

Interactive comment on “On an improved sub-regional water resources management representation for integration into earth system models” by N. Voisin et al.

Anonymous Referee #6

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Dear Editor and Authors,

With interest, I have read the manuscript by Voisin et al. The authors investigated generic reservoir operating rules for global and macro-scale hydrological models. They set up a hydrological model with such rules developed by Hanasaki et al. (2006), Doell et al. (2009), and Biemans et al. (2011), and applied it to the Columbia River Basin. First they compared the simulated results with observation for river flows, reservoir storage, and water use. Then, they proposed a new generic reservoir operating rule for multi-purpose reservoirs in snowmelt controlled regions and found it performed well in the basin. Finally, they compared the methodologies to calibrate the rules that were

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proposed in earlier literature.

More than 45,000 large dams have been constructed in the world, the modeling technique of reservoir operation for global and macro-scale hydrological models is still in its infancy. The draft paper reports some interesting findings of this field. The advance of reservoir modeling has been largely hampered by the complexity of problem and the availability of data for calibration and validation. The draft paper is unique and valuable because it reports the results of modeling exercise in the Columbia River Basin, one of the most data-rich major river basins in the world.

The paper is well written and structured. Particularly, the Introduction and Method Sections summarize the earlier works excellently. However, I got an impression that the Results and Discussion Sections could be further organized and deepen (see below for details).

Specific comments

Page 3504, line 14: “Doell and Lehner (2009)” reads “Doell et al. (2009)”.

Page 3506, line 25: I think one more question should be added at the beginning of questions: How well does the existing generic reservoir operation rule perform in a specific basin? Actually, the Results Section starts with answering this question. Indeed this is a quite important scientific question since both Hanasaki et al. (2006) and Biemans et al. (2009) used global hydrological models. Calibration of their models and validation of their simulation were more or less insufficient.

Page 3509, lines 1,6: “Grand” reads “GRanD”.

Page 3509, line 15 “(historical simulations obtained from Elsner et al., 2010) with parameter calibration...”: The Columbia River Basin includes irrigated area and its river flow is regulated by reservoirs. Does VIC include irrigation process? Did VIC use river flows when it was calibrated? If it was the case, were the effects of reservoirs and water withdrawal excluded from the observation? I’m interested in these points because the

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parameter of VIC might include some of these effects.

Page 3511, line 21 “Hanasaki et al. (2006) defined...”: Just a very minor correction. Hanasaki et al. (2006) describes “We set the maximum distance as grid intervals below the reservoir, approximately 1100 km downstream, or the distance traveled by released flow in a month (river flow velocity was set at 0.5 m s⁻¹ or 1300 km mo⁻¹).”

Page 3512, line 4 “In Hanasaki et al. (2006), grid cells can request water from only one reservoir”: Again a minor correction. Hanasaki et al. (2006) allowed grid cells to request more than one reservoir by introducing a coefficient *calc*. They described as “where *calc* is an allocation coefficient for grid-squares that had more than one reservoir upstream; *calc* is proportional to the mean annual inflow from upstream reservoirs, and *calc* is 1 if the grid point has only one irrigation reservoir upstream”.

Page 3513, line 4: Remove “yr”.

Page 3516-3521, Results Section: It would be further readable if the sub-sections of Results Section correspond to the scientific questions raised in the Introduction Section. I got an impression from the current form of manuscript that the questions are answered in different order and sometimes the answers are mixed up for more than two questions.

Page 3516, line 21, “Highest priority rule: irrigation or flood control or combined priorities”: It could be more readable if the authors specify the combination of equations for each here. For example, “Highest priority rule: irrigation (combination of Eq 3 and Eq 5) or flood control (Eq 4 and Eq5) or combined priorities (Eq 3 and Eq 6)”

Page 3519, line 14, “Demand and supply”: It would be more consistent if it is “Demand and supply validation”.

Page 3522, lines 12-16, “A more sophisticated...” This sentence is too long. Anyway, here is just a related comment. In case of grid-based simulation (and most likely sub-basin-based simulation as well), trans-grid-cell water transfer becomes critically

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important as the spatial extend of grid-cell getting finer. Otherwise, the grid-cells next to main stems become unrealistically prone to water scarcity.

Page 3523, lines 14-: The reservoir operation model used and discussed here is heavily influenced by the formulations of Hanasaki et al. (2006). Since their formulations were designed for the combination of natural-flow and water-withdrawal, it could be no surprise it performed best among combinations.

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