EGUsphere, referee comment RC1
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Comment on egusphere-2022-191

Giacomo Bertoldi (Referee)

Referee comment on "Apparent contradiction in the projected climatic water balance for Austria: wetter conditions on average versus higher probability of meteorological droughts" by Klaus Haslinger et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-191-RC1, 2022

General comments

This is valuable research, where changes in the climatic water budget (CWB) in the Alps, and future water scarcity risks are analyzed at an unprecedented spatial detail (1 km with a very good representation of mountain orographic factors).

It is also a work of great topical relevance and very timely, given the current 2022 heat wave in Europe and the water scarcity in the Alps.

This work explains well current and future alpine drought development mechanisms and shows how such events will become more likely in the future, despite possible year-round greater water availability in the Alps. Positive CWB signals are mainly caused by increasing rainfall, particularly during winter. On the contrary, the negative CWB changes during summer are caused by both increasing AED and slightly decreasing rainfall. Because of less snowpack contribution, water provision in the summer will become less constant and more connected to the liquid precipitation variability, and therefore, given the higher temperatures, summer water scarcity is more likely.

The figures are excellent ad full of information. Results are very interesting, especially for the spatial detail, which allows us to identify the local impacts of Alpine orography on the water budget. One relevant result is the finding that in the far future period the CC signal is much stronger in mountains than in lowlands.

I am looking for further research, showing how the 2022 summer drought will be compared to 2003 in terms of return period!

However, several methodological details need further clarification, especially on evaporation and glacier runoff estimation, and should be addressed before publication, as indicated below and in the specific comments.

- I am surprised by the strong increase of precipitation of the RCP 4.5 scenario for 2070 – 2100. Since most of the results are depending on this, and we know that climate models are still more uncertain in predicting precipitation trends than temperature, a discussion on the reliability of this high-precipitation RCP scenario would be very helpful.

- I am also a little surprised you do not find an important increase in Evaporative Demand. I am just wondering if this could be related to the quite simplified approach used to estimate evapotranspiration ET. This point deserves further discussion.
- **Title and journal.** The title triggers curiosity, but then reading the paper I found much more than this. The best parts of the paper are the high-resolution scenarios of climatic water balance (CWB) for Austria. So, the title is a little bit limiting. Changes in drought risk are only one of the aspects. I am also wondering if this paper fits better with HESS instead of NHESS.

Specific comments

Abstract. Please specify that you consider only meteorological drought.

- **Introduction (and title).**

L68 "How will future surface water availability change" I am not sure if the term surface water availability is correct. You are working with RCMS and a very simplified hydrological representation of the processes. What you get is mostly the water budget. Then you work on the CWB, which is simply a good indicator of the real surface water availability. Why do not also refer to CWB in the title?

To have an estimation of surface water you need to model also water infiltration, vadose zone hydrology, and groundwater recharge losses… which is of course beyond the purpose of the paper.

2 Data:

L80 "The broadly used RCP8.5 scenario is intentionally not included here, since its emission pathway is highly unlikely from today´s emissions trajectories,"

Sure? Are you so optimistic about the future?

L87 "EURO-CORDEX downscaling," Could you provide more information on the approach? How is orography taken into account for the downscaling?

3 Methods:

L119 "snowmelt model," Ok it is essential to consider snow melt in the CWB, but then you need a good snow melt model. Please provide here or later more information on how snow melt is modeled.

"**3.2 Atmospheric Evaporative Demand"** AED is a key parameter. For this is essential the calculation of ETP. Which is the accuracy of the calculated ETP? How has been validated?

Another key question on which I have some concern is how AED based on potential ET makes sense in an environment where real ET could be very different from FAO conditions, having very different land covers such as forests, rocks, and so on.

L158 "Herein, SG-CL is driven with gridded observations and the OEKS15 dataset for the reference and future projection runs, respectively." The statement is not clear to me.

"**glacier runoff"** This is also a key component of the CWB. The approach used is also not well explained. How a change in glacier area was estimated? How all the area above 2500 m is considered? Why this 2500 threshold?

"**3.5.2 Frequency Analysis - Return Periods**" Also here some parts are not clear.

How a return period can be calculated with not-stationary data?

10-y tr is not a too-low return period for an extreme drought? For floods, usually, much larger Tr are considered.

4 Results:

Results are very interesting, especially for the spatial detail, which allows us to identify the local impacts of Alpine orography on the water budget. I am looking at what the 2022 summer drought will look like in terms of return periods in comparison with the 2003 one!

Fig 3 I am surprised by the strong increase of precipitation of the RCP 4.5 scenario for 2070 – 2100. Since most of the results are depending on this, and we know that climate models are quite uncertain in predicting precipitation trends concerning temperature, a discussion on the reliability of this high-precipitation RCP scenario would be very helpful.

Fig 4d and L357. I am surprised that the annual average of mountain regions is only 34 mm/year. Given the total precipitation that should exceed 1000 mm/year and ET that should not exceed 500 mm/year, 34 mm seems a very little number since mountains act as "water towers.

Fig 4e. It is very interesting the increase of uncertainty in spring with the farthermost scenario. It is due to the major role of liquid precipitation? Please comment.

Fig 4f and L 292. What do you mean by rainfall? Only liquid precipitation? It is not clear!

Fig 5. Really beautiful Figure where the effect of elevation on the P/T relevance on changes in CWB is very clear. It would be nice to see the same Figure for different P and T scenarios may be in the supplementary material. What would happen without such a strong P increase?

L371 Fig 6c not 7c

L386 What is the drought duration? How do you define a drought period?

Acknowledgments: Is it possible to acknowledge in addition the ADO project?