POINT BY POINT REPLIES AND LIST OF MAJOR CHANGES

Referee #1:

Thank you very much for your thorough review. We very much appreciate your valuable suggestions.

The article analyses climate change impacts on runoff regimes in 93 rivers in Switzerland. The study is based on the results of a large Swiss research project, which provided consistent downscaled local climate projections under three emission pathways. The changes are presented with respect to seasonal and yearly changes in the mean discharge and with respect to the timing (seasonal shifts). Next, a time of emergence is presented, which is the time when a significant change of the seasonal and yearly means is detected. Additionally, changes of the runoff regimes are related to increasing global mean temperatures.

Evaluation of review criteria (details are provided by annotations in the PDF manuscript):

1. Does the paper address relevant scientific questions within the scope of HESS? Yes. The focus is on regimes in Switzerland, but methods and results are certainly of interest for other (alpine) countries.

2. Does the paper present novel concepts, ideas, tools, or data? Yes.

3. Are substantial conclusions reached? Yes.

4. Are the scientific methods and assumptions valid and clearly outlined? Yes.

5. Are the results sufficient to support the interpretations and conclusions? Yes.

6. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)? Due to the huge amount of data involved, not easily. But all datasets are publicly accessible.

7. Do the authors give proper credit to related work and clearly indicate their own new/original contribution? Yes.

8. Does the title clearly reflect the contents of the paper? Yes.

9. Does the abstract provide a concise and complete summary? It is rather long and not easy to read (too many numbers).

Reply: *Thank you for this comment. We shortened the abstract and reduced the numbers stated in the abstract.*

10. Is the overall presentation well structured and clear? In general, yes. Subsections of section Methods should be reordered to be consistent with section Results.

Reply: *Thank you for this suggestion. We reordered the subsections in the methods part (3.3 and 3.4).*

11. Is the language fluent and precise? In my opinion, many paragraphs seem to be too closely translated from German, which makes the text difficult to read. One specific concern: the frequently

used expression “signal of change” apparently refers to the sign of changes only (up or down), not to the magnitude of change – while in my opinion the term “signal” includes both, sign and magnitude.

Reply: *We replaced the phrase “signal of change” with “sign of change” or “direction of change” to make clear that it does not refer to the magnitude of change. The revised paper was also reviewed by a science editor.*

12. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used? N.a.

13. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated? See PDF annotations

Reply: *Thank you for your time reviewing the paper in detail. We appreciate your suggestions in the PDF. Comments which need some more explanations are discussed in the following:*

L50: this selection seems to be a bit biased. There are also publications by other groups, e.g. in Vienna.

Reply: *The following references were added:*

Blöschl, G., Schöner, W., Kroiß, H., Blaschke, A. P., Böhm, R., Haslinger, K., ... & Viglione, A. (2011). Anpassungsstrategien an den Klimawandel für Österreichs Wasserwirtschaft–Ziele und Schlussfolgerungen der Studie für Bund und Länder. Österreichische Wasser-und Abfallwirtschaft, 63(1-2), 1-10.

Goler, R. A., Frey, S., Formayer, H., & Holzmann, H. (2016). Influence of climate change on river discharge in Austria. Meteorologische Zeitschrift, 25(5), 621-626.

l136: This paragraph contains some assumptions whose effects need to be discussed: why use the last - and not the central - year of a 30-y window? what is the effect of the 95% significance? why 66% of the models?

Reply: *We adopted the thresholds from Mahlstein et al. (2011). They defined the year of emergence as the last year of the first 30-year window, where significant changes are detected (95% significance) for each of the simulations. The time of emergence is shown when 66% and 90% of the models show significant changes. This corresponds to "likely" and "very likely" in IPCC terminology. We rephrased the paragraph according to your suggestions and the suggestions of the other reviewers.*

“The time of emergence (Giorgi and Bi, 2009; Leng et al., 2016) indicates the time when significant changes in the distribution of seasonal and annual means emerge from natural variability. The Kolmogorov-Smirnov test was used to test whether two 30-year samples of seasonal or annual means are drawn from the same distribution. This test was conducted on the distributions of moving 30-year windows and the distribution of the reference period. The Kolmogorov-Smirnov test procedure was also used in previous studies (e.g., for precipitation Mahlstein et al., 2011; Gaetani et al., 2020), but other definitions of time of emergence also exist. Although Mahlstein et al. (2011) did not find significant differences from other definitions, Gaetani et al. (2020) found that the Kolmogorov-Smirnov testing procedure results in a more robust and earlier time of emergence. The testing was performed for each simulation under RCP8.5 and each catchment separately. Constraining the analysis to the RCP8.5 ensemble was motivated by the sufficiently large number of simulations, 20, within the ensemble. The time of emergence was then defined following the procedure used in Mahlstein et al. (2011) and refers to the last year of the 30-year moving window in which the

Kolmogorov-Smirnov test was rejected for the first time at 95% significance. This was done for each catchment and each simulation separately. We then considered the significance of changes in the seasonal and annual mean when at least 66% of the models detect a significant change in the same 30-year window. Sixty-six percent corresponds to the threshold referred to as "likely" in the IPCC terminology (Mastrandrea et al., 2010). Because changes in runoff may not be linear over time, the time of emergence may not be stable after the first detection. Even though changes in seasonal and annual runoff are tested as significant in one period, they may not be significant in all subsequent periods (e.g., due to nonlinear effects in snow melt or glacier melt contributions). Therefore, we also analyzed the temporal evolution of rejections of the null hypothesis for the Kolmogorov-Smirnov test (p-values smaller than 0.05)."

also, there is an inconsistency between the section title "seasonal changes" and the text where you mention seasonal and yearly means.

Reply: *We changed the section title to "Determining changes in seasonal and annual mean runoff".*

l144: "Since the time of emergence may not be constant in time" - What does this mean?

Reply: *The concept of time of emergence is based on a statistical test between two distributions of seasonal means (reference vs future). However, changes in runoff may not be linear over time. Even though changes in seasonal runoff are tested as significant in one period, they may not be significant in all periods afterwards (e.g., due to non-linear effects of enhanced snow melt, decreasing snow cover, increasing glacier melt and decreasing glaciation). This is the reason why we included Figure 7 showing the temporal evolution of the p-value over time. In order to make this point clearer, we included an explanation in the methods section as well as in the discussion section.*

Method section: "Because changes in runoff may not be linear over time, the time of emergence may not be stable after the first detection. Even though changes in seasonal and annual runoff are tested as significant in one period, they may not be significant in all subsequent periods (e.g., due to nonlinear effects in snow melt or glacier melt contributions). Therefore, we also analyzed the temporal evolution of rejections of the null hypothesis for the Kolmogorov-Smirnov test (p-values smaller than 0.05)."

