

Associate Editor

Thank you for submitting a revised manuscript for consideration of publication at HESS. I have reviewed the revised manuscript as well as the reviewer comments. I agree with the reviewers that minor edits should be made before publication at HESS. Please respond to the referee reports as well as make the requested changes from the journal file review. I have pasted the journal file review requests below for ease:

We sincerely thank you for handling our manuscript. We would also like to clarify how we addressed your suggestion regarding Figure 6 during the first review round. At that time, following the suggestions from you and the reviewer, we tested a month-organized layout but did not include it because the seasonal evolution was less clear; however, we did not explain this consideration sufficiently. In the present revision, we provide this earlier attempt and also test a third layout in which the monthly distributions are directly overlaid without vertical offsets, following Reviewer #2's further suggestion. After comparing all three layouts, we find that the revised scenario-organized, vertically offset line format provides the clearest presentation and have therefore retained it. Please see our response to Reviewer #2, Comment 3 for details.

1. Please note that this symbol "dragger" is used to indicate deceased authors. Kindly use a different symbol in the author list of the manuscript if the next file upload request.

Revised.

2. With the next file-upload request, please add the name of the corresponding author next to their email address in the "Correspondence to:" section of the manuscript's title page.

Revised.

Reviewer #1

Review for revised manuscript “Progressive groundwater decoupling may drive a shift toward shallower and faster terrestrial water cycling” by Sun et al. for consideration in HESS.

I appreciate the authors’ efforts to address comments from the previous review—I think many aspects of the manuscript have been clarified and improved. I have a few remaining minor comments/suggestions on the revised manuscript.

Comments:

19: “intrinsic seasonal tendency” is vague. Perhaps just “seasonal effect” or “seasonal shift”? Throughout the paper, the word “tendency” is used a lot and can be unclear without enough context. I would suggest to revisit each instance of “tendency” and determine if a different word choice would be better or if more context is needed. For example, on line 421, I assume “reorganization tendency” is referring to the shift toward shallow flow paths and suppressed intermediate water age contributions—it would be clearer to say “reorganization of flow paths” or “reorganization of water age”.

Thank you for this helpful suggestion. We revisited every occurrence of “tendency” throughout the manuscript and replaced all 10 instances in the main text with more precise, context-specific wording. Please refer to lines 19, 25, 55, 75, 221–222, 365–366, 408–409, 431, 454, and 493. All line numbers cited here and below refer to the tracked-changes version of the revised manuscript.

140-146: Even though the objective is not on the specific drivers of greening, it may still be worth briefly mentioning what those drivers are to ground the reasoning for the greening scenarios/observed trends. “Such greening trends have various drivers, such as CO₂ fertilization, climate change, and land management.”

We have added this sentence to the main text (Lines 152–154).

Table 1: The table is not very informative beyond saying that there were 16 scenario combinations. Instead, the text could just say that each hillslope configuration (list each configuration) had four forcing scenarios (list each scenario), giving a total of 16 model scenarios. Alternatively, the values of parameters that were changed to achieve each scenario (K, LAI, slope, etc.) could be provided in this table (instead of just checkmarks). In the previous review, I had suggested providing a table for these parameters in an SI table. The authors summarized LAI values in Table S1, but I think it would be good to include all relevant parameters that were altered to achieve the different model scenarios-- whether in main text or SI is up to the authors.

Following the reviewer's suggestion, we removed the original Table 1, summarized the four hillslope configurations and four forcing scenarios (16 combinations) in the main text (Lines 167–170), and provided their parameter values in Tables S1a and S1b of the Supplementary Information.

Figure 7: I don't think my suggestion in the previous review was clear enough—it is difficult to compare the left and right panels because the “x direction” axes are flipped between the two. Would it be possible to switch the x and y axes on the left panels (a, c, e, and g) to be consistent with the right panels and previous figures (x direction of distance along hillslope on the y-axis)?

Following the reviewer's suggestion, we revised Figure 7 and updated its caption.

Reviewer #2

In my view, the presented study is a timely and relevant contribution of interest to the readers of HESS, and I really enjoyed reading the manuscript which is overall well-written. While the authors have satisfactorily incorporated most comments made in the first round of revision, I do have a few additional comments the authors may want to consider before final publication.

- Although the authors already suggested potential implications for real-world applications of their modeling study (L547-558), I am missing a short statement on the influence of spatial scales, i.e., different processes may dominate at different spatial (and temporal) scales (e.g., Blöschl & Sivapalan, 1995). How would the authors expect age distributions and their reorganization to potentially change when upscaling, taking their hillslope configuration as a baseline?

