

Hydrol. Earth Syst. Sci. Discuss., referee comment RC3
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Comment on hess-2021-92

Guillaume Evin (Referee)

Referee comment on "Future changes in annual, seasonal and monthly runoff signatures in contrasting Alpine catchments in Austria" by Sarah Hanus et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2021-92-RC3>, 2021

General comments

This study investigates the projected evolution of hydrometeorological aspects in small mountainous catchments located in Austria, using a classic modelling chain: emission scenario / GCM / RCM / bias correction / hydrological model. This paper is very pleasant to read and I congratulate the authors for this fine work. I appreciated the detailed and concise description of the data and methods. The results are clearly presented and described. I hope that the following comments will help to improve the discussion of the results.

Areal meteorological inputs

There are several limitations concerning meteorological forcings. This is briefly discussed at l. 502-208 but it could be discussed earlier in the text. First, the typical problem with hydrological applications in mountainous areas is that weather stations are mostly located in plains, typically below 1000 m, while most of the area covered by the catchments is above. In addition to the fact that point measurements in space can misrepresent areal values, the problem is that there is generally a strong relationship between precipitation (and temperature of course) and altitude (see section 3.2 in Ménégoz et al., 2020), these altitudinal gradients being also dependent on the meteorological situations (Gottardi et al., 2012). Reanalysis datasets provided on a regular grid usually take these gradients into account, and the same kind of gradients could be applied to your interpolated data. Without this kind of corrections, I do not see how a correct water balance can be obtained. Could the authors comment on that point?

Bias-correction

It is very briefly mentioned at l. 104 that the climate simulations are bias-corrected using scaled distribution mapping. I would appreciate more details about the method proposed by Switanek et al. (2017) and applied in this study. For example, what is the distribution applied to the positive observed precipitation values? Is it a gamma distribution? It is not clear to me what we can expect concerning the correction of extreme values either. Looking at Figure 6, I was puzzled by the mismatch between observed and monthly runoff when climate simulations are used as inputs. It is acknowledged at l. 216 that there could be an "underestimation of temperature in these catchments in the climate simulations". I understand that the bias-correction is not performing very well then, is that correct? If it is the case, I think it should be discussed in more depth.

Climate model uncertainty

Section 4.6, dedicated to climate model uncertainty, could be improved. First, as indicated in Table 2 of the manuscript, different GCM / RCM combinations are used in EURO-CORDEX. However, at l. 493-495, it seems that these pairs of climate models are considered as different models (e.g. "model 10"). It must be understood that the different GCMs and RCMs have their own structure, parametrization and, as a consequence, effects on the simulated variables. It is well described in papers dedicated to the partitioning of the different uncertainties (Déqué et al., 2012, Christensen and Kjellström, 2020). The study by Evin et al., 2021 clearly shows the individual effects of each GCM and RCM on the mean seasonal changes of precipitation and temperature in EURO-CORDEX ensembles (my apologies for citing my own work).

Other uncertainties

In section 4.7, other types of uncertainties could be discussed. The hydrological model can have a huge impact and the bias-correction / downscaling methods can also have an important influence (Lafaysse et al., 2014).

Climate projections

In the discussion, I think it could be interesting to indicate that CMIP6 simulations are now available but cannot be used for this kind of applications considering that GCM outputs are particularly misrepresented in mountainous areas (I must contradict reviewer #1 here). CMIP6 simulations will probably be downscaled dynamically in the next few years and RCMs represent a real added-value in these areas (Rummukainen 2016). In addition, a few RCMs are now able to represent convective processes and are expected to improve the representation of the precipitation in future climate projections (e.g. CNRM-AROME, Fumière et al., 2020), in particular the "localized convective high-intensity summer rainstorms" indicated at l. 505.

Minor comments

- Abstract: l. 5: I would add "two emission scenarios:" before RCP 4.5 and RCP 8.5 for the reader who does not necessarily know these scenarios.

- Abstract: l. 15: "Minimum annual runoff..." I guess this result is still obtained with RCP 8.5, is that correct?

- Figure 3: I suggest adding a reference to Table 2 in order to remind the meaning of the different objective functions.

- l. 235: missing space after "year."

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