Discussion section: "For example, if the rejection of the null hypothesis is unstable in its temporal evolution, the time of emergence may be determined too early. This has been shown for some of the catchments in the present study. However, in most catchments a persistent detection of time of emergence (p-value < 0.05) in the distribution of the seasonal means was found shortly after the first detection of a time of emergence."

l200: I see almost identical runoffs in October and only small changes from J to M.

Reply: *We agree that mean runoff changes in October are small. The absolute changes between January to March are also small but the relative changes in these months are large. We made this clearer by pointing out the difference between absolute changes and relative changes and by adding a statement on this.*

"The glaciated catchment, Rosegbach–Pontresina, exhibits a strong decrease in July, August, and September (-3.1 to -6.7 mm/day) and a small absolute increase in winter runoff (+0.5 to +1 mm/day) under RCP8.5 (Fig. 5a). Monthly mean runoff does not change significantly in October."

l256: "is not necessarily persistent over time". What does this mean? Obviously, to detect "emergence" with the described method, assumes a monotonous trend, which in some watersheds is not occurring.

Reply: *We refer to the answer for line 144 above. This is now discussed/explained in more detail.*

Results section: "Due to the definition of time of emergence as the last year of a moving window in which the Kolmogorov-Smirnov test is rejected for the first time, time of emergence is not necessarily given for all periods after the first detection. Fig. 7 shows the temporal evolution of the time of emergence for the seasons under RCP8.5. Most of the catchments show persistent significant changes after the first detection of a time of emergence. However, some catchments reveal a time of emergence in a certain period but do not show a time of emergence afterwards. The problem of nonconstant rejections affects 17 catchments in winter, 3 catchments in spring, 25 catchments in summer, and 6 catchments in autumn. Most of these catchments show a persistent time of emergence for the rest of the century a few years after the first detection."

l296: what do you mean? Availabilty for which purposes?

Reply: *We refer here to the contribution of winter runoff to the yearly volume. The sentence was changed to "In nival and pluvial catchments, the contribution of winter runoff to the annual volume increases. "*

l308: is that true for all watersheds? In austrai, there is a sginificant positive trend in autumn precipitation north of the Alps main ridge.

Reply: *In most of the catchments, mean autumn precipitation is decreasing or not changing significantly. However, there are few catchments in the very east of Switzerland which show slightlyincreasing precipitation. A pattern of increasing autumn precipitation north of the Alps like in Austria is not found. We adapted this sentence to acknowledge the precipitation increase in few catchments.*

"In a few of the eastern catchments, autumn precipitation slightly increases, but the effect of enhanced evapotranspiration and the reduced contribution from glacier and snow melt are more dominant, and autumn runoff also decreases in those catchments."

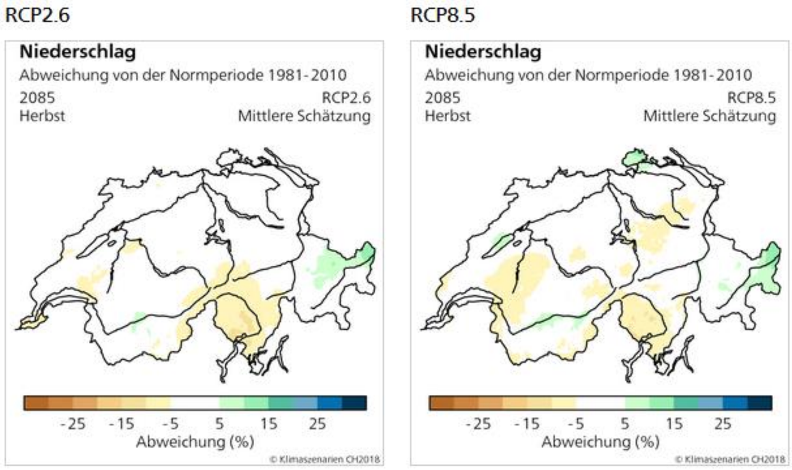

Figure from the NCCS Webatlas showing the changes in mean autumn precipitation for Switzerland under RCP2.6 (left) and RCP8.5 (right). Source: https://www.nccs.admin.ch/nccs/de/home/materialien-und-daten/daten/ch2018-webatlas.html

l315: misleading expression. winter and spring have an increase (Fig 4). Did you mean: on average for a year ?

Reply: *We apologize for this misleading expression. We refer to the decrease in the yearly mean runoff. This sentence was changed to make this clear.*

"This leads to the conclusion that on the annual average, less water will be available in Swiss rivers."

l316: a bit fuzzy: can you give examples?

Reply: *We provided some examples.*

"The shift in seasonality and thus a shift in the seasonal availability of water will impact many economic sectors. For example, increasing winter runoff may be beneficial for energy production, but decreasing summer runoff may lead to limitations in irrigation, particularly in lower-lying catchments where agricultural irrigation plays a crucial role."

l350: Either skip this paragraph - or make a statement on the severity of these uncertainties and why your work is still useful!

Reply: *This paragraph was extended, and the different sources of uncertainty were discussed in more detail.*

"Various sources of uncertainty affect our results. A detailed discussion of the uncertainties for the simulations is provided in Muelchi et al. (2021). Uncertainties arise from all the steps in the modelling chain: the scenarios of greenhouse gas concentrations, the climate models and their boundary and initial conditions, the postprocessing method (Gutiérrez et al., 2018), the hydrological model (Addor et al., 2014) and its calibration, and the underlying glacier projections; all these need to be considered in adaptation planning (e.g., Wilby and Dessai, 2010). Working with three emission scenarios and an ensemble of climate models partly addresses some of the uncertainty issues. Muelchi (2021)

compared the results for three catchments to simulations from three different versions of hydrological models, and the key findings are robust among both the models and the catchments."

l367: Fig 4 tells a differnt story!

Reply: *This sentence refers to figure 6 showing the time of emergence where the significance of changes is tested. We changed this sentence to avoid confusion and directly refer to the time of emergence.*

"A time of emergence of seasonal mean runoff was mainly found in summer and winter and for only a few catchments in spring and autumn."

Figure 5: Difficult to read overlapping shadings. Could it support easier comparison if you use the same runoff axis scale in all graphs? Or what about using Pardé coefficients instead of mm/d?

