Added value of seasonal hindcasts for UK hydrological drought outlook
Response to reviewers

Reviewer #1

Summary: The paper demonstrates the use of seasonal hindcasts for creating outlooks of ongoing droughts of river flows and groundwater levels conditioned on atmospheric circulation patterns. These outlooks can supplement traditional weather forecasts for exploring a wider range of plausible outcomes. The demonstration is made on the 2022 drought. Among others, the results of the case study indicate that drier than average winters would result in the continuation of the drought with a high likelihood of below normal to low river flows by spring and summer.

General evaluation: Overall, I find that the paper is interesting, meaningful and very well-prepared with some room for improvement, which mainly concerns additional discussions that could be made. Specifically, I recommend minor revisions according to the comments provided here below.

Response: We thank the reviewer for their positive comments about the manuscript. We are glad to hear the reviewer finds the paper to be interesting. Our response to each of the minor comments is presented below (in red).

Specific minor comments

- Lines 63−64 state that "the Anglian region is particularly vulnerable to prolonged dry weather and droughts as it is the driest region in the UK". Maybe discussions could be added on whether and how the added value of the practical framework proposed is expected to deviate across regions and across climatic conditions.

Response: We agree that there could be more discussion on the applicability of this approach across different regions. We will make this clearer in the revised discussion section to emphasize that this approach can be applied across different regions and climatic conditions, but storylines created for other regions should be conditioned on various combinations of circulation indices that are relevant for rainfall patterns in that region. For this study, the EA pattern is influential for rainfall in the Anglian region, hence there is added value of incorporating seasonal hindcasts of the EA pattern in hydrological outlooks to understand plausible worst cases.

- Lines 305−318 discuss the value of the proposed framework by comparing its output for the case examined with the observed winter 2022/23. In my view, these discussions are important for the paper and maybe they could also be supported by one or more figures. For instance, Figure S7 could be moved in the main manuscript.

Response: The retrospective discussion of winter 2022/23 serves to show that there were still some concerns about water resources after winter 2022/23, and that a rainfall response similar to the winter that actually transpired is included within the larger sample of hindcast winters employed in this study. On the latter point, we will, as suggested, move Figure S7 to the main text as it shows that the circulation patterns observed for winter 2022/23 resemble winters in Cluster 1 of the hindcast winters.

It should be noted that we are not attempting to predict or forecast winter 2022/23. Instead, conditional storylines explore plausible worst cases that are possibly outside the range of historical years and enable water managers to prioritise or re-direct operational resources to prepare for such an outcome. Thus, we do not think that extensive discussion of the observed winter is required or warranted. We will make the aims of our study clearer in the introduction and methods section.

- Right after lines 305−318, extensive discussions (and maybe a figure as well) could be added to highlight the benefits of applying the new framework along with the use of traditional weather forecasts, instead of using such forecasts only, in the case examined.

Response: We will expand our discussion of the use of conditional storylines alongside traditional weather forecasts. Should the editor invite a revision, we propose to include an additional figure comparing the widely used ensemble streamflow prediction (ESP) technique with the results from each circulation storylines which should show that pooling seasonal hindcasts can enhance risk awareness as it encompasses a wider range of outcomes compared to the traditional ESP technique which relies on repeating historical years.

We also propose to place greater emphasis on the utility of conditional storylines to explore plausible worst cases in the revised discussion – i.e. how bad could the 2022 drought have been given a winter with specific atmospheric circulation patterns. Understanding plausible worst cases of the hydrological drought in advance is beneficial for water companies as they can prepare for both supply-side measures to increase abstraction or demand-side measures to increase water efficiency. As the large sample of pooled hindcasts cover a wide range of plausible outcomes, exploring storylines of an event in near real-time could also be beneficial for the environmental regulator (e.g. Environment Agency and environmental conservation organisations) as they can explore possible impacts to the natural environment from either prolonged river flow deficits or abrupt drought-flood transitions. From a user's (e.g. water resources manager) perspective, this approach is valuable as the skill of available forecasts, though continuously improving, are currently not perfect. Having the information on what a plausible worst-case might look like is therefore useful from a water management perspective for planning purposes.