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Discussions

Interactive comment on "Comparison of Generalized Non-Data-Driven Reservoir Routing Models for Global-Scale Hydrologic Modeling" *by* Joseph L. Gutenson et al.

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Thank you for your thoughtful commentary! We will utilize your comments to clarify the applicability of this study and clarify our discussion of why we utilize the chosen reservoir routing schemes.

Response to General Comment #1: Though the majority of reservoirs in our study are primarily flood control, most are multipurpose and used for both flood control, irrigation, recreation, and hydropower. For example, the reservoirs along the Missouri River are also hydropower facilities. Interestingly, the Yazoo Basin Headwaters Projects are arguably more focused on flood control and yet the methods we use in this study are incapable of capturing the release behavior of these reservoirs. In order to broaden our evaluation to include a more diverse collection of dams, the authors would need historical inflow and discharge from for a comparable time period. We are not aware of any sizable databases that contain this information. Should this data exist to support this, the authors would gladly include this in their analysis. The authors will make it clear in the manuscript that the reservoirs in this study are almost exclusively multipurpose and perform more than flood control.

Response to General Comment #2: There are numerous studies that measure reservoir level fluctuations from space, many of these studies focus on measuring the areal extents of reservoirs, not predicting reservoir outflow. See for example Nguy-Robertson et al. (2018). The authors are aware of initiatives like Global Dam Watch referenced by the reviewer (e.g.http://globaldamwatch.org/) which provides precisely the type of information needed to implement the non-data-driven Doll & Hanasaki approaches, e.g. active storage volumes and total storage capacity. The majority of the more sophisticated approaches require site specific operational rule curves or training data which are not contained in the Global Dam Watch's GRaDv1.3 database which contains these attributes for 7,300 dams, a small fraction of the 38,660 dams geolocated in the GlObal geOreferenced Database of Dams (GOOD2).

We did not include the Burek et al. (2013) and Zajac et al. (2017) methods because of the strong assumptions that are made concerning storage capacity limits and naturalized streamflow thresholds (see lines 84-104) which are less parsimonious limiting their utility for forecasting. No doubt other approaches not included here could be more appropriate in certain contexts, however, the primary aim here is evaluating methods for use in hydrologic forecasting schemes applicable across the global domain. The authors do not assume that subsets of training data, i.e. historical discharge, are available to characterize operations, nor do they assume that real-time insights related to current reservoir levels can be known in a forecast setting. Non-data-driven methods are conceptualizations of reservoir operations that can be adapted to be a data driven approach but do not require training data in order to be implemented. We will alter the manuscript to describe that non-data-driven methods can be linked to statistical fitting techniques but that they are capable of being employed independent of such pairings.

Response to Minor Comment #1: We will go through the manuscript for any spelling or grammatical errors.

Response to Minor Comment #2: We will add these references to the manuscript.

Response to Minor Comment #3: This is true, Zajac et al. (2017) discuss this. GLoFAS is limited to 463 of the largest lakes and 667 largest reservoirs out of 33,000 large dams (>15 m high) registered with ICOLD. Limitations include 1) some information necessary for parameterization and validation of lake and reservoir routines is not available in the GRanD database suggested by two of the reviewers; 2) reservoir records for deriving case-specific operation rules (and related model parameters) are not readily shared. The two approaches (Doll & Hanasaki) are meant to address these limitations which contribute to considerable uncertainty around parameter values described by Zajac et al. (2018) that adversely affects model performance. We will correct this in the manuscript.

Response to Minor Comment #4: A decrease in Root Mean Squared Error is natural when model accuracy improves (i.e., KGE and R-Squared). The authors will add this information to the manuscript.

Response to Minor Comment #5: Calibration of the k coefficients would be better suited for the insertion of the Doll Method into a hydrologic routing scheme. The current study is investigating the feasibility of these methods and is a precursor to implementation in a large-scale hydrologic routing schemes. There is limited benefit to calibrating the k coefficients in this study, given that reservoir outflow information is rarely available at global scales to calibrate against so that calibrating the k coefficients operationally would be challenging without release records (see the discussion in Zajac et al. (2017) of an open access database for daily reservoir records). We will include these details within the manuscript.

References:

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Nguy-Robertson, A., May, J., Dartevelle, S., Birkett, C., Lucero, E., Russo, T., . . . Zentner, M. (2018). Remote Sensing Applications : Society and Environment Inferring elevation variation of lakes and reservoirs from areal extents : Calibrating with altimeter and in situ data. Remote Sensing Applications: Society and Environment, 9 (December 2017), 116–125. https://doi.org/10.1016/j.rsase.2018.01.001

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