Reply: *Thank you for your thoughts and suggestions. We fully agree on the difficulty of distinguishing between the shadings. Therefore, we provided figures for each RCP as well as a figure with the Pardé coefficients in the supplement. Since the representative catchments cover a large variety of different runoff regimes, the y-axis scale of the plots also varies strongly from 0-12mm/d for the Rosegbach (glaciated, pronounced peak) to 0-4 mm/d for the Venoge (pluvial, less pronounced peak). Using a constant y-axis (0-12 mm/day) would reduce the readability of the regime curves and changes would be hard to see. Therefore, we kept different y-axes to account for the different regimes. But we added a figure in the supplement showing the Pardé coefficient with same y-axes.*

14. Are the number and quality of references appropriate? Yes.

15. Is the amount and quality of supplementary material appropriate? Yes.

Please also note the supplement to this comment: https://hess.copernicus.org/preprints/hess-2020-516/hess-2020-516-RC1-supplement.pdf

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Referee #2:

Thank you very much for your thorough review. We very much appreciate your valuable suggestions.

Muelchi et al. describe the modelled effect of climate change on river regimes. For that they analyse runoff changes, regime changes and time of emergence of changes for three different climate scenarios. The motivation and novelty of the study are the use of newly released climate scenarios and hydrological model simulations that take changing aspects of climate change (for example glaciated area) into account. They supply detailed results on what changes in runoff are to be expected for Switzerland under the different scenarios. This is a great contribution and will be especially useful for water resources planning. For that the split of the analysis for the different seasons will be useful as well. Additionally, Muelchi et al calculate the time of emergence, which indicates that high elevation catchments will show climate change impact earlier than lowland catchments. The article is very well and thoroughly written. The presented results and not only their explanation will be useful for a broader community. Although there are several changes the authors should consider, most of them are minor. One main caveat of the presented results, is that they heavily rely on model results described in a manuscript currently under review. With no pre-print or open review process, the reviewers for this article have no way of judging the validity of the model. Is there a possibility that the model used and therefore the results presented in this article might change depending on the review comments on the data manuscript? How sensitive is the model to parameter choices and data uncertainty?

***Reply:** The paper on the description of the data set got recently accepted and will be published in the next days in Geoscience Data Journal. The final version of the manuscript was sent to the editor and you. The data set and thus the analysis in this paper hasn't change anymore. A short comparison of modelling results between modelling efforts of three Swiss research institutions (hydrological models: HBV-light and two versions of PREVAH) using the same climatic data set (CH2018) showed that results agree well on the sign of change This study is available in the PhD thesis of Regula Muelchi. This emphasizes the robustness of our results. We sent a copy of the revised data paper and a temporary link to the PhD thesis to the editor for the reviewers and the editor.*

Further comments:

Abstract

Please make clear that the second paragraph starts describing results. The change is too abrupt and leaves the reader guessing if the sentences still belong to the methods section or results. It would be good to include a descriptive sentence defining the concept of time of emergence already in the abstract. This could be taken from the introduction ("The time of emergence reflects the time when the climate signal emerges significantly from natural variability"). I agree with a previous reviewer that the detailed listing of percentage numbers is too extensive for the abstract and should be reduced.

***Reply:** The abstract has been rewritten, the section with the numbers has been deleted, and the concept of time of emergence is briefly defined.*

"Assessments of climate change impacts on runoff regimes are essential to climate change adaptation and mitigation planning. Changing runoff regimes and thus changing seasonal patterns of water availability strongly influence various economic sectors such as agriculture, energy production, and fishery and also affect river ecology. In this study, we use new transient hydrological scenarios driven by the most up-to-date local climate projections for Switzerland, the Swiss Climate Change

Scenarios. These produce detailed information on changes in runoff regimes and their time of emergence for 93 rivers in Switzerland under three Representative Concentration Pathways (RCPs), RCP2.6, RCP4.5, and RCP8.5. These transient scenarios also allow changes to be framed as a function of global mean temperature.

The new projections for seasonal runoff changes largely confirm the sign of changes in runoff from previous hydrological scenarios with increasing winter runoff and decreasing summer and autumn runoff. Spring runoff is projected to increase in high-elevation catchments and to decrease in lower-lying catchments. Despite strong increases in winter and some increases in spring, the annual mean runoff is projected to decrease in most catchments. Compared to lower-lying catchments, runoff changes in high-elevation catchments (above 1500 m a.s.l.) are larger in winter, spring, and summer due to the strong influence of reduced snow accumulation and earlier snow melt and glacier melt. The changes in runoff and the agreement between climate models on the sign of change both increase with increasing global mean temperatures or stronger emission scenarios. This amplification highlights the importance of climate change mitigation.

The time of emergence is the time when the climate signal emerges significantly from natural variability. Under RCP8.5, times of emergence were found early, before the period 2036–2065, in winter and summer for catchments with mean altitudes above 1500 m a.s.l. Significant changes in catchments below 1500 m a.s.l. emerge later in the century. Not all catchments show significant changes in the distribution of seasonal means, and thus no time of emergence could be determined in these catchments. Furthermore, the significant changes of seasonal mean runoff are not persistent over time in some catchments due to nonlinear changes in runoff."

1. Introduction:

L33: "became more precise and more reliable" Source?

Reply: *We added the reference to the technical report of the new climate scenarios.*

L54: Please include the reference after each specific finding listed in lines 55+56 Neither the time of emergence nor "framing of the results as a function of global mean temperature change" are new concepts. Please include appropriate references that indicate to the reader where theses concepts originated (e.g. Giorgi and Bi, 2009). A good overview of the concept "time of emergence" is provided by Leng et al. (2016).

Reply: *References have been added.*

2. Data

Although it is one of the declared novelties in the use of this study, it is unclear what "transient properties of climate change" are included in the model simulations besides regularly updating glaciated area. Especially since the study describing the model data is not available.

Reply: *Thank you for this comment. Most previous studies on climate change impacts on runoff regimes in Switzerland were driven by climate simulations for 30-year periods which were downscaled with a delta change approach. This approach does not capture changes in the variability. In contrast, our study uses runoff simulations driven by transient climate simulations (119 years from 1981-2099).*

Therefore, potential changes in the variability are incorporated in these simulations. We made this point clearer in the introduction as well as in the data section.

Data section: "The Hydro-CH2018-Runoff ensemble comprises transient long-term daily runoff projections for Switzerland for the period 1981–2099. These transient simulations incorporate the daily to interannual climate variability."

