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Hydrology and Earth System Sciences
Discussions

# *Interactive comment on* "Reliability, sensitivity, and uncertainty of reservoir performance under climate variability in basins with different hydrogeologic settings" *by* C. Mateus and D. Tullos

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We are extremely grateful to reviewers for their thorough and extremely helpful reviews. The attached manuscript represents major revisions made in response to the three reviewers' comments. These revisions are documented in detail in the notes below. We believe the manuscript is greatly improved as a result of responding to reviewers' concerns, and are very grateful for their thoughtful and comprehensive reviews. To help reviewers we have submitted two versions of the manuscript; one with tracked changes



(in blue) and a finalized "clean" version.

General comments:

1) The authors cite two papers (Rosero et al., 2010; Surfleet and Tullos, 2013) that show that "uncertainty for groundwater basins (. . .) is likely a result uncertainty associated with transfer of model parameters in the groundwater model." But those fundamental questions do not get addressed in the required detail. Therefore the suggested unpredictability of water resources in basins with substantial groundwater interactions can not be verified properly.

We agree with the reviewer that the uncertainty associated with the groundwater model was not adequately addressed in the original manuscript. We have added on the model fit (page. 10, lines 10-15). More substantially, we have added text, interpretation, and references in the Discussion around the uncertainty of the groundwater models (page 24, lines 5-19).

2) In conclusion the overall scientific contribution of the work is low. The authors use well-known models in a classical model chain. The more challenging part, the Bayesian approach DREAM, is not discussed at all. Only a reference is given, thus limiting the self-independence of the work.

We originally wrote the manuscript to be concise and provide only essential information to understand impacts of the modeling on the results. However, in this revised version, we have added content on the eight GCMs from which we acquired the temperature and precipitation projects (page. 8, lines 4-7), the selection of GHG emission scenario (page. 8, lines 7-11), the downscaling method (page. 8, lines 11-17), hydrologic model development (page. 8, line 18 to page. 9, line 30), model calibration and fit to observations (page. 10, lines 10-15).

We included more information about the algorithms underlying the DREAM analysis (page 8, lines 23-29) and about the development and transfer of parameter distributions (page 9, lines 10-27).

In addition, we clarified the novel contributions of this work (Page 4, lines 1-12), and have added a figure (Fig. 13) and discussion (page 24, line 20 to page 25, line 3) on the transferability of the results.

3) Limitations in the quality of the work restrict its usefulness as a case study regarding questions of climate change impact on water resources. The reviewer can therefore not recommend to accept the work. The reviewer recommends to work on the following issues: Since the assessment of the future water resources and its uncertainties is a vital part of the work, it needs to be clear how the inflows to the reservoir model are modeled.

We have added substantial detail regarding how inflows and their uncertainties are estimated. Please see responses to comment #3 above.

4) Crucial information about the climate change scenarios are missing. Which GCMs are used?

We added information about the eight GCMs used in this study. Please see to page. 8 lines 1-3.

5) Quantify the uncertainties of the ensemble. Using only the ensemble mean can reduce the overall uncertainty thus underestimating it. Why was only the ensemble mean used? For good reasons to do so, provide a discussion. The ensemble mean likely will impact the evaluation of the floods and their frequencies.

We extracted the 2.5, median, and 97.5 percentile values from each range of model output for each of the 8 GCMs. These are meant to be points of interest for the distribution of model outputs. We applied the ensemble mean for the three distributional points from the GCMs because running the reservoir operation simulations for three distributional points for each of the eight GCMs and two GHG emissions scenarios was beyond the available computational resources available to us. This explanation



has been added in the text (page. 9, lines 25-29).

6) Provide details about the Delta-Hybrid method, this seems to be a critical step in the model chain.

We added more details about the Delta-Hybrid methods and its advantages (page 8, lines 7-13).

7) The discussion on the hydrological modelling is very limited. Please provide discussion about calibration and validation. How did the models perform?

We have revised the text to provide additional detail on the hydrologic model development (page. 8, line 18 to page. 9, line 30) and model calibration and fit to observations (page, 10, lines 10-15).

8) No details at all were given about the VIC model. What are the differences between the models? What parameter sets where calibrated? What are the possible effects of using two very different models (with different sets / numbers of parameters) on the overall predictability?

We agree with the reviewer that more information about the VIC model was needed. We added more information about the VIC model projections (page 10, line 16 to page 11, line 2) and how the two datasets were matched based on water year (page 11, lines 3-9), and potential impacts of combining the two models (page 25, lines 17-27).

9) What is DREAM and how was it used? Why was DREAM only used for GSFLOW model? The cited paper does not help that much and the citation seams wrong.

Please see response to comment #2 above. As noted in the text (page 8, lines 18-21), GSFLOW projections are available only for the Santiam River Basin.

All the citations have been revised for the new version.

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 13891, 2014.

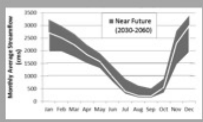
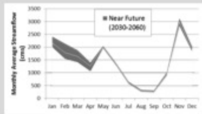
| Reservoir Network | **North Santiam (Detroit-Big Cliff reservoir system)** | **South Santiam (Green Peter-Foster reservoir system)** |
|---|---|---|
| **Hydrogeology** | High permeability, deep aquifers and springs<br>(90% High Cascades, 5% Western Cascades, 5% Alluvium) | Low permeability, low connectivity to aquifer<br>(95% Western Cascades, 3% Basalt, 2% High Cascades) |
| **Dominant Water Source** | Substantial groundwater recharge<br>Sustained baseflows | Shallow subsurface and surface flow<br>Rapid runoff response |
| **Precipitation Pattern** | Rain and Snow precipitation at Detroit reservoir (477 m)<br>25% of the basin (507 $km^2$) located in the snow precipitation area (>1,200 m) | Rain precipitation at Green Peter (310 m) and Foster (165 m) reservoirs.<br>6.5% of the basin (176 $km^2$) located in the snow precipitation area (>1,200m) |
| **Sensitivity to Climate Change**<br>**Response relative to historical**<br>**Across basins** | Winter: Increases, Higher<br>Summer: Decreases, Lower | Winter: Increases, Lower<br>Summer: Decreases, Higher |
| **Uncertainty across basins** | Higher winter and summer uncertainty<br><br> | Lower winter and summer uncertainty<br><br> |
| **Impacts on Reservoir Reliability across basins** | Higher uncertainty in meeting summer flow targets | Higher frequency of failures in meeting summer flow targets. |

**Fig. 1.**