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Interactive comment on "Value of seasonal streamflow forecasts in emergency response reservoir management" *by* Sean W. D. Turner et al.

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R: The paper contributes to a better management of storage reservoirs by the use of (synthetic) seasonal forecasts. A major focus of the work is the assessment of the impact of different operating policies (emergency response versus continually adjusted) in combination with forecast of different forecast skills. The general setup of the experiments addresses the long-term operation of a reservoir system (monthly time steps) in application to a drought management.

R: **General comments:** The research topic is highly relevant. The practical value of seasonal forecasts, either by the classical ESP approach or weather models, needs validation in application to the management of water resources. The presented methodology seems to be a suitable tool to address the skill of actual or synthetic sea-

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sonal forecasts, furthermore, the authors address approaches to generate synthetic forecasts with defined skills to conduct systematic experiments.

A: *Thanks for the positive feedback.*

R: **My main doubts are as follows:** The classification of “continually adjusted” and “emergency response” objectives is misleading and gets the paper into a wrong direction. In the way implemented, the “continually adjusted” objective is a constant setpoint (75%, see page 6, line 25) for the reservoir storage. This is a very unlikely parametrization for a storage reservoir with water supply objectives and an annual hydrological cycle. The motivation of such a guide curve is to shift water from the wet to the dry season in order to guarantee a reliable water supply under consideration of an uncertain, variable yield. On the other hand, the “emergency response” objective has the character of a (soft) constraint. Both are incomplete if used exclusively and actual reservoir operation typically include both elements among others for flood control, recreation, hydropower etc.

A: *We agree that the terms “continually adjusted” and “emergency response” are inapt, and in response to this comment (and the comments of Reviewer 2), we will change the terminology we use to describe the operating objectives. Rather than referring to the reservoirs as “continually-adjusted” and “emergency response”, we’ll use refer to “level objective” and “supply objective” (or similar). We also agree that reservoirs are typically multi-objective, requiring releases that consider both supply and other objectives. Our aim here is to show how those different objectives affect the value that might be gleaned from a forecast applied to the operation of a reservoir. The cleanest way to do this in an experimental set up is to separate the operating modes into two classes and then compare the performances using identical forecasts.*

R: After the introduction into seasonal forecast, the synthetic forecast used in the experiments are disconnected from the actual products available. You should address the skill of actual seasonal forecast products as a benchmark for the synthetic forecast used.

A: *We failed to mention that the two sets of forecasts are not entirely disconnected. The error structure embedded in the synthetic forecast model is trained using a member of the FoGSS forecasts. This ensures that even though the forecast is synthetic, its decay with lead time is realistic. We will expand the description of the synthetic forecast model to clarify these details in our revision.*

R: The paper may get published after major revisions. My advice is to give up the classification of “continually adjusted” and “emergency response” objectives and focus on the added value of seasonal forecasts of various skills in application to the reservoir management application.

A: *In response to this comment (and those made by reviewer 2), we propose to make the distinction between the two reservoir objectives in these simple terms: one objective targets constant storage by varying the release, the other targets constant release by varying the storage (or by allowing the storage to vary). This shift changes the role of storage from a target to a buffer, with consequent effects on forecast value that are brought out by our results. Rather than referring to the reservoirs as “continually-adjusted” and “emergency response”, we’ll use “level objective” and “supply objective” (or similar). Discussion will place more emphasis on the role of a storage buffer in obviating the need for accurate forecasts during much of the operation.*
We appreciate that a study into the added value of forecasts of different skills would constitute an interesting study. However, we feel that the originality of our work stems from the comparison of the operating types and in particular the surprising unpredictability of forecast value when applied to the supply objective.

Detailed comments:

R: Page 1, line 25: Do not forget the dimensioning of such a system, note that the storage volume of a reservoir is an explicit design decision.

A: *The context here is systems that have been designed and are already in operation. We'll change to "the performance of a given system depends on…"*

R: Page 2, lines 7-18: Very clear example of the misleading classification into "continually adjusted" and "emergency response". You address flood control as "continually adjusted", but drought management as "emergency response". You could turn it around with the argument that relevant floods occur only "every 20 years by design". This is misleading, because the typical reservoir operating policy will reserve both a free volume due to flood control, a minimum volume for water supply, both seasonal dependent.

A: *As noted above, we will change the description of the classification to highlight that the distinction is for a storage objective and a supply objective (rather than continually-adjusted and emergency response, which seems to have caused some confusion). Note for the storage objective, the operator is assumed to be unconcerned with maintaining supply, and vice versa. The typical policy of operating for both storage volume and supply is deliberately neglected, because we're trying to get at the influence of the operation type on the predictability of the forecast value in operation.*

R: Page 4, lines 10-16: Revise this paragraph. Spill should be included in Equation 2. Either use inflow or release volume consistently if you like to refer to a volume, or alternatively use inflow and release if this is in flow units, but them introduce a time step in the equations.

A: *We'll modified this as suggested.*

R: Page 5, lines 22-32: You refer to advantages of the SDP. But against what kind of other technique? Furthermore, this description is biased and it appears that SDP has no disadvantages at all.

A: *SDP is the conventional approach to design reservoir operating rules, so this is why we adopted it. There are multiple variants of SDP (such as approximate dynamic programming or stochastic dual dynamic programming; see Castelletti et al., 2010) as well as other approaches to reservoir operation (such as the parameterization-simulation-optimization framework; see Koutsoyiannis and Economou, 2003), which aim at improving the scalability of SDP to larger water systems. We understand that the paragraph might be biased towards the advantages of SDP, so we will discuss briefly about its main disadvantages.*

R: Page 5, line 34 -: This seems to be a deterministic technique only, please clarify.

A: *Yes, this is a deterministic technique that optimizes a sequence of release decisions using a (deterministic) forecast of the inflow process. We will clarify this aspect in the revised version of the manuscript. Justification for use of a deterministic approach will be included in section 4.1, where we intend to state that "operations are simulated using both the control rules and the deterministic model predictive control model using the median value from the full FoGSS forecast ensemble (i.e., we take the median of the ensemble at each lead time). While this ignores the spread of the ensemble, the chosen method provides a clear indication of the contribution of the forecast to the performance of the operation. In contrast, methods that use the spread of the ensemble require in the decision process are complex, often requiring arbitrary decisions by the user. This makes experimentation laborious and results hard to diagnose…"*

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R: Page 7, lines 1-3: Results do not belong in here.

A: *We think this is matter of stylistic preference, since the graphs presented are intended to justify the chosen objectives and do not show any result of either experiment executed. We'll either move this into a new results section or include a statement to the effect that the graphs are given merely to highlight the suitability of the operating objectives chosen.*

R: Page 8, line 20: Do you refer to Multi-stage Stochastic Optimization rather than Dynamic Programming? In the following, this paragraph reads more like a methodology section, not a results one.

A: *Thanks for picking this up—we meant Multi-stage Stochastic Optimization. The description of prior results will be removed.*

References

Castelletti, A., Galelli, S., Restelli, M., Soncini-Sessa, R. (2010). Tree-based reinforcement learning for optimal water reservoir operation. *Water Resources Research*, 46(9).

Koutsoyiannis, D., Economou, A. (2003). Evaluation of the parameterization-simulation-optimization approach for the control of reservoir systems. *Water Resources Research*, 39(6).

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