Introduction section: "However, these studies are based either on older climate model generations or on climate simulations downscaled with a delta change approach. The delta change method is based on climate simulations downscaled for 30-year periods both in the reference period and in future periods and does not provide continuous transient simulations for the whole 21st century. Therefore, this approach does not simulate daily to interannual variability (Bosshard et al., 2011). More sophisticated downscaling approaches have been developed, such as quantile mapping (Teutschbein and Seibert, 2012; Gudmundsson et al., 2012). They correct not only for the mean bias but for the full distribution, are applicable to long-term climate simulations, and allow transient scenarios to be established. Using quantile mapping as a downscaling approach can intensify and increase the number of projected extremes (Roessler et al., 2019). Therefore, the present study uses the Hydro-CH2018-Runoff ensemble (dataset: Muelchi et al., 2020; Muelchi et al., 2021) run with the most up-to-date local climate change scenarios for Switzerland, CH2018."

3. Methods

L104: partial duplicated from line 79.

Reply: *Sentence is removed.*

3.1 Study area: For those not familiar with Swiss geography a map of the different regions or a change to East/West/South/North would help with the descriptions. Listing the catchment characteristics as a table (S1) is difficult to read. Additional map overviews would help similar to Figure 1. They should present catchments glaciated area and fraction of precipitation falling as snow. This can be included in the supplement.

Reply: *Thank you for your suggestions. Figure 1 has been changed according to different suggestions by the reviewers. It now comprises lat/lon information, location within Europe, and a rough classification of the different regions in Switzerland. Also, figures for degree of glaciation and for snow fraction have been inserted in the supplement.*

3.4. Time of emergence of seasonal changes: Others have used this method before. Please cite to make clear where previously used methods were applied compared to method decisions made by the authors. Additionally, please justify why this specific method was chosen and what uncertainties this choice might entail (Gaetani et al. 2020).

Reply: *The whole section on time of emergence has been rewritten to account for suggestions raised by different reviewers.*

"3. 3 Determination of the time of emergence of seasonal and annual runoff changes

The time of emergence (Giorgi and Bi, 2009; Leng et al., 2016) indicates the time when significant changes in the distribution of seasonal and annual means emerge from natural variability. The

Kolmogorov-Smirnov test was used to test whether two 30-year samples of seasonal or annual means are drawn from the same distribution. This test was conducted on the distributions of moving 30-year windows and the distribution of the reference period. The Kolmogorov-Smirnov test procedure was also used in previous studies (e.g., for precipitation Mahlstein et al., 2011; Gaetani et al., 2020), but other definitions of time of emergence also exist. Although Mahlstein et al. (2011) did not find significant differences from other definitions, Gaetani et al. (2020) found that the Kolmogorov-Smirnov testing procedure results in a more robust and earlier time of emergence. The testing was performed for each simulation under RCP8.5 and each catchment separately. Constraining the analysis to the RCP8.5 ensemble was motivated by the sufficiently large number of simulations, 20, within the ensemble. The time of emergence was then defined following the procedure used in Mahlstein et al. (2011) and refers to the last year of the 30-year moving window in which the Kolmogorov-Smirnov test was rejected for the first time at 95% significance. This was done for each catchment and each simulation separately. We then considered the significance of changes in the seasonal and annual mean when at least 66% of the models detect a significant change in the same 30-year window. Sixty-six percent corresponds to the threshold referred to as "likely" in the IPCC terminology (Mastrandrea et al., 2010). Because changes in runoff may not be linear over time, the time of emergence may not be stable after the first detection. Even though changes in seasonal and annual runoff are tested as significant in one period, they may not be significant in all subsequent periods (e.g., due to nonlinear effects in snow melt or glacier melt contributions). Therefore, we also analyzed the temporal evolution of rejections of the null hypothesis for the Kolmogorov-Smirnov test (p-values smaller than 0.05)."

Discussion:

It is unclear what the "not shown" brackets indicate. Are these results that you found but do not present? Are these results of the climate simulations that are included in CH2018, 2018? Since they carry the interpretation of the results, please set the findings in context with previous studies regarding snowmelt, precipitation and evaporation development under climate change conditions in Switzerland.

Reply: *We apologize for the confusion. "not shown" refers to results from either CH2018 simulations (precipitation) or results from the hydrological model (evapotranspiration and snow melt) which are not explicitly presented in the paper. However, they reflect the processes leading to our results (water balance). We removed the brackets. We discussed the differences between our study and previous studies.*

"Previous studies on climate change impacts on the runoff regime in Switzerland (e.g., Koeplin et al., 2012, 2014; Horton et al., 2006) were driven by other emission scenarios, other and fewer climate model chains, different methods of postprocessing the climate model output, and/or different hydrological models and calibration. Despite these differences, the sign of change in those studies agrees in most seasons with the signs in this study. A strong dependence of runoff changes on elevation was also found by Koeplin et al. (2012), with lower-lying catchments being less affected by climate change. The largest difference concerns the annual mean runoff. Koeplin et al. (2012) found an increase (up to +50%) in annual runoff for high-elevation catchments and no change for lower-lying catchments in the annual volume. In contrast, our study projects a decrease in the annual mean runoff not only for high-elevation catchments but also for most of the lower-lying catchments. However, not all catchments show a robust decrease among the climate model chains. This difference between our results and previous studies may arise from the use of the most recent generation of Swiss climate change scenarios (CH2018), which project slightly different precipitation changes with

less summer drying and wetter winters (CH2018, 2018) than the previous scenario generation, CH2011, which was used by Koeplin et al. (2012). The different handling of glacier melt processes and the new projections of glacier extents (Zekollari et al., 2019) may also result in slightly different projections in glaciated catchments. The Hydro-CH2018-Runoff ensemble uses transient glacier projections that are updated every 5 years in the hydrological model. Koeplin et al. (2012) used static glacier projections for 30 years. The strongest uncertainties in glaciated catchments were also found by Addor et al. (2014) due to the different handling of glacier extents and resulting glacier melt. Furthermore, the difference in the input data, transient projections versus delta change projections with same baseline time series for the reference period, may add to the different signs."

The current focus of the discussion is on high elevation/glaciated catchments. Please include interpretation of changes in lowland catchments as well. Especially since statements like "Lower lying catchments show generally a later time of emergence" (L340, Discussion) and "the pluvial catchments in the lowlands will face decreasing spring runoff" (L365, Conclusion) remain unexplained.

