We highly appreciate this positive overall assessment of our work and we thank the reviewer for her or his interest in our work as well as for the thoughtful comments that helped to strengthen our analysis. Below, we provide clarifications and our perspectives to respond in detail to the individual reviewer comments.

(1) Reviewer Comment:

The authors divided the whole period into four subperiod to calculate the Sumax, its relation with climatic indices, and its influence on hydrological response. However, I would question whether such a division could produce reasonable results. First, many climatic indices don't show significant difference among four periods, making it difficult to see the relation between these indices and the Sumax. Second, regression based on only four points has large uncertainty and occasionality. For example, in Figure 10, if we remove the point with largest Sumax, a significant negative relation between ΔIE and Sumax can be obtained. Maybe the authors can attempt to increase the number of subperiod or discuss this issue in a limitation section.

Reply:

Thank you for pointing this out. We indeed divided the entire period into four sub-periods. The maximum vegetation-accessible water storage volume in the unsaturated root zone of the subsurface is the definition of root zone storage capacity Sumax (see first paragraph in the original manuscript). To be survived, the root systems of vegetation and the associated vegetation-accessible water storage capacity (Sumax) are therefore at a dynamic equilibrium with and responding to the ever-changing conditions of its environment. However, as these changes occur at landscape scale and are mostly reflected by the composition of plant species present in a specific spatial domain, the changes occur at time-scales that reflect the life-cycles of individual plants. Thus, periods of at least 20-years are required to reflect this and for meaningful estimates of Sumax, as also demonstrated by many other studies (e.g. Gao et al., 2014; Lan et al., 2016; Singh et al., 2020; Stocker et al., 2023). We therefore had to strike a balance between the number of independent time periods and the robustness of the associated Sumax estimates. We deliberately chose to emphasize fewer but longer time periods and thus rather reliable estimates of Sumax.

However, we positively acknowledge and agree with the point raised by the reviewer. We will add some discussion of this limitation in the revised version of the manuscript.

(2) Reviewer Comment:

For most of figures, I cannot see the necessity of using gradual color to distinct the results of different period, since they can be clearly distanced by the x-axis. Instead, for Figure 9b, I think showing the period of each point by different color would be better.

Reply:

Thank you for pointing this out. We agree that it is not necessary to use gradient colour scheme for some figures, as already clear enough based on their different values. However, we still prefer to make the readers more clearly aware of the difference between each dot when they just see the figures. We completely agree with your suggestion about Figure 9b. We will change that colour scheme in the revised manuscript.

<u>(3) Reviewer Comment:</u>

There are lots of variables in this paper. I would like to suggest the authors to provide a table to show the meanings of all the variables to make the paper easier to follow. Besides, if I don't miss something, I think some variables are not explained. (1) Equation 7 is confusing. What does f(x) mean? What does Srd(t) and what is the difference from Srd,n(t)? The meaning of n is not explained. (2) The subscripts o and o' described in 5.4 haven't appeared in the method section. I guess it may be explained in the missing 4.1.2 section.

<u>Reply:</u>

Thank you for pointing this out, this is indeed an excellent suggestion. The *f(x)* in equation 7 indicates a symbol of general function and it is equal to the following equations. There should not be *Srd(t),* and we missed *n* in *Srd(t)* here in equation7.And *n* here indicates one specific year. And it is our fault to make you confused about 4.1.2 section. We will correct this and clarify all the variables clearly and consistently in a table in the revised manuscript.

<u>(4) Reviewer Comment:</u>

As pointed out by another reviewer, the abstract is too long. The three paragraphs are actually telling one thing, that is, the three hypotheses and the related to them. I also suggest the authors to change the expression of the hypotheses to the form of scientific question, at least for the first paragraph of abstract. I was really confused when I read the second hypothesis for the first time because it was contradictory to the title, and finally I realize that it is just a hypothesis which is rejected later. I think express them more straightly could help readers get your main conclusions more easily.

<u>Reply:</u>

We completely agree with this suggestion. We will reformulate concisely our abstract to make it shorter and clear in the revised manuscript.

