We thank Dr. Brunner for the valuable comments that have significantly improved the clarity of the paper and highlighted important points to take up in the discussion.

I think that analyzing the link between temporal precipitation clustering and flood occurrence and duration is important because it helps to improve our understanding of important flood drivers. The establishment of such a link is an interdisciplinary research effort involving analyses of climatological and hydrological data. While I generally appreciate the analyses presented in this paper, I think that the consistency and link between the climatological and hydrological analyses could/should be improved by unifying methodology across variables and by better embedding the study's findings in the hydrological literature. I would like to highlight a few points, which I consider to be important from a hydrologist's point of view:

Comment 1

Threshold choice: You use a seasonally varying quantile threshold for precipitation while they use a fixed annual quantile threshold for streamflow. I think that threshold choice should be consistent and that the use of a fixed instead of a variable threshold would be more sensible for the given application as the occurrence of high-flows might be more directly related to absolute than relative exceedances. The results might substantially depend on this important methodological choice. Mixing variable and fixed thresholds does in my opinion not make sense. In any case, assessing the sensitivity of the results to the choice of threshold type (variable vs. fixed) would be highly desirable and facilitate the interpretation of your results. In addition, some of the precipitation-related results also seem to refer to exceedances of annual 99% quantiles (e.g. Fig. 2).

Our choice of seasonally-varying percentiles to define extreme precipitation can indeed be confusing, all the more so as extreme discharge events are selected using fixed percentiles. We did not sufficiently justify this choice in the original manuscript version. It is motivated by two reasons.

First, the statistical significance of the clustering is more difficult to assess when the extreme events series is non-homogeneous, i.e., when the likelihood of extreme events has a seasonal cycle. In theory, it would be possible to estimate that cycle and use it to generate non-homogeneous Poisson series to test for clustering significance. However, it introduces more uncertainty and seasonal variations in clustering significance would be overlooked. As we see from our results these are substantial.

Second, seasonal variations in extreme precipitation/discharge occurrence are not necessarily aligned, and in fact they are not over much of Switzerland. In the Jura, extreme discharge occurs preferentially during winter when the magnitude of precipitation extremes is lower than in summer and fall. Similarly, the larger precipitation extremes over the Swiss Plateau in summer are not accompanied by significantly more frequent extreme discharge. Choosing fixed percentiles to define precipitation extremes is therefore not ideal. Our methodology is admittedly constrained by the fact that we take a country-wide approach and try to analyse regions with different climates and hydrological regimes.

We suggest reformulating the methods section relative to the definition of extremes by adding the following: "*Three reasons justify the choice of seasonally-varying thresholds for* *precipitation and fixed thresholds for discharge. First, such a choice removes the influence of the seasonality in extreme precipitation magnitude. The occurrence rate of extreme precipitation events is therefore constant across the year, and detecting clustering significance is straightforward. Second, impacts of discharge extremes are usually related to their absolute rather than relative magnitude. Third, the seasonal cycles of extreme precipitation and discharge magnitudes are not in phase over much of Switzerland (Figures 2 and 3). The most extreme discharge does not necessarily occur after the heaviest precipitation events. Surface conditions, like soil saturation, presence of snow/ice, vegetation cover, or evaporative demand, considerably shape the discharge response to heavy precipitation (Paschalis et al. 2014). As they vary substantially from one season to the next, the discharge response to the same precipitation magnitude may differ depending on the season.*"

Comment 2

Region definition: The precipitation analysis is performed for a different set of regions than the catchments selected for the high-flow analysis (at least partially from Fig 4). In order to allow for a direct comparison of the results obtained from the two analyses (precipitation vs. discharge), it would be desirable to use the same catchment delineation used for the hydrological analysis also for the precipitation analysis. Such an analysis would be straightforward as areal precipitation sums for the 93 catchments could be derived from the gridded precipitation data set used for the analysis.
Catchment selection: The study is based on 93 selected catchments. It would be important to point out how and why this sub-selection was made (l. 95-101).

We use two sets of catchments, one for the statistical precipitation analyses, the other for the extreme discharge analyses, for the reason that the set of 93 gauged catchments does not cover the whole country. This is why we use a hydrological partitioning of Switzerland with 63 catchments. However, we agree that this may make it difficult to compare results from both sets of analyses. Hence, we will include in the appendix the results for the 93-catchment set corresponding to Figures 4, 5, 7 and 8. We will also make it more explicit why we choose these two sets of catchments.
Regarding catchment selection: this point was raised by other reviewers as well. Catchment selection was performed by Muelchi et al. (2021) based on several criteria: data availability, the absence of major lakes, minimal human influence and satisfactory calibration results in their hydrological model. They are well distributed across Switzerland and cover the range of climates and hydrological regimes that is typical of this country. This is an advantage since it allows us to explore the potential role of extreme precipitation temporal clustering across regions, climates and hydrological regimes, and to see the limits of our analysis. We will include this information in the revised version, along with an appendix table containing catchment details (river, area, elevation, etc.)