Reference

Blöschl, G., & Sivapalan, M. (1995). Scale issues in hydrological modelling: a review. *Hydrological processes*, 9(3-4), 251-290.

Thanks for this helpful suggestion. We have added a discussion of scale effects and the expected manifestation of the identified reorganization when upscaling from idealized hillslopes to real catchments (Lines 453–468) and cited the study suggested by the reviewer (Blöschl and Sivapalan, 1995). All line numbers cited here and below refer to the tracked-changes version of the revised manuscript.

- Related to my first comment, I am also missing a brief statement on the potential validation of findings when moving from the synthetic modeling case to real-world

application at the catchment scale (e.g., using water stable isotope observations as fingerprints of water origin?)

We have clarified that future work will combine different types of field observations to further validate our findings. Please refer to Lines 468–472.

- L455-462: I have difficulties relating this paragraph and its explanations to Figure 6. I assume one major reason that the other reviewers and the AE also emphasized is that the Figure itself is not quite intuitive to understand. I am wondering if it would be possible to overlay the different months (as the AE already suggested), but maybe as line plots with different colors representing the months (without filling).

Thank you for this suggestion. We compared three layouts:

(1) distributions grouped by forcing scenario. In this layout, we removed the filling, used a different colored line for each month, and slightly increased the vertical spacing between months. All monthly curves use the same probability-density scale and are shifted vertically only for visual clarity (revised Figure 6, reproduced below as Figure 6-1);

(2) distributions grouped by month, as suggested during the first review round (Figure 6-2); and

(3) distributions grouped by forcing scenario, with the monthly lines directly overlaid without vertical offsets (Figure 6-3).

Layout (2) made the seasonal evolution difficult to follow, whereas the extensive overlap in Layout (3) made changes in the distributions difficult to distinguish. Layout (1) provided the clearest representation of the seasonal changes, and we therefore adopted it for the revised Figure 6.