Reply: *Runoff changes in lower lying catchments are now discussed in more detail (various changes/additions in the discussion section). Generally, lower lying catchments are less affected by climate change and runoff in these catchments is mainly governed by evaporation and precipitation. Snow related processes play a minor role in these catchments. However, the changes in lower lying catchments are not negligible in terms of impacts because water is needed for irrigation or for cooling infrastructure.*

Conclusions:

Instead of referring to "sophisticated methods" please briefly mention them. Especially since they are highly relevant for the novelty of this study.

Reply: *We changed "sophisticated methods" to "quantile mapping".*

Figures:

Fig. 2/3 To keep in line with the rest of the article it would be good to describe first the RCP2.6 scenario and then RCP8.5.

Reply: *In the text, results for RCP8.5 are discussed first and then RCP2.6. Therefore, we finally decided to keep the order of Fig. 2 and 3 but changed the order in Fig. 4 in order to first show RCP8.5 (a) and then RCP2.6 (b).*

Fig. 5: People with red-green vision deficiency will struggle interpreting these graphs. Please choose a different colour scheme for this figure and figure S5.

Reply: *Thank you for this important comment. We apologize for this and changed the color scheme according to recommendations of ColorBrewer (https://colorbrewer2.org/) to make sure that the figure is also readable for people with red-green vision deficiencies.*

Fig. 8: Please include column headings directly in the figure.

Reply: *Column headings (+1.5°C,+2°C,+3°C) are included in figure 8 as suggested.*

Other:

L 295 Replace “neglectable” with “negligible”.

Reply: *We replaced this.*

Gaetani, M., Janicot, S., Vrac, M., Famien, A.M. and Sultan, B., 2020. Robust assessment of the time of emergence of precipitation change in West Africa. Scientific reports, 10(1), pp.1-10.

Giorgi, F. and Bi, X., 2009. Time of emergence (TOE) of GHGâˇARˇ forced precipitation change hotâˇARˇ spots. Geophysical Research Letters, 36(6).

Leng, G., Huang, M., Voisin, N., Zhang, X., Asrar, G.R. and Leung, L.R., 2016. Emergence of new hydrologic regimes of surface water resources in the conterminous United States under future warming. Environmental Research Letters, 11(11), p.114003.

SC #1

This paper uses the most recent climate projections combined with a sophisticated downscaling approach known as quantile mapping, to develop predictions of changes to the flow regime under three climate change scenarios for 93 catchments in Switzerland. In addition to quantifying mean annual and seasonal changes in runoff, this paper investigates changes in seasonality (i.e. changes in the timing of flows) as well as providing estimations for the time of emergence, and how the time of emergence is expected to change in time. This paper contributes to an important facet of climate change research and provides valuable insights towards climate change adaptation policies and management strategies. With the continual improvement of climate change models, it is critical that research towards understanding changes to the flow regime under future climate scenarios is implemented with the most current climate change models. In general, this paper serves that purpose and provides novel insights towards furthering our understanding of how the flow regime is expected to change in the future. However, there are several components of this paper that undermine its ability to effectively communicate these findings, and below are my suggestions on ways that the paper could be improved, all of which are meant to be constructive.

Reply: *Thank you very much for your thorough review. We very much appreciate this very helpful and improving review.*

This review is structured as follows:

1. QUESTIONS POSED BY THE HESS REVIEW CRITERIA ARE ADDRESSED.

2. SUGGESTIONS CORRESPONDING TO SPECIFIC SECTIONS OF THE PAPER.

3. ISSUES OF GRAMMAR AND PHRASING.

1. HESS review criteria

Questions 1-3. Does the paper address relevant scientific questions within the scope of HESS? Does the paper present novel concepts, ideas, tools, or data? Are substantial conclusions reached?

The questions posed within this research paper, namely how climate change will affect the flow regime in a variety of hydroclimate regions in Switzerland, are within the scope of HESS. Although the research questions posed in this paper are not novel, and similar analyses have been done on the topic, this paper uses the most current climate change projections and a more sophisticated method for downscaling the course climate model output. For these reasons, the data obtained from this study can be considered a relevant and novel contribution to the area of research.

Furthermore, the authors were able to determine not only how the flow regime is expected to change in the future, but also quantify how changes to the flow regime will differ under various warming scenarios.

Reply: *We are glad to read that you think that our study is relevant.*

Question 4. Are the scientific methods and assumptions valid and clearly outlined?

The scientific methods are clearly outlined in the methods section however, the section headers are quite vague and could be more informative (discussed fully in question 10). Several assumptions could be explained in more detail, for example, why the decision to use 90% as the criteria to determine direction changes of temperature in simulations, and 66% for the change in seasonal and yearly mean of emergence time? It is also assumed that the three RCP's correspond to the three warming levels (+1.5°C, +2°C, and +3°C), but isn't explicitly stated in the text.

Reply: *Thank you for your comment. We extended the description of methods (various parts in the methods section). The 90% refer to the model agreement on the sign of change. This means that 90% of the models show either positive or negative changes in the runoff indicator (not in temperature). We chose these thresholds following the IPCC terminology where 90% refers to "very likely" and 66% to "likely".*

Additionally, an explanation on the choice to use the mean elevation as a metric for comparing between catchments, rather than a metric that would better represent the variability of elevations between catchments could be valuable. Since the catchments used in your study cover a wide range of sizes (14-1700 km2) and elevations (476- 2700 masl), wouldn't using mean elevation as a basis of comparison run the risk of comparing large catchments that may have a significant area in both high and low elevations (but their mean would be a mid-elevation), with smaller mid elevation catchments (that do not have any high or low elevation components)? If this was an issue then perhaps a different metric should be used which more accurately captures the variability of catchment elevations. If this was not a concern, then it should be addressed and explained how the inability to account for variability in elevations among catchments did not influence the outcomes of this study.

Reply: *A previous study by Koeplin et al. (2012) showed that the catchment response to climate change can be directly linked to the mean altitude. Therefore, we chose mean altitude of the catchment to show the elevation dependence of our results. We added a sentence to make this clear.*

"The changes in seasonal and annual runoff were also analyzed as a function of the mean elevation of the catchments to show the elevation dependence of runoff responses. Other elevation-related characteristics of a catchment might have been used. However, a study by Koeplin et al. (2012) showed that catchment responses to climate change in Switzerland can be directly linked to mean altitude."

Köplin, N., Schädler, B., Viviroli, D., & Weingartner, R. (2012). Relating climate change signals and physiographic catchment properties to clustered hydrological response types. Hydrology and Earth System Sciences, 16(7), 2267-2283.

