

***Interactive comment on “Multi-criteria parameter estimation for the unified land model” by B. Livneh and D. P. Lettenmaier***

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We thank the editor, Dr. Bettina Schaeefli, for the constructive comments. We respond below to the comments in the order they were raised.

-We have added details regarding our handling of cases where different criteria show tradeoffs. We have retained the multi-objective structure, however we have attempted to more clearly state the necessary assumptions for comparison among the single and multi-criteria calibrations.

-We have expanded the text to better explain our rationale. Our primary objective in this manuscript was to compare among various calibration criteria (e.g. Q, ET, TWSC) for

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their utility in improving simulations of surface hydrology. In this sense, it is not really a requirement to select a “single best parameter set”. However, to facilitate comparison in model performance when calibrated towards the various criteria, it is convenient to select a “single best value” for each, rather than simply a likelihood, or a range. We now clarify this perspective in the text.

-We agree with the editor’s comment and have added a discussion describing the inherent difference in the information content between the three variables (Q, ET, and TWSC).

-We now discuss briefly the observational uncertainty and the problem of commensurability (among criteria) to the corresponding discussion.

-We have added a reference to Schaeefli and Gupta, 2007. In addition, we have added a discussion (including a citation), cautioning the reader to interpreting the NSE comparison for the major reasons, e.g. function of target observation variability, lacks simulated vs. observed comparison in absolute terms. Nonetheless, we argue that the methodology used here could be easily modified to include other performance metrics.

-This point has been clarified in the text. The role of the Pareto front in the paper was to identify a set of model parameters that are optimized with respect to multiple (3) objective functions, given the desire of comparing model performance when optimized towards single, or multiple criteria. Of course, each parameter set on the Pareto front will have inherent tradeoffs. To facilitate comparisons against other single, or multi-criteria optimizations, we opted to selected a single parameter set from each Pareto front as a means of describing the efficacy of that particular optimization. This of course, could have been done following a minimum Euclidian distance approach, or based on some metric describing the range of performance(s) among Pareto members. Our approach was most similar to the former, in that we gave equal weighting to each objective function (3) to select a single-representative model performance (NSE in this case) from each optimization.

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-We have replaced the former discussion of calibration improvements using more than one reference signal with a more concise discussion. This finding is likely due to the imposed constraint on the number of iterations in the optimization scheme; wherein, an additional signal has the potential to direct the parameter search towards more optimal areas within the parameters space.

-We thank the editor for this insightful suggestion and have added this to our discussion.

-We have removed mention of travel times from the conclusions

-The caption has been updated to read “improvements with respect to a priori model performance”.

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