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Comment on hess-2021-518

Anonymous Referee #2

Referee comment on "Unfolding the relationship between seasonal forecast skill and value in hydropower production: a global analysis" by Donghoon Lee et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-518-RC2, 2022

The paper contributes a global analysis about the value of long-term forecast for hydropower reservoirs. Specifically, the authors contrast the performance of three alternative operating schemes, basic control rules, perfect forecast-informed, and realistic forecast-informed. The latter use forecast information generated with a statistical prediction model based on four large-scale climate drivers along with local drivers (inflow and soil moisture). Results obtained for 735 hydropower reservoirs show that most dams could benefit from perfect forecasts, with these gains that strongly depend on dam characteristics; only a small number of dams however attains a performance improvement when realistic forecasts are used. The topic of the paper is absolutely timely and important, and fits nicely within HESS scope. The numerical analysis is robust and well designed, and the manuscript is clearly written. Overall, I think the paper could be a strong contribution to the ongoing debate about the relationship between forecast skill and value. Below I'm suggesting a few points to further improve the paper before accepting it for publication.

1) the description of the dam inflow prediction model in section 3.1 is not totally clear:

1a. I did not understand is the determination of the optimal set of lead-months at line 155. Does this mean that, for each station/HP reservoir, you constructed 7 forecasts (i.e. M1 to M7) and then selected the best lead-time as the one characterized by the minimum MSE? If this interpretation is correct, how can you then run a Model Predictive Control with a 7-month prediction horizon in case the best lead-time is shorter than 7? Moreover, since forecast accuracy generally decreases with lead-time, how likely will be then selecting a lead-time longer than one month?

1b. at line 142 the authors mention the generation of streamflow forecast for 1,200 stations, but the HP reservoirs are 735. why are you generating a higher number of forecasts wrt the reservoirs? moreover, is it correct to say you built 1,200 independent forecast models, one for each station, right?

1c. at line 138 you say that state-of-the-art physically-based forecasts fall short on lead-times up to 7 months, but actually these lead-times are covered by existing products such as ECMWF seasonal forecasts available on the Copernicus Data Store. I would thus recommend to better contextualize this point.

2) the labeling of dams in success/failure (section 3.1.1) based on the comparison of IPF against the average IPF raises the following question: while the definition of IPF implies that forecast-informed operation is beneficial when IPF>0, I don't understand why a failure (i.e. IPF < mean(IPF)) implies that basic control rules and perfect forecast-informed operations generate similar amounts of hydropower (lines 251-252). According to this condition, I guess a dam can be classified as failure even if IPF > 0, right?

3) while I fully trust the statistical forecast model used by the author, I think the paper could benefit from some benchmarking of the resulting forecast skill against existing, physically-based forecast products. this is likely not necessary for all the models, but it could be a useful, complementary information for some representative cases, possibly selected across different climate regions.

4) the results show how the overall value of forecast information for hydropower production is (unfortunately) relatively small. Did the author consider how much is the potential influence of the experimental settings, particularly in terms of (A) informing the operation with monthly inflow forecasts and (B) assuming the reservoirs are operated to maximize total (or average) hydropower production. About (A), the work by Bertoni et al. 2021 shows how some reservoirs could benefit more from predicting the inflow peak over a given horizon, rather than the average inflow, as this information is useful in hydropower operations to avoid spilling water. About (B), I was wondering if in this context the maximization of the firm energy could benefit more than the maximization of total production as it is more related to extreme conditions.

MINOR:

- in eq. 2c, the mass balance equation includes the evaporation losses. where are these data coming from?