<u>(5) Reviewer Comment:</u>

For the Sumax determined by hydrological model, the authors regarded all parameters on the pareto front as feasible. However, there are some extremely low values for some metrics such as NSEQ and NSElogQ. I think it would be better to select the behavioral solutions based on the threshold of each metric for analysis. Also, I would like to suggest the authors to present the metrics for each subperiod produced by scenario 1, *and that for the whole period T produced by scenario 2 in Table S3, to allow for a direct comparison between two scenarios.*

Reply:

Thank you for pointing this out. Although we presented all feasible pareto front solutions to show the uncertainty of our model, we already chose the most balanced solution based on the overall performance metric described by the Euclidian distance (DE) (see 4.3.1 section). In any case, the choice of which solutions to keep as feasible will always have to have a subjective aspect. In particular, for sets of Pareto optimal solutions there are multiple ways to deal with that as in detail described by e.g. Efstratiadis and Koutsoyiannis (2010) or Gharari et al. (2013). We deliberately chose to use all solutions on the Pareto front to obtain a conservative estimate of uncertainty.

We will clarify that in the revised manuscript and we will add the performance metrics for each time period based on scenario 1 in the revised supplement.

(6) Reviewer Comment:

Although the calculation and analysis are solid, the main conclusion of this paper is not so favorable for its publication. The results indicate that the change of Sumax neither controls the drainage/evaporate water flux partitioning, nor affects short term hydrological response dynamics, and considering the variation of Sumax also leads to little improvement in hydrological model performance. So a reader may question why we need to care about Sumax. I suggest the authors to add some open discussion on the significance of Sumax and its influence on hydrological cycle. Besides, given that the conclusion is different to some other studies, it is strongly recommended to discuss what factors determine whether the hypotheses 2 and 3 would be rejected, i.e., in what kind of catchments, considering the change of Sumax would improve model performance? This will make the conclusion of this paper more general and useful.

Reply:

This is an interesting comment. Indeed, the results in our paper imply that the temporal evolution of Sumax does not control variation in the partitioning of water fluxes and has no significant effects on fundamental hydrological response characteristics of the Upper Neckar basin during time period from 1953-2022 (see Conclusion section in the original manuscript). As the statements in our conclusion, we already said this conclusion is limited in our study basin, in a cool-temperature climate with ample summer precipitation. This combination does not only lead to rather low Sumax, but also implies that in such an environment, where sufficient precipitation is available during the periods of highest canopy water demand (i.e. highest EP, and thus summer) Sumax is of minor relevance: The much less pronounced effects on hydrological response we found in our analysis are a consequence of the rather low absolute magnitude of Sumax that remains below 115 mm in the study region. These low Sumax values reflect lower storage requirements in summer, due to a precipitation pattern in the Neckar basin that is more evenly spread throughout the year. In other words, the fact that here ~55 – 60 % of the annual precipitation falls in summer (Fig. 3f, k in the original manuscript) when it is needed most by vegetation due to high EP, removes the need for larger Sumax as water storage buffer to allow vegetation to survive. However, the lower the magnitude of Sumax, the more frequently storage deficits can be overcome by even rather small rainstorms and the less water is (or needs to be) stored. Even if the relative changes are similar between Bouaziz et al. (2022) in a somewhat more humid catchment and our study, abundant summer precipitation causes absolute Sumax fluctuations of less than ±20 mm over time in the Neckar. This in turn limits the influence of the changes on the hydrological response, which has wider implications on the use of models in the Neckar basin and potentially in other temperate regions with similar hydro-climatic characteristics (see 6.2 section). This in itself is already an interesting finding as it gives modellers process-based evidence that the use of time-invariant Sumax as model parameter will be also sufficient for meaningful predictions over at least the next few decades in such environment. However, it also needs to be expected that in more arid regions with less summer precipitation, where Sumax is higher (see e.g. Gao et al., 2014; Stocker et al., 2023) changes in Sumax will play a much more prominent role.

We totally agree that a more detailed discussion of which reasons cause the less pronounced effects in our study and potentially more pronounced effects in other environments will be helpful for the reader. We will thus expand on the discussion in the revised version.

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