The uncertainties associated with this study are only briefly discussed at the end of the discussion and more detail is required in order for the reader to determine whether or not the findings are justifiable, provided the associated uncertainties.

Reply: *True, we extended the discussion on the uncertainties.*

"Various sources of uncertainty affect our results. A detailed discussion of the uncertainties for the simulations is provided in Muelchi et al. (2021). Uncertainties arise from all the steps in the modelling chain: the scenarios of greenhouse gas concentrations, the climate models and their boundary and initial conditions, the postprocessing method (Gutiérrez et al., 2018), the hydrological model (Addor et al., 2014) and its calibration, and the underlying glacier projections; all these need to be considered in adaptation planning (e.g., Wilby and Dessai, 2010). Working with three emission scenarios and an ensemble of climate models partly addresses some of the uncertainty issues. Muelchi (2021) compared the results for three catchments to simulations from three different versions of hydrological models, and the key findings are robust among both the models and the catchments."

Question 5. Are the results sufficient to support the interpretations and conclusions?

The results are sufficient to support the interpretations and conclusions in this study, however if possible the authors should consider including quantitative rather than relative changes for some of their results. For example, in section 4.2 consider including the quantitative differences in both the changes in the timing and magnitude of the peak runoff, rather than simply stating that "runoff decreases strongly in the summer months and less strongly in the autumn months". Based on figure 5 it appears that the changes in timing and magnitude could be expressed more specifically, instead of only mentioning relative changes.

Reply: *Thank you for this comment. We tried to incorporate a more quantitative language and added more numbers. The manuscript has also been reviewed by an English editor.*

Although provided the specificity of the climate change projections to Switzerland, it could be useful to discuss a broader applicability of the findings from this study. Would these findings also apply to other snow dominated and glaciated catchments around the world? Or other countries with a range of hydroclimate regimes like Switzerland?

Reply: *We added a statement on the applicability of our results to other regions.*

"The findings of this study concern runoff regime changes for Switzerland. The pronounced changes in high-elevation catchments highlight the strong influence of temperature changes on snow- and glacier-melt-driven catchments, and thus they also indicate that similar runoff responses may be found in other snow- and glacier-dominated regions. The results for lower-lying catchments, which are mainly driven by evaporation and precipitation changes, may not be directly transferable to other regions. The runoff response in such catchments depends on local precipitation patterns and their changes under climate change."

Question 6. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)?

Although admittedly I am not familiar with this type of analysis, I believe that the description of the experiment is sufficient to allow for reproducibility by other scientists.

Question 7. Do the authors give proper credit to related work and clearly indicate their own new/original contribution?

Proper credit is provided to related work and it is clearly differentiated from original contributions.

Question 8. Does the title clearly reflect the contents of the paper?

The title adequately reflects the contents of the paper, however it is vague and could include greater detail without becoming too long. Seeing that what sets this paper apart from previous research is the use of an up to date climate model and a more sophisticated downscaling approach, these details could be included in the title, both to represent the contents of the paper more accurately and better captivate readers. Additionally, including that the paper investigates a variety of hydroclimate regimes may increase the appeal to a broader audience (those outside of Switzerland).

Reply: *Thank you for your suggestion regarding the title. We changed the title to "Future changes and time of emergence for pluvial to glacial runoff regimes in Switzerland based on the newest transient hydrological scenarios".*

Question 9. Does the abstract provide a concise and complete summary?

The abstract provides a complete summary of the paper, however including some minor details could improve the clarity of the abstract. For example, a brief explanation of the concept of "time of emergence", like was done in the first sentence of section 3.2, would make it more applicable to a broader audience. Additionally, when discussing the changes of average relative runoff, it would be good to include the reference point of this change (from the reference period discussed in section 3.2?).

The examples provided in regard to impacts from changing runoff regimes are mainly industry based. Perhaps it would be good to mention environmental impacts and flood/drought concerns as well? The same applies to the introduction, where only economic impacts are discussed as being affected: "sectors such as agriculture, fishery, hydropower generation, and tourism."

Reply: *We added a brief explanation of the concept of time of emergence and added a statement on the ecological impacts. A companion paper (https://doi.org/10.5194/hess-2020-667) discusses climate change impacts of moderate extremes for Switzerland.*

"Assessments of climate change impacts on runoff regimes are essential to climate change adaptation and mitigation planning. Changing runoff regimes and thus changing seasonal patterns of water availability strongly influence various economic sectors such as agriculture, energy production, and fishery and also affect river ecology. In this study, we use new transient hydrological scenarios driven by the most up-to-date local climate projections for Switzerland, the Swiss Climate Change Scenarios. These produce detailed information on changes in runoff regimes and their time of emergence for 93 rivers in Switzerland under three Representative Concentration Pathways (RCPs), RCP2.6, RCP4.5, and RCP8.5. These transient scenarios also allow changes to be framed as a function of global mean temperature.

The new projections for seasonal runoff changes largely confirm the sign of changes in runoff from previous hydrological scenarios with increasing winter runoff and decreasing summer and autumn runoff. Spring runoff is projected to increase in high-elevation catchments and to decrease in lower-lying catchments. Despite strong increases in winter and some increases in spring, the annual mean runoff is projected to decrease in most catchments. Compared to lower-lying catchments, runoff changes in high-elevation catchments (above 1500 m a.s.l.) are larger in winter, spring, and summer due to the strong influence of reduced snow accumulation and earlier snow melt and glacier melt. The changes in runoff and the agreement between climate models on the sign of change both increase with increasing global mean temperatures or stronger emission scenarios. This amplification highlights the importance of climate change mitigation.

The time of emergence is the time when the climate signal emerges significantly from natural variability. Under RCP8.5, times of emergence were found early, before the period 2036–2065, in winter and summer for catchments with mean altitudes above 1500 m a.s.l. Significant changes in catchments below 1500 m a.s.l. emerge later in the century. Not all catchments show significant changes in the distribution of seasonal means, and thus no time of emergence could be determined in these catchments. Furthermore, the significant changes of seasonal mean runoff are not persistent over time in some catchments due to nonlinear changes in runoff."

Question 10. Is the overall presentation well-structured and clear?

In general, the paper is well structured and for the most part follows a logical flow. However, the sub-section headers are very vague and, in my opinion, do not provide enough detail to adequately represent the contents of each sub-section. For example, instead of "Changes in runoff regimes" for section 3.2 it could be something like "Criteria for determining changes in runoff regimes" or even "Interpreting changes in runoff regimes". Section 3.3 titled "Changes with increasing global mean temperatures", should specify what changes you are referring to. Similarly, for sub-sections 4.1 and 4.2, titled "Seasonal and yearly mean changes" and "Changes in the runoff regime" respectively, it is unclear which changes are being referred to. An alternative option for the section 4.2 header could be to specify that the section illustrates the changes in the runoff for each of the six representative hydroclimate regimes.

