Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2019-7-RC2, 2019

Hydrology and Earth System Sciences
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Discussions

Interactive comment on "Representation of Water Management in Hydrological and Land Surface Models" *by* Fuad Yassin et al.

Anonymous Referee #2

Received and published: 24 February 2019

The paper "Representation of Water Management in Hydrological and Land Surface Models" presents a new scheme for representing reservoir operation in large-scale hydrological and land-surface models. The paper is relevant to HESS readership. It starts by providing a relatively good review of the reservoir operation algorithms both in operational and large-scale models, although several new contributions have missed (please see below just as a sample). The paper is well-written, particularly in the first two sections and the way different algorithms are classified is interesting because it provides a fresh perspective on taxonomy of existing reservoir operation models. The algorithm proposed is simple conceptually and therefore is suitable for the application suggested, although it may end up awfully over-parameterized, in the case of suggested configuration when storage/release thresholds are updated at each month.

This makes the algorithms very limited in scope because the data support for such parametrization is not available in many places of the globe, even in North America despite what mentioned in the paper. Overall, the paper makes a modest contribution to the discussion around representing reservoir operation in large-scale models by providing a new modeling hypothesis, however while the pros of the algorithm is well highlighted, the cons are not really discussed. In addition, I do not believe a new reservoir algorithm, which potentially requires a lot of parameters and cannot represent the dynamics of water withdrawals, can solve the diverse set of grand challenges embedded in "Representation of Water Management in Hydrological and Land Surface Models". As a result, I do agree with the Anonymous Referee #1 that the contribution made is largely oversold. Finally, some of the details in the modeling and results should be better summarized and very important implications, particularly on the trade-off between representing reservoir storage and release, should be better discussed. I suggest the paper undergoes major revisions to address the specific issues raised below:

1) The title should be changed: A new reservoir algorithm cannot solve all problems in representing water management in large-scale models.

2) Although pre-2015 contributions are covered relatively well, new contributions are largely overlooked. Please update the literature review. The contributions named below are just a very limited sample of important new contributions missed in the paper and are given only to help authors to start refurbishing their introduction and framing their algorithm in a wider context:

Pokhrel, Y. N., Hanasaki, N., Wada, Y., & Kim, H. (2016). Recent progresses in incorporating human land–water management into global land surface models toward their integration into Earth system models. Wiley Interdisciplinary Reviews: Water, 3(4), 548-574.

Hanasaki, N., Yoshikawa, S., Pokhrel, Y., & Kanae, S. (2018). A global hydrological simulation to specify the sources of water used by humans. Hydrology and Earth

System Sciences, 22(1), 789.

Ehsani, N., Vörösmarty, C. J., Fekete, B. M., & Stakhiv, E. Z. (2017). Reservoir operations under climate change: storage capacity options to mitigate risk. Journal of Hydrology, 555, 435-446.

Masaki, Y., Hanasaki, N., Biemans, H., Schmied, H. M., Tang, Q., Wada, Y., ... & Hijioka, Y. (2017). Intercomparison of global river discharge simulations focusing on dam operationâĂŤmultiple models analysis in two case-study river basins, Missouri–Mississippi and Green–Colorado. Environmental Research Letters, 12(5), 055002.

Solander, Kurt C., John T. Reager, Brian F. Thomas, Cédric H. David, and James S. Famiglietti. "Simulating human water regulation: The development of an optimal complexity, climate-adaptive reservoir management model for an LSM." Journal of Hydrometeorology 17, no. 3 (2016): 725-744.

Coerver, H. M., Rutten, M. M., & van de Giesen, N. C. (2018). Deduction of reservoir operating rules for application in global hydrological models. Hydrology & Earth System Sciences, 22(1).

3) Section 3.3: The authors suggest updating the storage/release parameters on the monthly scale to represent the seasonality: So should we end up with 72 parameters for a single reservoir?! Is this something really suitable for using in the context of large-scale models that have already a lot of parameters and face with scarce and low quality observations particularly in terms of human-water interactions? Because of being heavily over-parameterized, this scheme is only suitable where there are at least multiple years of continuous and high quality data available: Even in North America, such data availability is widely limited considering the discontinuity in in-situ measurements of storage and release across regional reservoir networks even in western Canada and US, where most of the case studies of this work are located. The fact that many large dams are privately owned and therefore the data are not publicly available is not mentioned anywhere in the paper: This is the particularly the case of large hy-

droelectric dams in US, Canada and Brazil that together account for large proportion of annual reservoir storage globally. Please discuss properly this important issue of the scheme along with other limitations of the proposed model at least with the same weight as its strengths. Highlighting the limitation of the proposed algorithm must be a key consideration during revisions.

4) Section 4.1: What are the uncertainties in the generalized parameterizations? The percentiles corresponding to monthly target storage and release should be different for different reservoirs and I can imagine that it might be several combinations of percentiles that can provide similar modeling efficiency even in one single reservoir: Please discuss and provide some evidence on the uncertainty in these generalized parameterizations.

5) Figure 11 shows an explicit trade-off between reservoir release and reservoir storage during calibration: This means that it is impossible to reach the skill in representing each objective function without compromising on the other, implying that the algorithm is unable to track both reservoir release and storage optimally at the same time: Isn't it a limitation in the model? How much this uncertainty contributes into uncertainty in identifying the role of reservoir in modifying the natural streamflow regime? This very important point seems to be wholly ignored at this stage and should be addressed in revisions.

6) Figure 11 again: It is surprising that the results during validation do not show the trade-off observed during calibration in several reservoirs: Doesn't this show that the parametrization is very sensitive to the period used for parameter identification? Also, the results during calibration are non-dominated by definition; however, do the results during validation also remain non-dominated when compared with other possible parametrizations that have been dominated during the calibration? The sensitivity of model parameters to training data and the robustness of results during validation should be well discussed during the revision and supported by experimental results.

7) Incorporation of the algorithms in the considered large-scale model seems to be limited to one reservoir at the time. Whereas in real cases, multiple reservoirs are built over one river and therefore the cal/val procedure and the skill of the reservoir algorithm should be tested when the outflow from one reservoir is the inflow to the next reservoir. The paper ignores this as many other similar contributions do. But I believe this is worth at least proper discussion because the challenge is out there and has remained, indeed, unsolved. Up to the time that the problem of considering multiple reservoirs in one basin is not properly solved, the results of large-scale models remain only as naive simulations of a virtual hydrologic reality at the basin-scale, which contributes to a huge uncertainty at regional, continental and global scales.

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