, line: 24: “More likely” is not equal to “more important”, please apply terminology consistently

22. Page 19, line: 10-11: “This is.. 20th century”: At first glance, this statement seems contradictory to the previous sentence. Please add some text about the changes towards T3 (1971-2000) to clarify this.

23. Page 19, line: 14-15: “The fraction .. later period”. Had to read this sentence a few times before I understood what was meant. Please clarify what is meant with the later period and specify that with 1911-1940/1941-1970 is mean between/from period T1 to period T2.

24. Page 19, line: 16-21: I thought that the areas “which cannot be calculated”(l:19) and “where both, P and human water use is not the dominant driver”(l:20) are the same areas. But here they have different fractions associated.

25. Page 20, line: 2: “STANDARD”: I haven’t seen this model reference before whilst you refer to this specific version of model in earlier paragraphs. Please use consistent namings.

26. Page 20, line: 13-16: “In addition ... in STANDARD”. Incomplete sentence, please reformulate

27. All of section 4.2 and many parts of 4.3/4.4 are results, no discussion. Please reshuffle.

28. Page 21, line: 21-22: “the effect .. time aggregation”. Was this specifically evaluated? If yes, where (I cannot find the associated results section).

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29. Page 23, line: 26: Would dam construction indeed lead to significant decreases in long-term Q? I would think that dam construction would mainly influence the timing of runoff peaks/lows. Could you give a reference for this statement?

30. Page 24, line: 2:8: “For example... “anthropogenic effects”: Do you expect that under the different climate forcings the absolute value of the anthropogenic impacts (mainly irrigation I would say) also changes or is this difference in outcome (relative contribution) only determined by changes in P)

31. Page 25, line: 20-21: “e.g. ISI-MIP2.1”. Could you mention more model intercomparison projects? Think of Agmip, Earth2Observe.

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