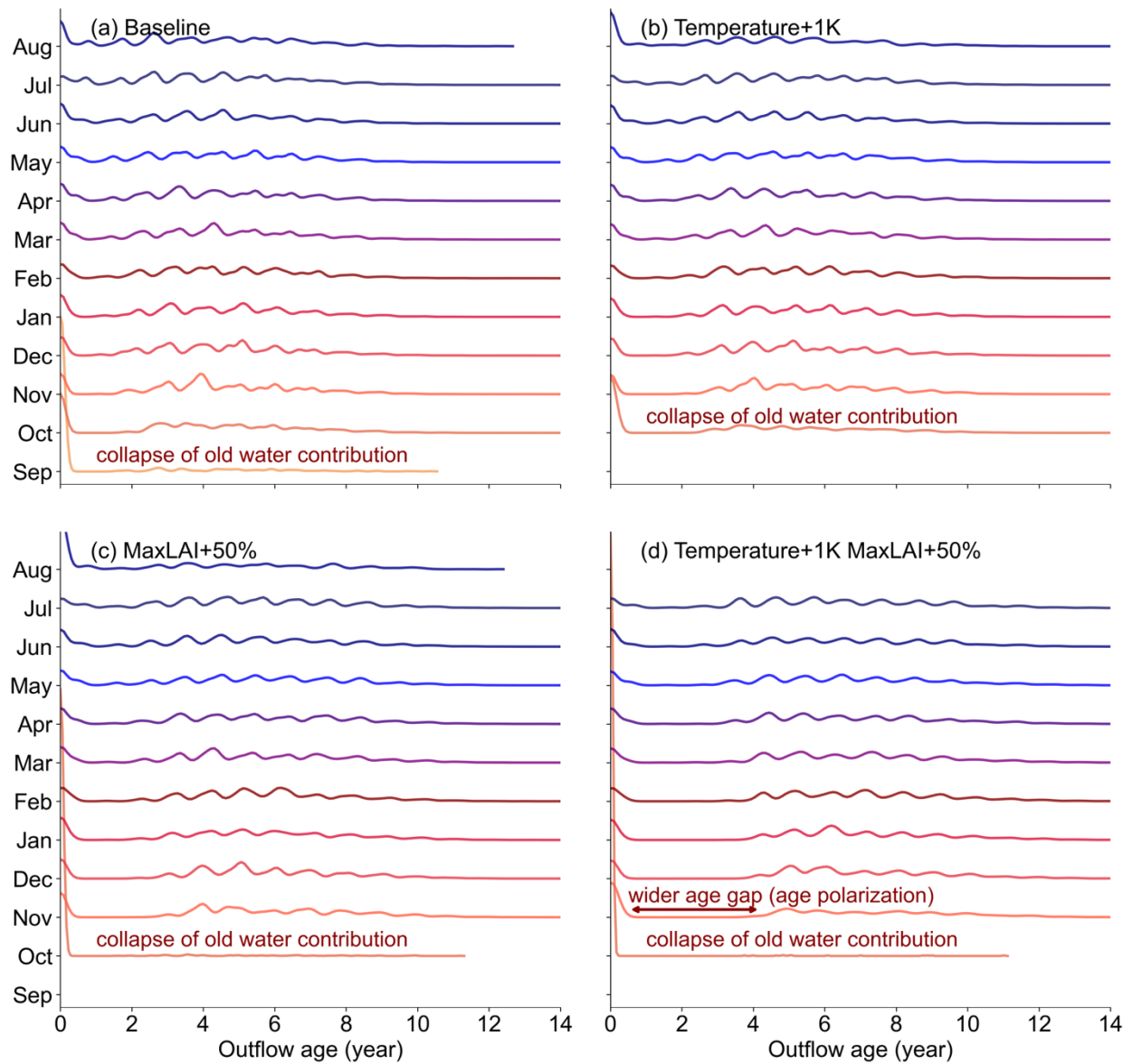


Figure 6-1

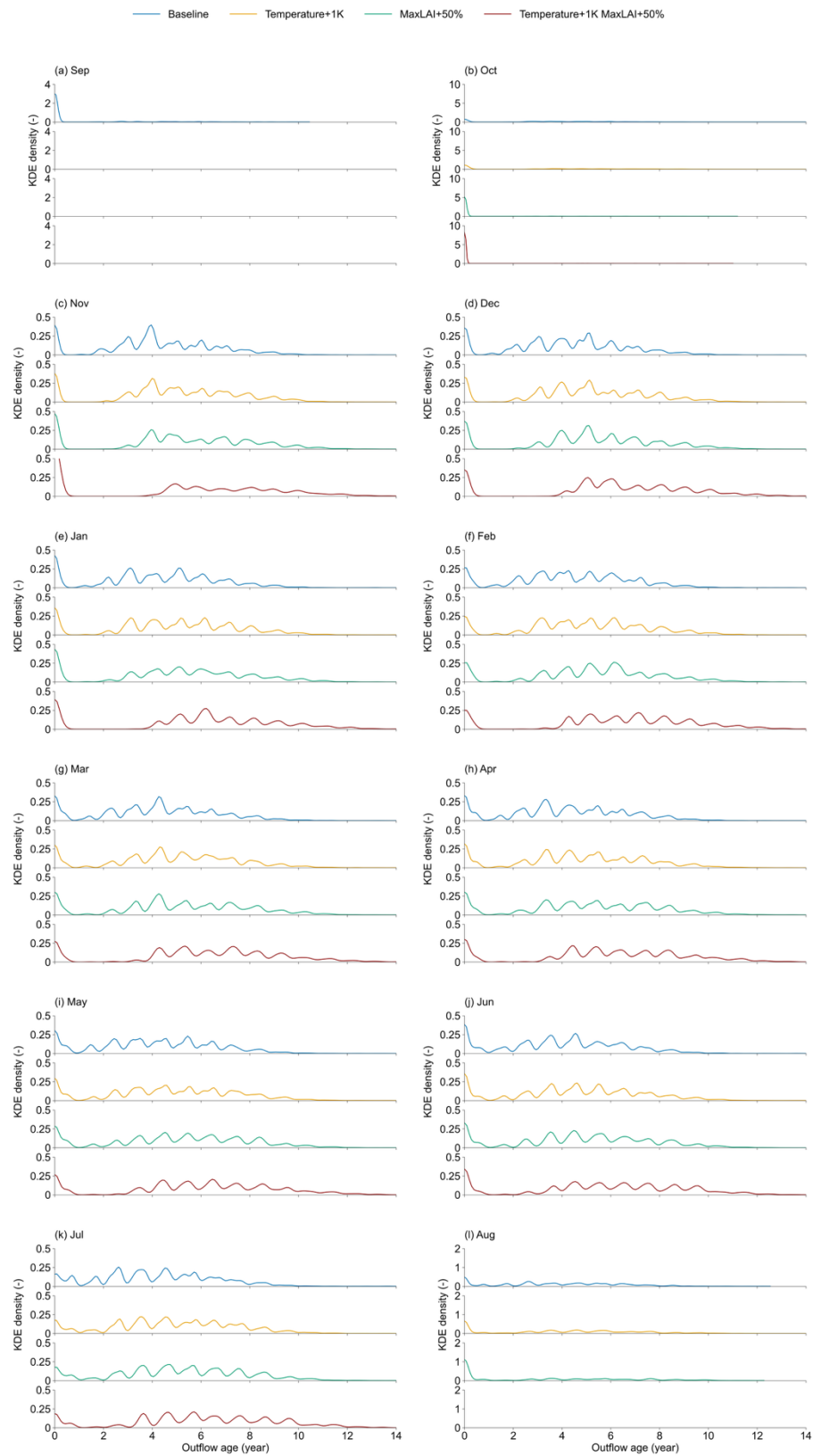