Comment 3

Persistent flood periods (l. 137): I would rather call these something like ‘high-flow periods’ as a period of 30 days is likely to contain several potentially independent events.

Furthermore, L and N seem to be mixed up in the equation as L must be > N if the temporal resolution of the data is daily. If you would like to look at events, I would apply some event definition where a flood has a defined start and end.

The manuscript was indeed confusing on the issue of “persistent floods” and the wording has to be modified. Your suggestion of “persistent high-flow periods” is good and we propose to adopt it in the revised version. To speak of “events” may be deceitful since we do not identify specific events with a beginning and end. Our metric for persistent high flow can thus include long-lived extreme discharge events but also recurrent, independent events. L and N were also in the wrong order and we corrected the mistake (L > N); thank you for pointing it out.

Comment 4

Results: It would be valuable to link the results in addition to the climatological literature also to the hydrological literature about flood seasonality, flood generation processes, ... E.g. l.165-167: literature on antecedent conditions and the interplay between different flood drivers; l. 282-290: literature related to rain-on-snow events; l. 288-289: literature on flood volumes and peak-volume dependencies; L. 267: literature to regime types.

Thank you for this comment. In the initial manuscript version, the discussion of our results was not clearly separated from that of the seasonality in extreme discharge and precipitation, which could lead to some confusion. We suggest separating the two: first, a review of the literature on the seasonality of extreme discharge and precipitation in Switzerland in a “Study region” section; and second, a discussion of the links between our results and the hydrological literature in the Discussion section (see below).

“*Switzerland can be divided into several regions with distinct climates and hydrological regimes: the Jura, the Plateau, the Alps and the Southern Alps (Figure 1-b) (MeteoSwiss 2013, Aschwanden and Weingartner 1985). These regions notably exhibit quite different seasonal cycles in extreme precipitation and discharge occurrence. In the Plateau, the heaviest precipitation occurs chiefly during summer (Figure 2-c) (Helbling et al. 2006, Diezig et al. 2007, Panziera et al. 2018), as a result of convective instability (Stucki et al. 2012), frequent westerly winds and Atlantic water vapour transport (Giannakaki et al. 2016). In summer, however, evapotranspiration is highest and soils are less saturated than in the cold season. Consequently, extreme discharge events are about equally likely to occur in winter, spring and summer (Figure 3). In the Jura, while the magnitude of extreme precipitation events still peaks in summer, its seasonality is less pronounced. About 20% of extreme precipitation events indeed occur in winter and spring each (Figure 2), triggered by forced orographic ascent of moist westerlies (Froidevaux and Martius 2016). Extreme discharge, however, is mostly confined to winter and spring, largely driven by rain-on-snow processes (Diezig et al. 2007, Helbling et al. 2006, Koplin et al. 2014).*
As in the Jura, the seasonal cycle in extreme precipitation occurrence over the Alps is not strong (Figure 2) (Frei and Schär 1998, MeteoSwiss 2013}. The peak is reached in summer and fall for most catchments, when extreme precipitation occurs as a result of local convective instability (Stucki et al. 2012), but winter and spring still concentrate 30-40% of

extreme events. The outlook for discharge is very different, however. Alpine catchments, especially at high elevations, are mainly driven by snow- and glacier melt (Aschwanden and Weingartner 1985). Thus, extreme discharge is almost exclusively confined to summer (Figure 3-c) (Koplin et al. 2014, Muelchi et al. 2021b). Finally, the Southern Alps experience extreme precipitation mostly during summer and fall (Figure 2-c,d) (Frei and Schär 1998, Isotta et al. 2014). Such behaviour results from the frequent southerly advection of moist Mediterranean air caused by upper-level troughs (Barton et al. 2016). These atmospheric conditions are connected to potential vorticity streamers or cut-offs centred west of the Alps, which are most frequent during fall (Martius et al. 2006). Extreme discharge in this region also occurs primarily during fall (50-60% of events; Figure 3-d)."