It is also difficult to draw the connection from the sub-sections in the methods, to the sub-sections in the results, which I believe is largely due to the vagueness of the sub-section titles. Maybe re-ordering or renaming some of these headers will provide a more logical flow to the paper. Perhaps making sub-section 4.2 the first sub-section in the results section will better represent the order of operations proposed in the methods section.

Reply: *Thank you for this suggestion. We tried to make the headers of the sections more precise and informative.*

Question 11. Is the language fluent and precise?

In addition to several grammatical errors (addressed in section 3), I found that some of phrasing and language used was awkward. One term that is repeated throughout the paper is "signal", which in this paper is meant to indicate whether the change is positive or negative. In most instances, either "signal of change" or "signal direction" and in some cases "direction of change" is used. In my opinion, I find the use of the word "signal" slightly awkward in this context and typically think of it in the sense of either a strong or weak signal, rather than an indication of whether the change is positive or negative. Perhaps using "sign of change" or "direction of change" like was used in parts of the text, would help to clarify the distinction between magnitude (strong/weak) and direction (positive/negative).

The word "strong" is used many times throughout the paper (38 times to be exact) and in some cases, if possible, should be replaced by more specific language. Mentioning that A has a strong influence on B, or that A has experienced a strong increase, doesn't provide much information to the reader without any explanation of what constitutes a strong influence or strong increase.

The terms elevation and altitude are used synonymously throughout the paper, which I think is ok, however only using one might help to clarify and improve the readability of the paper.

Reply: *The term "signal" was replaced to "sign". Furthermore, we rephrased our statements to be more quantitative and submitted the revised manuscript to an English editor.*

Question 12. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used?

In the methods section it might be good to specify which months are included for each season, when describing seasonal mean changes. It is evident when looking at the figures, but I think this information should also be included in the text for clarity.

There are some acronyms that are not defined in the text including RCP and the PREVAH model.

Reply: *We implemented your suggestions and defined the acronyms.*

Question 13. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated?

Consider having sub-sections within section 4.1 for each season (winter, spring…) to better organize the text and make it easier to interpret differences in runoff between the seasons. This could also be applied in subsequent sections, by breaking up the text so that it is more digestible. For example, including headers to differentiate between yearly and seasonal changes or making each of the six example catchments in section 4.2 their own paragraph each with a header so that readers can more easily find information within the text.

Reply: *We implemented your suggestion and included sub-sections.*

In section 4.1 when discussing changes in the mean runoff, it might be useful to include the results from the RCP 4.5 scenario in text because they may reveal insights towards important thresholds of change regarding an increase or decrease in runoff, which would be useful in terms of policy and management decisions. This is particularly the case in the spring where under the RCP8.5 changes were predominantly positive and under RCP2.6 some catchments shifted from positive to negative.

Reply: *Thank you for this comment. We referred to the results of RCP4.5 in section 4.1.2 for spring runoff.*

Figures:

For someone unfamiliar with Switzerland it is not obvious which country we are looking at in figure 1. It is difficult to discern where exactly we are looking in geographic space. Maybe including names of surrounding countries or different colors for surrounding countries to provide some context for the location. The figure is also missing a north arrow and perhaps an insert showing location within Europe could be useful. The figure caption should also mention that the figure is of Switzerland.

Reply: *Figure 1 has been changed according to various suggestions by the reviewers. It comprises lat/lon information, location within Europe, and a rough classification of the different regions in Switzerland. Also, figures for degree of glaciation and for snow fraction have been inserted in the supplement.*

In figure 2 the caption should specify what changes are being referred to (i.e. the fact that it displays changes in runoff). The same would then apply to figure 3 and figure 8.

Reply: *The caption was adjusted according to your suggestion.*

At the end of section 4.1 (beginning from Line 186), the text describes that the RCP8.5 is represented in Figure 4a when I believe that it is meant to refer to Figure 4b. Based on this I would suggest either re-arranging the text to describe the results of RCP 2.6 first, or re-arranging the figure to have the RCP 8.5 as a) and RCP 2.6 as b).

Reply: *Figure 4 was rearranged to display the changes for RCP8.5 in a) and for RCP2.6 in b).*

Question 14. Are the number and quality of references appropriate?

The number and quality of references are appropriate and to my knowledge there are only a few instances where potential referencing errors were made, which are addressed in section 3 of this review.

Question 15. Is the amount and quality of supplementary material appropriate?

The amount and quality of supplementary material is appropriate however, as mentioned previously, including some of the results from the RCP 4.5 may contribute to the interpretation of results from this study.

Reply: *The intention to only show RCP2.6 and RCP8.5 is to show the potential range of changes. However, we referred to the results for RCP4.5 in section 4.1.2.*

2. Suggestions relating to specific sections

Results:

• In section 4.3 consider moving the sentence describing the changes in yearly means (line 250) to follow the section of the text describing the changes in all seasons (line 253-255) then begin a new paragraph for the sentence in line 255 beginning with "Due to the definition…"

Reply: *The sentence has been moved according to your suggestion.*

Discussion:

• The first sentences in the first two paragraphs are stated as facts. Maybe these should be stated as projections?

Reply: *We reformulated these sentences to make clear that these are the results of projections.*

• Overall, the discussion seems to be lacking detail and implications of the findings of this study are quite vague: "This leads to the conclusion that throughout the year there will be less water available in Swiss rivers. The shift in seasonality and thus a shift in the seasonal availability of water will impact many different sectors." Instead of simply stating that throughout the year there will be less water available in Swiss rivers, it should be highlighted, in my opinion, that the greatest reduction in runoff occurs during periods where risk of water scarcity is the highest (during summer). This could then be followed by a more detailed, but brief discussion on implications to various sectors.

Reply: *Thank you for this comment. A brief discussion on the implications has been added.*

"The shift in seasonality and thus a shift in the seasonal availability of water will impact many economic sectors. For example, increasing winter runoff may be beneficial for energy production, but decreasing summer runoff may lead to limitations in irrigation, particularly in lower-lying catchments where agricultural irrigation plays a crucial role."

