

## **Review of “Storyline Analytical Framework for Understanding Future Severe Low-Water Episodes and Their Consequences” by Rondeau-Genesse et al.**

### **Summary**

This study presents an interesting analysis of streamflow droughts in Quebec using a storyline approach. The authors sampled for low-flow and severe drought events similar to the 2021 drought based on a range of metrics within hydrological simulations (HYDRTEL) driven by the CRCM5-LE regional climate model large ensemble. The authors find that drought analogues in a 2°C and 3°C world are drier with lower streamflow compared to 2021. This approach is a powerful way to communicate future changes in drought severity by anchoring analysis on a recent observed event and this study is a valuable contribution to an emerging body of literature on the creation of storylines for hydrological extremes. This article is well-suited for HESS and should be considered for publication after addressing the following comments. I hope my comments will help the authors improve their paper.

### **Comments**

1. Bias-adjustment of climate model: The authors mention that the detrended quantile mapping bias adjustment technique was applied for precipitation. It isn't clear whether the bias adjustment was applied to each ensemble member independently from each other? It is recommended that any parameters for bias adjustment applied to single-model-initial-condition large ensembles should be computed from the pooled ensemble rather than individual ensemble members to preserve the range of internal variability in the original ensemble. It would be good if the authors can clarify their approach.
2. Hydrological model: more details of the hydrological model would be appreciated. For example, was the model calibrated to observed streamflow in any way and what is the spatial resolution of the hydrological model? Were there any statistical downscaling methods applied to further downscale the large ensemble data prior to hydrological modelling? Related to this, would the authors be able to provide some indication of model performance compared to observed flows at gauges (e.g. in the supplement)? There should also be some discussion of the simulated river flows driven by ClimEx over the historical period – do they exhibit similar hydrological behaviour to observed river flows and where does observed flows lie within the wider range of ClimEx simulated flows?
3. SPEI calculation: Have the authors looked at how their results might change if the SPEI distribution for the future periods are fitted to the parameters calculated from the historical period? This could serve as a good sensitivity test for whether the decision to calculate SPEI separately for historical and future period is a valid approach.
4. Changes in drought analogues: as the authors note, there are interesting hydrological dynamics within the future analogues (such as changes in winter thaw and changes in the timing of low flow season) which deserves a bit more discussion. Could the authors provide a time series of P, PET and simulated flows for the baseline observed 2021 and for the top 10 future drought analogues (either at particular selected catchments or averaged)? The readers can then visualise these temporal changes easier.
5. Discussion: The current Discussion needs to be reframed. The section seems out of place and reads more like a separate literature review rather than an actual discussion of the results. Perhaps the authors could reframe this to link to the results of the paper (e.g. how these storylines can be used to further drive water quality models or how flow indicators from the drought analogues could be used to infer different drought impacts). Much of the socio-economic impacts of the 2021 drought could actually go in the introduction to highlight the severity of the event and motivate why the authors decided to choose the 2021 event as a

case study. There should also be further discussion of the utility of the storyline approach and future work (e.g. are there limitations to the storyline approach? How can such an approach be used alongside other climate change projection products?)

### Minor amendments

- IPCC (2023) should be cited according to the official suggested citation according to the IPCC:  
  
Lee, J.-Y., J. Marotzke, G. Bala, L. Cao, S. Corti, J.P. Dunne, F. Engelbrecht, E. Fischer, J.C. Fyfe, C. Jones, A. Maycock, J. Mutemi, O. Ndiaye, S. Panickal, and T. Zhou, 2021: Future Global Climate: Scenario-Based Projections and Near-Term Information. In *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 553–672, doi:10.1017/9781009157896.006.
- L80 – The authors may consider expanding the literature search and also refer to more recent studies which have also used an analogue approach to sample for drought/heatwave storylines – The following three studies may be useful, the first two for meteorological droughts and the third for hydrological droughts:
  1. Faranda, D., Pascale, S., and Bulut, B.: Persistent anticyclonic conditions and climate change exacerbated the exceptional 2022 European-Mediterranean drought, *Environ. Res. Lett.*, <https://doi.org/10.1088/1748-9326/acbc37>, 2023.
  2. Liao, Z., An, N., Chen, Y., and Zhai, P.: On the possibility of the 2022-like spatio-temporally compounding event across the Yangtze River Valley, *Environ. Res. Lett.*, 19, 014063, <https://doi.org/10.1088/1748-9326/ad178e>, 2024.
  3. Chan, W. C. H., Arnell, N. W., Darch, G., Facer-Childs, K., Shepherd, T. G., Tanguy, M., and van der Wiel, K.: Current and future risk of unprecedented hydrological droughts in Great Britain, *Journal of Hydrology*, 130074, <https://doi.org/10.1016/j.jhydrol.2023.130074>, 2023.
- L108 and elsewhere – there are several mentions of a questionnaire that was given to stakeholders to gather information on the 2021 drought and to disseminate results. More discussion of what the outcomes from this questionnaire should be given. Could the questionnaire be published in the supplement as well for transparency?
- L155 – what is MG24HQ?
- Font sizes in all figures could be bigger. Consider showing a subset of the results and putting other sub-plots in the supplementary materials. For example, Figure 3 could be simplified by including SPEI-3 averaged over May-Oct rather than each month separately (the monthly plots could go in the supplementary materials).
- The Limitations section should go within the Discussion section rather than Results.