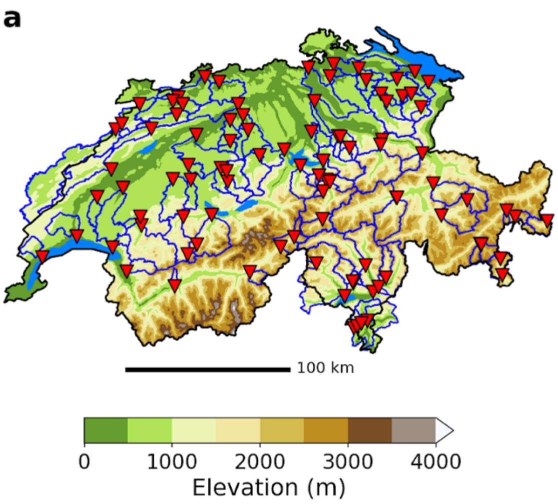

Figure 1. (a) Topography of Switzerland (shading, with major lakes shown in light blue) and gauged catchments used in this study (catchment boundary: blue lines; catchment gauge location: red triangles). The thick black line indicates the Swiss border. (b) Switzerland's topography (shaded) and major climate/hydrological regions (red).

Regarding links of our results to the hydrological literature, we can expand the discussion as follows:

"*Still, from the perspective of surface impacts, clusters remain relevant, regardless of their overall frequency, if they increase flood hazard. The discharge response to both clustered and non-clustered extreme precipitation events typically peaks one day after the event (Figure 12), consistent with the findings of Froidevaux et al. (2015). However, our results show that clusters of precipitation extremes strongly impact the likelihood of occurrence and the duration of high-discharge events, particularly at low elevations (Figures 10 and 11). This influence is noticeably larger than for non-clustered precipitation extremes (Figure 12). On average, daily accumulated precipitation during clustered and non-clustered extremes is similar. Instantaneous precipitation rates might be different, but it is not possible to verify it given the daily resolution of the precipitation data. However, the first extreme in a cluster event likely increases soil moisture, which enhances the discharge response to the subsequent precipitation extremes (Merz et al., 2006; Nied et al., 2014; Paschalis et al., 2014). The role of antecedent soil moisture on flood generation and volume is well-documented for*

Switzerland and Alpine catchments (e.g., Keller et al., 2018). This may explain why extreme discharge probability decreases more slowly after clustered precipitation extremes compared to non-clustered events (Figure 12).
This difference is quite high in the Southern Alps (e.g., Figure 9-c,d), possibly due to the fact that floods in this area generally occur in the fall (Figure 3-d; Barton et al. (2016)) when clusters bring substantial amounts of precipitation (Figure 7-d). There, frequent clusters leading to extreme precipitation accumulations are likely to be an important precursor of major flood events, as confirmed by observations of several damaging clustering periods (Barton et al., 2016). This region of Switzerland also experiences the largest precipitation extremes (Umbricht A, 2013). Additionally, it is characterised by poor infiltration rates, steep slopes and weak soils (Aschwanden and Weingartner, 1985). Infiltration excess (connected to Hortonian-type storm runoff generation) may therefore be more rapidly reached than in the rest of the country. Coupled with saturation excesses following the first extreme event in a cluster, it might explain why the region stands out in most of our analyses. By contrast, in the Alps during winter, though clustering is statistically significant, its impact on extreme discharge is quite limited. This results most likely from the fact that discharge in Alpine catchments is lowest in winter, when much of the precipitation falls as snow and the magnitude of precipitation extremes is generally lower.
Finally, the case of Western Switzerland during spring is interesting. Though rare, clusters are responsible for almost all extreme precipitation accumulations (Figure 7-b). Over this region, floods are somewhat less frequent in spring than in winter (Figure 3-a,b), despite similar extreme precipitation likelihood (Figure 2-a,b). This may result from fewer rain-on-snow events, a major flood process for the region (Aschwanden and Weingartner, 1985; Köplin et al., 2014) but also drier soils coupled to high infiltration rates (Aschwanden and Weingartner, 1985). Yet, spring floods can still be quite devastating, since precipitation generally falls as rain instead of snow, and limited vegetation cover makes erosion more likely. Consequently, cluster events that affect Western Switzerland during spring should be the focus of further research."

We know little about the literature on flood volume and peak-volume dependence, and would be grateful if you could point us to relevant papers.

Comment 5

Term flood risk: This paper only addresses the hazard part of risk and I would therefore talk about hazard rather than risk.

We agree and would refer to hazard only in the revised version.

Comment 6

Flood recession timescales: how are they defined (l. 278)?

"Recession timescale" has a very specific meaning in hydrology which we do not use here. Instead, it would be preferable to rephrase the sentence as "*This may explain why the* *likelihood of extreme discharge occurrence decreases noticeably slower after clustered extremes than after non-clustered extremes.*”

Comment 7

Figures: I would recommend to reconsider color choices for figures, i.e. use continuous scales
for continuous variables and diverging scales only for data with a logical break point (e.g. decreases vs. increases). Furthermore, the figure captions are a bit too short and it would be helpful if you could provide more detailed descriptions of what is displayed in the figures (also what the subpanels refer to).

Thank you for this comment. We will update most of the figures to avoid diverging colour bars for continuous variables.