3. Issues of grammar and phrasing

Reply: *Thank you for your suggestions regarding grammar and phrasing in our text. We implemented your comments.*

- Line 10: "…are essential for climate change adaptation…"
- Line 11: "…have a strong influence on various sectors…"
- Line 33: "…changes became have become more…"
- Line 35-37: seems like this sentence is missing a citation.
- Line 37: RCP acronym not written out fully. From line 66: "…greenhouse gas (GHG) concentration pathways: RCP2.6, RCP4.5, and RCP8.5." If you are explaining the acronym for GHG, then RCP should be explained as well.
- Line 48: perhaps instead of "glaciated catchments" something like "glacial extent" is more representative of the climate change impact.
- Line 61: "Using quantile mapping as a downscaling approach…"
- Line 61-62: At the end of line 61 it is unclear what is meant by "partly different runoff characteristics."? Some elaboration may be required.
- Line 62: I believe the Roessler et al. (2018) citation should actually be Keller et al. (2018). Would also be good to mention where this test catchment was located.

Reply: *We are referring to the paper Roessler et al. (2019) (https://doi.org/10.1016/j.cliser.2019.01.001). The year of publication was wrong.*

- Line 78: how do you define "medium-sized" catchments? Could be good to include the range of basin sizes used in the study here.

Reply: *A range of catchment size has been given.*

- Line 81: Define acronym for PREVAH model.
- Line 96: "…GCM-RCM chains…"
- Line 114: Would be good to specify what you are referring to when you mention seasonal and mean changes.
- Line 157: Instead of "stronger changes" maybe something like "stronger positive changes" or "larger increases".
- Line 168: Similar to the suggestion above, instead of stronger changes specify that the changes are more negative in this case in mountainous catchments.
- Line 171: "…average change is across all catchments…"

• Line 192: "…elevated elevation…"

• Line 200: Again, more specific language could be used when referring to "strong changes".

• Line 222: The type of regime is not mentioned like it is for the previous catchments

• Line 228: "…of the peaks is are less pronounced…"

• Line 245: Awkward phrasing: "Catchments without time of emergence show…" maybe instead write "…without an emergence time…" or "…without a time of emergence…".

• Line 262: Awkward phrasing. Could be written as "However, this may lead to pre-mature detections of emergence time, that do not persist in time."

• Line 265: "…levels are similar than to the…"

• Line 295: Negligible instead of neglectable?

• Line 278: "… patterns get become more pronounced."

• Line 297: What is meant by "(not shown)"? Is this referring to a figure or a reference?

Reply: *We apologize for the confusion. "not shown" refers to results from either CH2018 simulations (precipitation) or results from the hydrological model (evapotranspiration and snow melt) which are not explicitly presented in the paper. However, they reflect the processes leading to our results (water balance). We clarified this in the revised version.*

• Line 303: Same as line 297.

Reply: *We apologize for the confusion. "not shown" refers to results from either CH2018 simulations (precipitation) or results from the hydrological model (evapotranspiration and snow melt) which are not explicitly presented in the paper. However, they reflect the processes leading to our results (water balance).*

• Line 309: Instead of saying: "…glacier melt is important in early autumn today…" maybe better to say something like "…glacier melt is important in early autumn under current climate conditions…"

• Line 323: "…policy makers…"

• Line 334: In the sentence: "Strongest uncertainties in glaciated catchments…", consider specifying why you are referring to in terms of uncertainty. Glacial extent? Glacial melt? Changes in runoff?

• Line 339: Awkward phrasing, particularly for "lacks completely". Might also be useful to specify that the influence described is on runoff.

• Line 363: "…runoff due to the retreating glaciers…"

• Line: 374: "…strongly damped dampened but not avoided…"

SC #2

Nice work. However, I would recommend looking at the following publication (Finger et al. 2012): https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2011WR010733 This publication is, to my knowledge, the first publication coupling glacier retreat, satellite snow cover data and distributed physically-based hydrological modelling and is accordingly an important contribution to "Future runoff regime changes". The study outlines how the retreat of glaciers will drastically decrease water availability in summer, how warmer temperatures will lead to enhances snowmelt in spring and how fall storms will lead to high water events in fall. The study also shows that water infrastructure is not adapted for these new conditions. You might also read the NZZ article about the study (in German): https://www.nzz.ch/wasserkraft-in-den-bergen-wird-massiv-abnehmen-1.16334488. And another article was written together with the hydropower operators: https://www.researchgate.net/publication/258518824_Weitreichende_Auswirkungen_des_Klimawandels_auf_die_Wasserkraftproduktion_in_einem_Schweizer_Alpental

Sincerely yours, David C Finger

Reply: *Thank you for highlighting your paper and the newspaper article. We mentioned your paper in the introduction text but forgot to add it in the list of references. We apologize for this mistake.*

List of most relevant changes to the manuscript:

General:

- Rephrasing of unclear sentences
- Corrections according to suggestions by English editor
- Replaced “signal of change” with “sign of change” or “direction of change”

Title:

- Changed to “Future changes and time of emergence for pluvial to glacial runoff regimes in Switzerland based on the newest transient hydrological scenarios”

Abstract:

- Shorter (less numbers)
- Time of emergence explained
- Ecological impacts mentioned
- Statement on comparison with previous studies added

Introduction:

- Highlighting differences between new hydrological scenarios and previous scenarios

Data:

- Transient property explained and highlighted

Methods:

- Section names changed
- 3.3 and 3.4 switched
- 3.2: definitions of seasons added; explanation on threshold decisions added; explanation on choice of elevation indicator added
- 3.3: mostly rewritten to make it clearer and to explain the method behind time of emergence; choice of thresholds and methods explained; explanations on temporal evolution of time of emergence added

Results:

- Section names changed
- Creation of sub-sections under 4.1 and 4.2
- More quantitative language used

Discussion:

- Results for lower lying catchments discussed in more detail
- Examples of potential implications on economic sectors discussed
- Differences between new hydrological scenarios and previous scenarios discussed
- Potential applicability of our results to other regions discussed
- Uncertainties and limitations further discussed

Figures:

- Fig. 1: Added location within Europe, topography, and rough separation of different regions in Switzerland
- Fig. 4: switched a) and b)
- Fig. 5: changed color scheme according to colorbrewer's suggestions for color blind readers
- Fig. 7: replaced station numbers with catchment names
- Fig. 8: added headers for 1.5°C, 2°C, and 3°C
- Supplement:
    - S1&S2: new figures with degree of glaciation and fraction of precipitation falling as snow
    - S7: Pardé coefficients
    - S8-S11: Runoff regimes for each RCP separately