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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Seasonality of hydrological model spin-up time: a case study using the Xinanjiang model" *by* Mohammad M. Rahman et al.

Anonymous Referee #2

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General Comments:

The authors present an analysis of model spinup time (defined here as the number of days for fully saturated and fully dry model initializations to converge) as a function of model run start season and modeled basin aridity. To explore this spinup time variability, they apply the conceptual Xinanjiang hydrologic model to 18 MOPEX basins, mostly located in the South-Central U.S. They find statistically significant relationships between aridity index and model spinup time, as well as variability in required spinup time depending on the start season of the model run. They also find that the seasonality of spinup time varies for "wet" and "dry" basins. Their study culminates in a well-defined exponential relationship between aridity index and spinup time that poten-

tially has relevance for other applications using a similar model configuration.

The authors make a nice case for the importance of model spinup in hydrologic modeling studies and the lack of consensus in quantitative methods and strategies for assessing model spinup. Their research question on the variability in spinup time based on climatic setting is an interesting one. However, I don't think the study in its current state addresses this question in a way that is relevant to the broader hydrologic modeling community. Specifically, I believe the authors should address the following key points:

1) What is the authors' working hypothesis for this study? What is the conceptual basis for expecting spinup time to vary based on aridity and season? Why focus on these two factors and not others, such as geophysical or biological conditions?

2) Model spinup can be a significant burden for hydrologic models covering large, distributed regions or highly complex physical process-based models, both of which can be computationally intensive. Lumped and conceptual models are often less expensive to run and therefore spinup time is less of a concern. I recommend that the authors make a better case as to why it is appropriate to use the conceptual Xinanjiang model applied to a small subset of individual basins to answer the broader question of what controls spinup time. If we do not expect spinup times to be similar for conceptual and physical models, would we expect the same climatic or environmental controls?

3) Following from (1) and (2), there are systems that are known to require longer spinup times, such as deep groundwater aquifers, large surface storages, etc. Is the study model configuration capturing any of these slower processes, or purely focused on shallow soil water storage? How appropriate is this model configuration for the study basins' dominant hydrologic regime? How generally applicable are the findings if these processes are not represented? I recommend the authors provide a bit more detail on the model and its appropriateness for the study basins.

4) How does the model calibration affect the results? The calibration procedure is a bit

difficult to understand based on the description provided, so I recommend going into a bit more detail on what was done and how it may/may not be impacting spinup times.

5) The authors present some interesting patterns in seasonality of spinup time. However, there is little discussion of the potential physical reasons for the patterns. Are these patterns simply mirroring seasonal patterns of precipitation? Are there other physical or climatic controls that might explain some of the spread, or help us determine how we can apply these results to other models or domains? I recommend expanding the discussion section to address some of these questions, which should give the paper a much broader relevance.

Specific Comments:

Overall: The paper is nicely organized and figures are clear. However, it would benefit from additional grammar/typo editing throughout the paper.

1. Introduction: Portions of the introduction section (e.g., lines 16-27) read more like methods than introduction. I would recommend moving these specifics on the model strategy to the methods section and dedicate a bit more of the intro to addressing the study hypotheses and rationale.

2. Materials and Methods 2.1 Study area: Why choose only snow-free basins? I would guess because the model does not represent snowpack dynamics, but this should be stated. Why these particular 18 basins? The basins are primarily in the South-Central US (with 2 exceptions), not distributed across the US. I recommend describing the hydrologic regime in this region so we understand some of the seasonal patterns better – what is the seasonality of precipitation? Is there deep groundwater storage? What controls the runoff response?

2.2 Xinanjian Model: The model assumptions and configuration are fairly important for this study, so I think more detail on the model description is warranted. For example, it is not clear whether this is a lumped or distributed model when applied to the individual

basins. What types of hydrologic systems does the model perform well in, and what types do poorly with this conceptual representation?

2.4 Parameters, Calibration, Validation: The calibration/validation procedure is not really described here, and is only vaguely described in the next section. I recommend expanding this section to detail the calibration/validation procedure so the reader can understand the potential sensitivity of the spinup results to the calibration.

2.5 Simulation Design: Per the previous comment, it is difficult to disentangle the calibration procedure and the spinup procedure based on the description provided. I recommend separating the descriptions and clarifying the procedures.

3. Results and Discussion: Per the general comment, I recommend adding discussion on the possible physical reasons for some of the observed patterns. As written, this section is really just results. SMM and its calculation should be better defined. The results really need to be related back to the model assumptions, climate regime, or physical basin characteristics to be relevant to other studies.

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