Figure 6-2

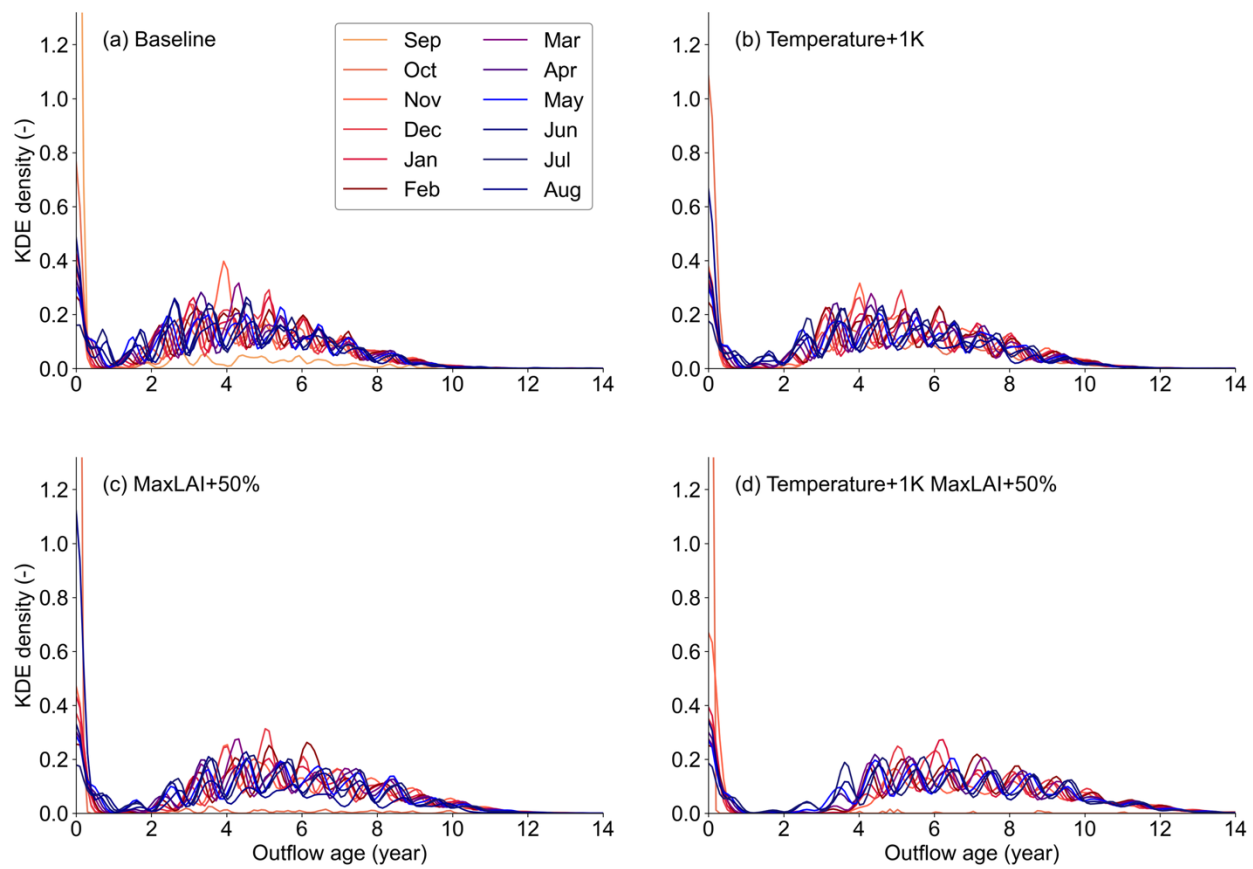


Figure 6-3